

# **ROLLYU** PRECISION



## **SHEET METAL FABRICATION HANDBOOK**

## **Chapter 1: Introduction to Sheet Metal Fabrication**

- Definition and history-----4
- Advantages of sheet metal vs. other manufacturing methods-----5
- Key applications in medical devices, robotics, electronics, and automation--7

## **Chapter 2: Rollyu Precision Overview**

- Company strengths: ISO 9001 & ISO 13485 certified-----10
- Industries served: medical, photonics, life sciences, robotics, semiconductor--13
- Differentiators: tight tolerances, full-service capabilities, fast turnarounds--14

## **Chapter 3: Materials & Material Selection**

- Common materials used:-----16
  - Stainless steel (304, 316)
  - Aluminum (5052, 6061)
  - Cold-rolled steel (CRS)
  - Galvanized steel
  - Titanium, Copper alloys
- How to choose based on application, corrosion resistance, strength, weight, cost--20

## **Chapter 4: Fabrication Processes at Rollyu**

- **Laser Cutting**
  - Material thickness limits-----24
  - Tolerances & edge quality-----26
- **CNC Bending**
  - Bending radii, bend relief, springback-----30
  - K-factor and design tips-----32
- **Welding (TIG/MIG/Spot)**
  - Suitable materials, heat-affected zones-----34
- **Tapping & Threading-----39**
- **Deburring & Edge Treatment-----42**
- **Surface Finishing**
  - Anodizing, powder coating, bead blasting, plating-----46

## **Chapter 5: Design for Manufacturability (DFM)**

- Optimal bend radius guidelines-----69
- Hole-to-edge and hole-to-bend distance-----74
- Tab-and-slot design tips-----78
- Tolerance recommendations-----82
- Countersinks-----85
- Fastener options: PEMs, rivet nuts, welding studs-----89

## **Chapter 6: Quality Control & Inspection**

- Tools used: CMMs, height gauges, pin gauges-----93
- Critical dimension checks-----100
- Weld integrity inspection-----103
- Surface finish standards-----106
- Full traceability with ISO certification-----109

## **Chapter 7: Application Examples by Industry**

- **Medical Devices:** equipment enclosures, chassis, support structures--112
- **Semiconductors:** EMI shielding, brackets, control panels
- **Photonics:** optical instrument housings
- **Robotics & Automation:** mounting plates, frames, custom sheet enclosures

**Chapter 8: Case Studies-----116**

- Use real projects to showcase problem-solving and manufacturing excellence

**Chapter 9: FAQs for Sheet Metal Projects-----118**

**Chapter 10: Getting a Quote-----121**

# Chapter 1: Introduction to Sheet Metal Fabrication

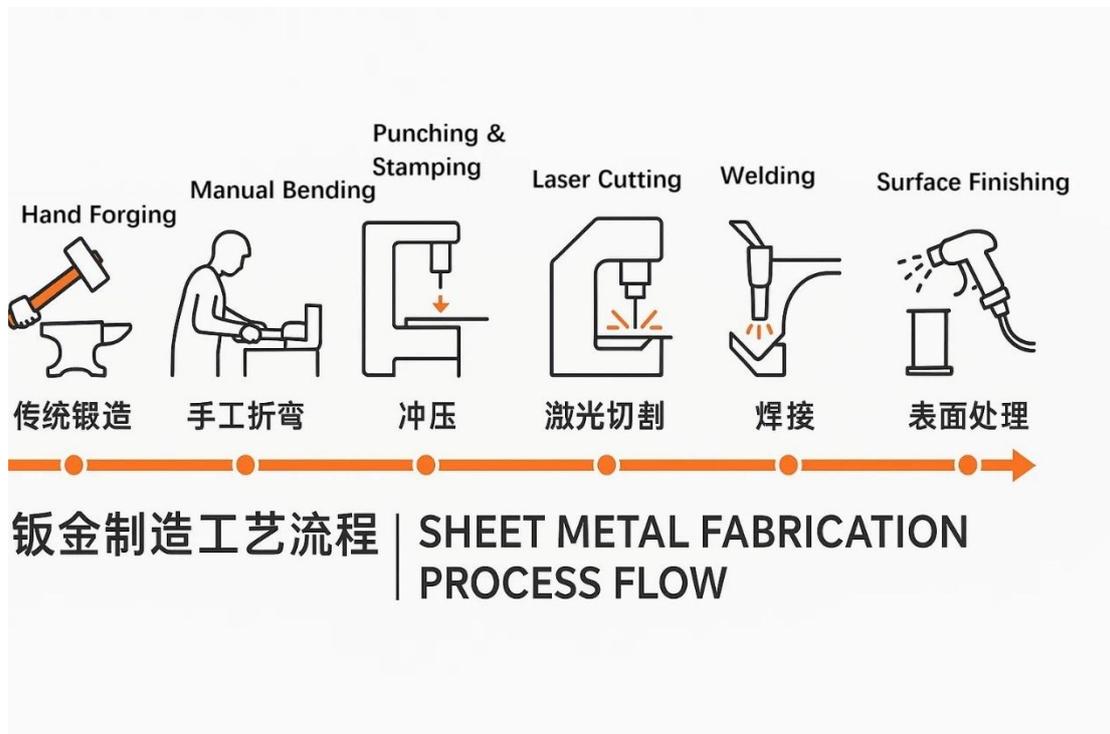
- **Definition and history**

## Introduction to Sheet Metal Fabrication: Where Precision Meets Versatility

Sheet metal fabrication transforms flat metal sheets into durable, functional components through cutting, bending, forming, and welding. This process supports a wide range of industries, from medical devices and electronics to aerospace and energy systems. At Rollyu Precision, we specialize in custom sheet metal fabrication, combining CNC laser cutting, press brake forming, TIG/MIG welding, and surface finishing to deliver high-tolerance metal parts with consistent quality.

Whether it's precision-cut housings for medical instruments, stainless steel brackets for automation systems, or aluminum enclosures for electronics, our fabrication services ensure tight tolerances, clean finishes, and scalable production. We work with materials including stainless steel, aluminum, copper, and galvanized steel—providing options for corrosion resistance, strength, and thermal management.

Our laser cutting service offers sharp edge quality and minimal heat distortion, ideal for intricate geometries and complex profiles. Backed by ISO 9001 and ISO 13485 certifications, Rollyu delivers reliable metal fabrication with full traceability and quality control.



- **Advantages of sheet metal vs. other manufacturing methods**

Sheet metal fabrication offers numerous advantages over other manufacturing methods, including cost-effectiveness, high accuracy, fast turnaround times, and versatility in design and material choices. It's also known for durability, strength, and ability to be easily customized.

In today's manufacturing landscape, speed, flexibility, and scalability are essential. For engineers, product designers, and OEMs, **sheet metal fabrication** offers a powerful combination of precision, material variety, and cost-efficiency — all without the need for expensive tooling or long setup times. At **Rollyu Precision**, we specialize in **custom sheet metal fabrication** and provide end-to-end support from **metal laser cutting** to final assembly.

But what makes **sheet metal fabrication** a better option compared to CNC machining, die casting, or plastic molding? Let's explore the core advantages and applications across industries.

Feature	Sheet Metal Fabrication	CNC Machining	Die Casting / Molding
Tooling Required	None or minimal	None	High (dies/molds required)
Material Efficiency	High (nesting, minimal scrap)	Lower (subtractive)	High once tooling is made
Lead Time	Fast — ideal for prototypes & production	Moderate	Long (tooling creation required)
Design Revisions	Easy to change	Moderate	Difficult & expensive
Surface Finish Options	Powder coat, anodizing, plating	Machined, bead blast, anodizing	Limited unless post-finished
Cost for Small Runs	Low	Moderate	High

### What Are the Advantages of Sheet Metal Fabrication?

**Sheet metal fabrication** has become one of the most widely used manufacturing methods for producing precise, durable, and cost-efficient parts. From **medical equipment and automation systems** to **consumer electronics** and **industrial machinery**, this process offers a smart combination of performance and flexibility.

One of the biggest advantages of sheet metal fabrication is its **cost-effectiveness**—especially for small to mid-volume production runs. With no need for expensive tooling or molds, it offers a faster and more affordable path to market compared to casting or injection molding. Another strength lies in its **design flexibility**. Engineers can easily adjust hole placements, flange lengths, or bend angles without retooling, making it ideal for both prototyping and frequent design updates. Combined with **tight tolerances and high repeatability**, this allows for the production of **complex and high-precision parts** with consistent quality.

Sheet metal also stands out for its **material versatility**. Whether you're working with **aluminum, stainless steel, cold-rolled steel, copper, or brass**, it can be cut, bent, and finished to meet a wide range of functional and cosmetic requirements. At **Rollyu Precision**, we provide full support across **laser cutting, CNC bending, welding, surface treatment**, and assembly to ensure every part is production-ready.

Beyond speed and precision, sheet metal fabrication offers **strong mechanical properties**, including excellent durability and structural strength—even in thin profiles. That makes it suitable for load-bearing brackets, frames, and enclosures that require both performance and longevity.

In industries where **short lead times, customization, and reliability** matter, sheet metal fabrication continues to prove its value. It's a trusted solution for teams looking to bring high-quality metal components to market faster, more efficiently, and with greater control over quality and cost.

Sheet metal fabrication, a cornerstone of modern manufacturing, offers numerous benefits. This process of creating metal structures by cutting, bending, and assembling has revolutionized industries. Let's delve into some of the key advantages from Rollyu's sheet metal fabrications:

- **Versatility:** Metal fabrication allows for creating a wide range of products, from small components to large machinery.
- **Durability:** Fabricated metal products are known for their strength and longevity, resistant to warping and corrosion.
- **Customization:** Offers the flexibility to create custom designs, catering to specific needs and specifications.
- **Efficiency:** Advanced techniques like laser cutting and CNC machining provide quick and precise results.
- **Cost-Effective:** Mass production capabilities reduce overall costs, making it economically viable for large-scale projects.
- **Strength-to-Weight Ratio:** Metals, especially alloys like aluminum, offer high strength with relatively low weight, ideal for various applications.
- **Aesthetics:** Metal fabrication provides options for aesthetically pleasing finishes, including painting and powder coating.
- **Recyclability:** Most metals used in fabrication are recyclable, supporting sustainable manufacturing practices.
- **Innovation:** Constant technological advancements in metal fabrication processes lead to continuous improvement in product quality.
- **Safety:** Fabricated metal structures, when done correctly, meet high safety standards, essential in industries like automotive and construction.

- **Key applications in medical devices, robotics, electronics, and automation**

Sheet metal fabricated parts are essential to the performance and reliability of today's most advanced technologies. From robotics and automation to medical devices and electronic systems, the applications of sheet metal fabrication span structural frames, protective enclosures, and precision-mounted brackets. These metal fabricated parts must not only meet strict dimensional tolerances but also withstand demanding environments, which is why material selection and surface finishes for sheet metal fabrication play a critical role. At Rollyu Precision, we offer a full range of fabrication materials — including stainless steel, aluminum, and copper alloys — along with surface finishes such as anodizing, powder coating, brushing, and plating to meet both functional and cosmetic requirements. Our manufacturing processes are built around precision, scalability, and speed, with design-for-tolerance guidance to ensure optimal fit and performance. Whether you need high-volume production or rapid prototypes, Rollyu Precision supports you from concept to delivery with expert fabrication solutions tailored to your application.

Here's a more detailed look at the applications:

**Surgical Robotics:**

Assist surgeons in minimally invasive procedures, improving precision and reducing recovery time.

**Drug Delivery:**

Enable precise and efficient delivery of medications, including through robotic syringe assembly and automation of pharmacy processes.

**Diagnostic Imaging:**

Enhance accuracy and speed in disease detection through robotic systems.

**Rehabilitation:**

Support intensive, repetitive training for recovery from neurological and physical impairments.

**3D Printing and Robotics:**

Enable rapid prototyping and customization of medical implants and prosthetics, along with streamlining post-processing steps like polishing and inspection.

**Robotics:**

**Service Robots** in Healthcare: Assist healthcare staff with non-patient care tasks like delivering supplies, cleaning, and disinfecting.

**Laboratory Automation:** Optimize pathology processes and reduce manual labor in labs.

**Pharmacy Automation:** Ensure accurate and efficient dispensing of medications.

**Telepresence and Remote Care:** Enable doctors to remotely monitor and assist patients.

**Workforce Training:** Simulate patient scenarios for medical professionals.

# SHEET METAL FABRICATION HANDBOOK



Satellite & Space



Dental Equipment



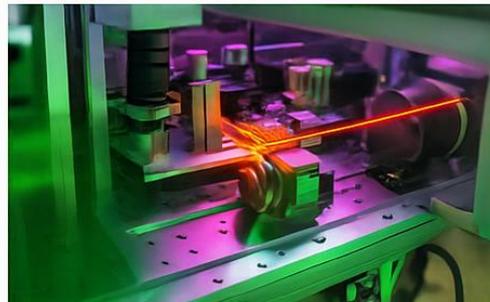
Renewable Energy



Medical Devices



Life Sciences



Photonics



Semiconductor



Robotics

**Electronics:****Manufacturing Automation:**

Streamline the assembly and production of electronic components, including pick-and-place operations and testing.

**Material Handling:**

Robots handle materials like printed circuit boards, reducing errors and improving efficiency.

**Automated Inspection:**

Vision systems and robotic arms enable precise inspection of electronic components.

**Automation:****Robotic Process Automation (RPA):**

Automate repetitive administrative tasks like data entry and document processing, freeing up human workers for more strategic tasks.

**Warehouse Automation:**

Use robots for picking, packing, and shipping of goods, improving speed and accuracy.

**Industrial Robotics:**

Automate various processes on assembly lines, from welding and painting to material handling.

**Laboratory Robotics:**

Automate tasks in laboratories, such as moving samples, testing, and synthesizing compounds.

## Chapter 2: Rollyu Precision Overview

- **Company strengths: ISO 9001 & ISO 13485 certified**

At Rollyu Precision, quality is more than a promise — it's a system backed by internationally recognized standards. As an ISO 9001 and ISO 13485 certified manufacturer, we operate under rigorous quality management frameworks that ensure every part we produce meets the highest levels of consistency, traceability, and performance.

**ISO 9001** certification demonstrates our ability to deliver products and services that consistently meet customer and regulatory requirements across industrial sectors. It ensures structured quality management, customer focus, and continuous process improvement.

**ISO 13485**, tailored specifically for the medical device industry, reinforces our commitment to risk management, regulatory compliance, and product safety. This standard is essential for supporting customers in regulated environments, where documentation, process validation, and patient safety are non-negotiable.

Together, these certifications provide clear benefits:

- **Enhanced product quality and reliability**
- **Robust risk management practices**
- **Regulatory compliance for global medical markets**
- **Customer assurance and supply chain credibility**
- **A competitive edge in both industrial and medical sectors**

Both standards require regular **internal and external audits**, driving a culture of accountability and continuous improvement. Whether we're machining complex medical enclosures or producing precision sheet metal parts for automation, Rollyu Precision delivers with confidence — certified, documented, and ready for your most demanding applications.

Certificate of Registration



This is to certify that the Quality Management System of

**Shenzhen Rollyu Precision Machining Co., Ltd**

Unified Social Credit Code: 91440300MA5FNK2A4W

Operation Address: 307, Building 9, 98 Industrial Park, Wanfeng Community Center Road, Xinqiao Street, Bao'an District, Shenzhen City, Guangdong Province, China(Operating Office); 101, Building 10, Songshan Industrial Zone, Bogang Community, Shajing Street, Bao'an District, Shenzhen City, Guangdong Province, China(Office, Production)

Registered Address: 307, Building 9, 98 Industrial Park, Wanfeng Community Center Road, Xinqiao Street, Bao'an District, Shenzhen City, Guangdong Province, China

applicable to

**Processing and sales of precision metal components for medical devices (dental equipment, passive external fixation devices for orthopedic surgery, medical robotics, and rehabilitation devices)**

has been assessed and registered by NQA against the provisions of

**ISO 13485:2016**

This registration is subject to the company maintaining a quality management system, to the above standard, which will be monitored by NQA.

Certified Clients shall accept regular surveillance assessments, the validity of certificates shall be maintained for the positive result of audit.

The information of this certificate can be checked on CNCA's website ([www.cnca.gov.cn](http://www.cnca.gov.cn))

SNQA's website: [www.snqa.com.cn](http://www.snqa.com.cn)



Managing Director

Certificate Number: 135049

Issue Date: 29 May 2025

Valid Until: 29 May 2028



0015



The use of the UKAS Accreditation Mark indicates accreditation in respect of those activities covered by the accreditation certificate number 015 held by NQA.  
NQA is a trading name of NQA Certification Limited, Registration No 09351758, Registered Office: Warwick House, Houghton Hall Park, Houghton Regis, Dunstable, LU5 5ZX, UK.  
This certificate is the property of NQA and must be returned on request.  
Shanghai NQA Certification Co., Ltd. Address: Room 2201, 958 Lujiazu Ring Road, China (Shanghai) Pilot Free Trade Zone.

ISO 9001



## QUALITY MANAGEMENT SYSTEM CERTIFICATION

Certificate No.: 69123Q00082R05

### Shenzhen Rollyu Precision Machining Co., Ltd

Unified Social Credit Identifier: 91440300MA5FNK2A4W

**Registered Address:** 307, Building 9, 98 Industrial Park, Wanfeng Community Center Road, Xinqiao Street, Bao' an District, Shenzhen City, China

**Postal Address:** 307, Building 9, 98 Industrial Park, Wanfeng Community Center Road, Xinqiao Street, Bao' an District, Shenzhen City, China

**Business Address:** 101, Building 10, Haoyi Songshan Industrial Zone, No. 20, Shazhong Road, Bao' an District, Shenzhen City, Guangdong Province/307, Building 9, 98 Industrial Park, Wanfeng Community Center Road, Xinqiao Street, Bao' an District, Shenzhen City, China

According to your organization's application, our company carries out certification audit in accordance with the requirements of the Quality Management System (GB/T19001-2016/ISO9001:2015).

Your company has been assessed to meet them, the certificate is hereby issued.

**For the following activities:** Production and sales of mechanical equipment parts and hardware accessories

Date of first issue: Apr. 23,2023

Date of issue: Apr. 25,2025

Certificate Expiry: Apr. 22,2026

Surveillance audits approved and affixed a qualified mark to maintain the continuous validity of the certificate

First  
surveillance  
audit

Second  
surveillance  
audit



中国认可  
国际互认  
管理体系  
MANAGEMENT SYSTEM  
CNAS C343-M



The certified organization shall undergo surveillance audits in accordance with regulations during the validity period of this certificate and be qualified to maintain the continuous validity of the certificate. Whether the certification qualification is valid can be checked by scanning the QR code or visiting our website ([www.zpcc.cn](http://www.zpcc.cn)). For more information, please visit the website of Certification and Accreditation Administration of China ([www.cca.gov.cn](http://www.cca.gov.cn)).



ZPCC Certification Service

### Guangdong Zhongpeng Certification Co., Ltd.

1603-1605, Huatong Building, No. 8, Ganli Second Road, Gankeng Community, Jihua Street, Longgang District, Shenzhen City  
Postcode: 518000 Tel: 0755-28289126 Website: [www.zpcc.cn](http://www.zpcc.cn)

- **Industries served: medical, photonics, life sciences, robotics, semiconductor**

Rollyu Precision proudly serves high-technology and quality-critical industries where precision, reliability, and compliance are non-negotiable. Our expertise in CNC machining and sheet metal fabrication supports leading companies across the medical, photonics, life sciences, robotics, and semiconductor sectors. From surgical device components and optical alignment housings to lab automation brackets and vacuum-compatible semiconductor parts, we manufacture to the highest standards of cleanliness, tolerance, and traceability. With ISO 9001 and ISO 13485 certifications, Rollyu is trusted by engineers and procurement teams who demand consistent quality and responsive production for both prototyping and full-scale manufacturing.

- **Differentiators: tight tolerances, full-service capabilities, fast turnarounds**

## **What Sets Rollyu Precision Apart**

Rollyu Precision specializes in producing tight-tolerance, high-complexity components using stainless steel, titanium, brass, plastics, ceramic, and aluminum. Our services include precision sheet metal fabrication, Wire-EDM, CNC machining, laser marking (UDI-compliant), surface treatments, and full QA traceability.

At Rollyu Precision, we don't just manufacture parts — we deliver solutions engineered for the most demanding industries. What truly sets us apart is our ability to combine ultra-tight tolerances, fast turnarounds, and full-service capabilities under one ISO 9001 and ISO 13485-certified roof.

Several factors differentiate Rollyu Precision and make them stand out in the precision machining and sheet metal fabrication industry:

### **Tight Tolerances, No Compromises**

We specialize in high-precision CNC machining and sheet metal fabrication with tolerances down to  $\pm 0.002$  mm, ensuring every component meets exacting standards for fit, form, and function — especially in critical industries like medical devices, photonics, and semiconductors.

### **Full-Service Capabilities**

From DFM (Design for Manufacturability) support to CNC machining, laser cutting, bending, welding, surface finishing, and assembly, we provide end-to-end manufacturing solutions under one roof — simplifying your supply chain and improving part consistency.

### **One-Stop Manufacturing Partner**

From CNC machining, sheet metal fabrication, and welding to finishing, assembly, and inspection, we manage every step in-house — ensuring consistency, accountability, and end-to-end traceability.

### **Certified for Regulated Industries**

Our ISO 9001 and ISO 13485 certifications guarantee strict quality management and documentation practices, making us a reliable partner for medical, aerospace, and life sciences applications.

### **Solutions for Complexity**

We specialize in the parts others turn away — tight cosmetic specs, multi-material assemblies, critical GD&T features, and engineering-driven iterations.

### **Customer-Centric Approach:**

Customization Options: Rollyu Precision offers customized solutions to meet diverse industry needs, providing flexibility in material compatibility.

### **Fast Turnarounds-- Speed Without Sacrificing Quality**

With lean production workflows, rapid prototyping services, and flexible scheduling, we meet tight deadlines without compromising quality. Our agility helps you bring products to market faster and keep production timelines on track.

Whether it's rapid prototyping or low-volume production, our lean manufacturing workflow and real-time scheduling system allow us to deliver high-precision parts in as fast as 5–7 days.

### **Reliable Packaging**

Rollyu Precision uses premium protective packaging materials to ensure safe and damage-free delivery of precision parts.

### **Comprehensive Services:**

Beyond sheet metal fabrication: In addition to CNC machining and sheet metal fabrication, Rollyu offers a range of services, including rapid prototyping, mass production, surface treatment, finishing, and custom engineering solutions.

In summary, Rollyu Precision distinguishes itself through its strong emphasis on quality control, advanced manufacturing capabilities, broad industry expertise, customer-focused approach, and comprehensive service offerings.

Whether you're building next-generation medical devices, optical systems, or robotics, **Rollyu Precision is your partner from design to delivery.**

## Chapter 3: Materials & Material Selection

### Common Materials Used in Sheet Metal Fabrication

Each material offers unique properties, making them suitable for different applications.

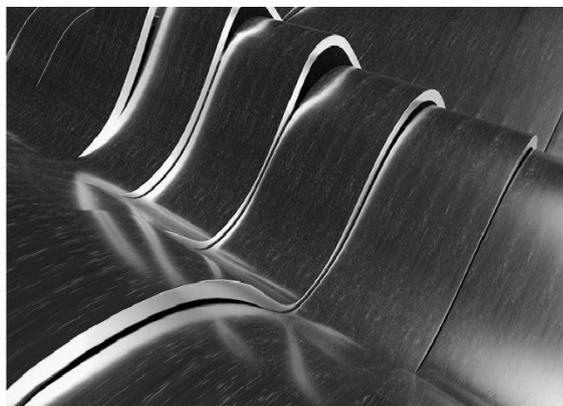
#### 1. Stainless Steel

- **Grades:** 304, 316, 430, 321
- **Properties:** Corrosion-resistant, strong, clean surface finish
- **Applications:** Medical equipment, food processing, enclosures, brackets, cleanroom parts
- **Advantages:**
  - Excellent corrosion and oxidation resistance
  - Hygienic and easy to clean (especially 316 in medical or marine)
  - High strength-to-weight ratio



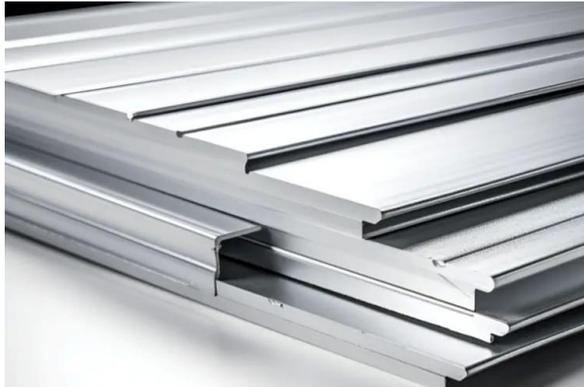
#### 2. Mild Steel (Carbon Steel)

- **Grades:** A36, 1018, CRS (Cold-Rolled Steel), HRPO (Hot-Rolled Pickled & Oiled)
- **Properties:** Cost-effective, easy to weld and form
- **Applications:** Industrial housings, chassis, structural supports
- **Advantages:**
  - Lower material cost
  - Excellent weldability and machinability
  - Suitable for powder coating or painting



### 3. Aluminum

- **Grades:** 5052, 6061, 3003
- **Properties:** Lightweight, corrosion-resistant, good thermal/electrical conductivity
- **Applications:** Electronics housings, medical devices, transportation panels
- **Advantages:**
  - Lightweight and strong
  - Natural corrosion resistance
  - Excellent for CNC + sheet metal hybrid parts



### 4. Galvanized Steel

- **Types:** G90, Electro-galvanized
- **Properties:** Carbon steel with zinc coating for corrosion resistance
- **Applications:** HVAC systems, outdoor enclosures, automotive
- **Advantages:**
  - Superior rust protection in humid or outdoor environments
  - Maintains paint adhesion
  - Cost-effective alternative to stainless steel



### 5. Copper

- **Properties:** Excellent electrical and thermal conductivity, antimicrobial
- **Applications:** Electrical components, busbars, heat sinks, EMI shielding
- **Advantages:**
  - Highly conductive
  - Malleable and formable

- Ideal for RF and grounding applications



## 6. Brass

- **Composition:** Copper + Zinc alloy
- **Properties:** Corrosion-resistant, decorative appearance, antimicrobial
- **Applications:** Architectural panels, instruments, electronic connectors
- **Advantages:**
  - Attractive gold-like finish
  - Good formability
  - Naturally resistant to bacteria

## 7. Titanium (for high-end applications)

- **Grades:** Grade 2, Grade 5 (Ti-6Al-4V)
- **Properties:** High strength-to-weight, corrosion-resistant, biocompatible
- **Applications:** Aerospace panels, medical implants, defense systems
- **Advantages:**
  - High-performance material
  - Excellent corrosion resistance in aggressive environments
  - Lightweight but strong

Material	Key Features	Common Uses
Stainless Steel	Corrosion-resistant, strong	Medical, food, enclosures
Mild Steel	Cost-effective, weldable	Industrial, frames, structures
Aluminum	Lightweight, corrosion-resistant	Electronics, medical, transport
Galvanized Steel	Rust-resistant coating	HVAC, cabinets, outdoor panels
Copper	Conductive, antimicrobial	Electronics, EMI, heat sinks
Brass	Decorative, corrosion-resistant	Architecture, electronics, instruments
Titanium	Ultra-strong, corrosion-resistant	Aerospace, surgical, defense

## How to choose based on application, corrosion resistance, strength, weight, cost

### How to Choose the Right Material for Sheet Metal Fabrication

Selecting the appropriate material is critical to ensuring that sheet metal parts meet essential requirements for **functionality, durability, cost-efficiency, and manufacturability**. The ideal material must align with multiple project-specific factors, including the **intended application, environmental exposure, mechanical strength, weight constraints, and budget limitations**.

The material you choose plays a pivotal role in determining a part's **performance, appearance, longevity, and production cost**. While many metal options are available, understanding the unique properties and benefits of each helps optimize both **design and production outcomes**. Flat sheet metal serves as the foundation for countless fabricated parts — from brackets and covers to enclosures and panels — highlighting its **versatility and widespread application across industries**. For example, **aluminum sheet metal** is widely used in precision manufacturing due to its **exceptional strength-to-weight ratio and inherent corrosion resistance**, making it well-suited for aerospace, electronics, and medical device components.

Material selection is often one of the most complex and consequential decisions in the sheet metal fabrication process. Choosing the wrong material not only affects part quality but can also result in **increased manufacturing time, rework, or even project failure**. This article aims to streamline your decision-making process by outlining key considerations and material options for **sheet metal fabrication and cutting**.

At **Rollyu Precision**, we support a broad range of material options to meet the diverse needs of high-performance industries. To simplify your selection, we've outlined the most commonly used sheet metals below. These include **aluminum alloys, stainless steels, carbon steels (low, medium, and high), copper, and non-alloy steels** — each selected for their unique performance characteristics in real-world fabrication scenarios.

#### 1. Consider the Application Environment

Environment	Recommended Materials	Why
Indoor/Controlled	Mild Steel, Aluminum 3003	Cost-effective; limited corrosion exposure
Outdoor/Marine	Stainless Steel 316, Galvanized Steel, Aluminum 5052	High corrosion resistance
Medical/Cleanroom	Stainless Steel 304/316, Titanium, Anodized Aluminum	Biocompatible, cleanable, contamination-free
Electronics	Copper, Brass, Aluminum	Conductivity, shielding, lightweight
High Heat/Stress	Stainless Steel 316, Titanium, Aluminum 6061	High-temperature and structural stability

## 2. Corrosion Resistance Comparison

Material	Corrosion Resistance	Use Case
<b>Stainless Steel 316L / 1.4404 / X2CrNiMo17-12-2</b>	Excellent (marine/chemical)	Marine applications, chemical equipment, and pharmaceuticals
<b>AISI 321 Annealed Stainless Steel (SS)</b>	Excellent, particularly against intergranular corrosion	Exhaust manifolds and systems (automotive, aerospace) Chemical processing equipment Dental Equipment Surgical Instrument
<b>Stainless Steel 304 / 1.4301 / X5CrNi18.10</b>	Very good	Cleanroom, architectural, enclosures Food processing
<b>Aluminium 6061 / 3.3211 / Al-Mg1SiCu</b>	Good	Outdoor panels, electronics housings, aerospace parts
<b>Aluminium 5052 / 3.3523 / AlMg2,5</b>	Good	chemical, marine, food processing and general engineering applications as well
<b>Galvanized Steel</b>	Moderate to good	HVAC, automotive, outdoor boxes
<b>Mild Steel</b>	Poor (unless coated)	Indoor parts with powder coating
<b>Titanium</b>	Excellent	Aerospace, surgical equipment

## 3. Strength and Structural Integrity

Material	Tensile Strength (MPa)	Strength-to-Weight	Notes
Titanium Grade 5	~900	Excellent	High-end, lightweight, premium strength
Stainless Steel 304	~520	Moderate	Durable and formable
Aluminum 6061	~310	High	Great for structural, lightweight parts
Mild Steel (CRS)	~370	Moderate	Weldable, cost-effective
Brass	~300	Low	Mostly used for aesthetics or EMI

#### 4. Weight Considerations

Material	Density (g/cm <sup>3</sup> )	Comment
Titanium	4.51	45% lighter than steel, very strong
Aluminum	2.7	Lightweight, widely used in transport/medical
Stainless Steel	~8.00	Heavy, strong
Mild Steel	~7.85	Moderate weight
Copper	8.96	Very heavy; used where conductivity is key

#### 5 . Cost and Budget Fit

Material	Relative Cost	Best Use When
Mild Steel	\$	Budget-sensitive projects with coatings
Galvanized Steel	\$\$	Need moderate corrosion protection economically
Aluminum 5052	\$\$	Lightweight and formable
Stainless Steel 304	\$\$\$	Moderate corrosion resistance, durable
Stainless Steel 316	\$\$\$\$	Harsh environments (marine, medical)
Titanium	\$\$\$\$\$	Weight-sensitive and high-performance needs

#### Decision Flow Summary

##### Step 1: Define Application

- Is it **structural, decorative, or functional** (e.g., shielding, thermal)?
- Is the environment **corrosive, cleanroom, or outdoor**?

##### Step 2: Prioritize Material Properties

- **Corrosion Resistance** → Stainless 316, Aluminum 5052, Titanium
- **High Strength** → Stainless 304/316, Titanium
- **Lightweight** → Aluminum, Titanium
- **Conductivity** → Copper, Brass

##### Step 3: Match to Budget

- **Low Cost** → Mild Steel + Powder Coating
- **Balanced Performance/Cost** → Aluminum 5052 or Galvanized Steel
- **Premium Needs** → Stainless 316, Titanium

## Decision Flow Summary

### Step 1 Define Application

- Is it structural, decorative, or functional (e.g. shielding, thermal)?
- Is the environment corrosive, cleanroom, or outdoor?



### Step 2 Prioritize Material Properties

Corrosion Resistance → Stainless 316, Aluminum 5052, Titanium  
High Strength → Stainless 304/316, Titanium  
Conductivity → Aluminum, Titanium  
Conductivity → Copper, Brass



### Step 3 Match to Budget

Low Cost → Mild Steel + Powder Coating  
Balanced Performance/Cost → Aluminum 5052 or Galvanized ed Steel  
Premium Needs → Stainless 316, Titanium

Choosing the right sheet metal material is a balance between **performance requirements** and **cost constraints**. At **Rollyu Precision**, we help our customers make informed decisions by offering **material consulting**, **DFM support**, and **rapid prototyping** using a full range of metal grades and certified sources.

# Chapter 4: Fabrication Processes at Rollyu

- **Laser Cutting**

## The Basics of Laser Cutting — Precision Solutions from Rollyu Precision

At Rollyu Precision, laser cutting plays a critical role in our advanced precision manufacturing capabilities, enabling us to deliver complex, high-accuracy components across multiple industries. Laser cutting is a highly efficient manufacturing process that uses a concentrated, high-powered laser beam — precisely controlled and focused through advanced optics — to cut a wide range of materials with exceptional accuracy and edge quality.

Compared to traditional cutting methods such as plasma cutting, laser cutting offers numerous advantages: superior precision, minimal material distortion, cleaner edge finishes, and significantly lower energy consumption. While plasma cutting may handle thicker materials, laser cutting excels in producing fine features, intricate geometries, and tight tolerances, making it ideal for applications that demand both accuracy and repeatability.

At Rollyu Precision, our laser cutting equipment operates under CNC (Computer Numerical Control) programming, ensuring consistent, repeatable results even on the most complex designs. We routinely process a diverse range of materials, including stainless steel, mild steel, aluminum, and copper alloys, as well as engineering plastics and specialty composites. Our advanced fiber laser and CO<sub>2</sub> laser systems are optimized to handle both prototyping and full-scale production runs with rapid turnaround times.

Beyond cutting, Rollyu Precision also leverages laser technology for precision welding, part marking, engraving, and surface texturing — providing our customers with fully integrated laser-based manufacturing solutions under one roof. This comprehensive approach reduces lead times, ensures process consistency, and supports industries where quality, traceability, and tight tolerances are non-negotiable, such as medical devices, photonics, semiconductors, automation, dental equipment, semiconductors and robotics.

We support customers from prototyping to full-scale production with a full suite of **CNC machining and sheet metal fabrication processes**, all governed by ISO 9001 and ISO 13485 certified quality systems.



## ○ Material thickness limits

At Rollyu Precision, understanding material thickness limits is critical for selecting the right fabrication process and ensuring high-quality results across industries such as medical devices, photonics, robotics, and semiconductors. Material thickness not only affects the choice of cutting, bending, and welding methods, but also impacts tolerances, part functionality, and overall manufacturing cost.

### 1 Typical Sheet Metal Thickness Range

- **Thin Gauge Sheet Metal:**  
0.2 mm – 3.0 mm  
(Ideal for precision enclosures, medical housings, small brackets, and detailed photonics components.)
- **Medium Gauge Sheet Metal:**  
3.0 mm – 6.0 mm  
(Common for structural brackets, panels, automation frames, and robotics assemblies.)
- **Thick Gauge Plate Fabrication:**  
6.0 mm – 25.0 mm  
(Applied in heavy-duty equipment, machine bases, semiconductor frames, and industrial automation.)

At Rollyu Precision, our advanced CNC laser cutting, bending, and forming equipment can process materials across this full spectrum with tight tolerances and consistent repeatability.



## 2 Process-Specific Thickness Limits

Process	Minimum Thickness	Maximum Thickness	Typical Tolerance
Laser Cutting	0.2 mm	20 mm (mild steel)	±0.05 mm
		15 mm (stainless steel)	
		10 mm (aluminum)	
CNC Punching	0.5 mm	6.0 mm	±0.10 mm
Bending/Forming	0.5 mm	12.0 mm	±0.20 mm (depending on material type & geometry)
Welding	0.5 mm	25.0 mm	As per design

*Note: Actual limits depend on material type, alloy grade, and part geometry. Thinner materials may require special tooling to avoid warping or distortion.*

## 3 Materials Commonly Processed at Rollyu Precision

- **Aluminum:** 5052, 6061, 7075 — 0.5 mm to 12 mm
- **Stainless Steel:** 304, 316 — 0.5 mm to 15 mm
- **Mild Steel (Carbon Steel):** SPCC, A36 — 0.5 mm to 20 mm
- **Copper & Brass Alloys:** 0.3 mm to 6 mm
- **Titanium & Specialty Alloys:** 0.5 mm to 10 mm

## 4 Key Considerations for Material Thickness in Sheet Metal Fabrication

- **Design Tolerances:** Thinner gauges require tighter flatness control and may be prone to warping.
- **Formability:** Thicker materials require larger bend radii and higher tonnage presses.
- **Cost Impact:** Thicker materials increase raw material cost, cutting time, and secondary processing.
- **Application Demands:** Cleanroom assemblies (semiconductors, photonics) often require thinner gauges; heavy industrial automation may require thick plate fabrication.

### Rollyu Precision: Your Sheet Metal Fabrication Partner

With ISO 9001 and ISO 13485 certified processes, Rollyu Precision offers full-service sheet metal fabrication — from laser cutting, CNC punching, precision bending, and welding to post-fabrication finishing and assembly. Our cross-industry experience ensures that every part meets your performance, quality, and timeline expectations.

**Contact us for sheet metal fabrication inquiries:** [info@rymachining.com](mailto:info@rymachining.com)

## ○ Tolerances & edge quality

### Tolerances & Edge Quality in Sheet Metal Fabrication — Rollyu Precision

At Rollyu Precision, controlling tolerances and achieving superior edge quality are fundamental to our precision sheet metal fabrication services. Across industries such as medical devices, photonics, semiconductors, automation, and aerospace, dimensional accuracy and clean edges are critical to both function and aesthetics.

#### 1 Dimensional Tolerances in Sheet Metal Fabrication

Tolerances depend on material thickness, fabrication process, and part geometry. The table below summarizes the general capabilities at Rollyu Precision:

Process	Typical Tolerance Range
Laser Cutting	±0.05 mm to ±0.10 mm
CNC Punching	±0.10 mm to ±0.20 mm
Bending/Forming	±0.20 mm to ±0.30 mm (depending on part size, bend length, material type)
Welding & Assembly	±0.30 mm to ±0.50 mm (depending on accumulated tolerances)
Post-Machining (if required)	(if Down to ±0.01 mm

**Note:** Medical, semiconductor, and photonics applications often require customized tighter tolerances, which Rollyu Precision achieves through controlled processes, in-process inspections, and precision fixturing.

#### 2 Edge Quality Considerations

Edge quality directly affects part functionality, fit-up, and cosmetic appearance, especially for visible components or critical interfaces.

Cutting Process	Edge Quality Description
Fiber Laser Cutting (Default at Rollyu Precision)	Clean, sharp edges with minimal burrs; suitable for medical-grade and cosmetic applications
CO <sub>2</sub> Laser Cutting	Smooth edge finish, slightly more oxidation on thicker materials
CNC Punching	May exhibit slight burrs or tool marks on complex features; often followed by deburring
Post-Cut Deburring (Optional)	Removes micro-burrs for improved safety, coating, and assembly fit
Electropolishing or Surface Finishing	Applied for medical, semiconductor, or photonics parts requiring ultra-clean, burr-free edges

### 3 Why Tolerances & Edge Quality Matter

- **Medical Devices:** Precision fit for assemblies, no sharp edges that may pose patient risk.
- **Photonics & Optics:** Edge smoothness affects alignment and optical path stability.
- **Semiconductor Equipment:** Clean edges minimize particle generation in cleanroom environments.
- **Automation Systems:** Accurate mating of assemblies ensures long-term repeatability.
- **Aesthetics:** Cosmetic panels, covers, and enclosures benefit from flawless edge finishes.

### Rollyu Precision — Total Control from Cutting to Assembly

With ISO 9001 and ISO 13485 certified quality management, Rollyu Precision tightly controls each stage of sheet metal fabrication:

- ✓ Laser Cutting with micron-level precision
- ✓ CNC Bending with programmable angle control
- ✓ TIG, MIG, and laser welding with minimal heat distortion
- ✓ In-process dimensional inspections using CMM and precision gauges
- ✓ Post-processing including deburring, anodizing, and powder coating

Every part we fabricate is engineered for accuracy, consistency, and cosmetic excellence — ready for demanding industries where quality is non-negotiable.

**Partner with Rollyu Precision for your precision sheet metal projects:  
[info@rymachining.com](mailto:info@rymachining.com)**

- **CNC Bending**

### **CNC Bending in Sheet Metal Fabrication — Rollyu Precision**

CNC bending is one of the most critical operations in precision sheet metal fabrication. At Rollyu Precision, our advanced CNC press brake systems deliver highly repeatable and accurate bending for a wide variety of metals and applications across industries such as medical devices, photonics, automation, semiconductors, and aerospace.

#### **1 What is CNC Bending?**

**CNC bending** is a precision metal forming process that uses computer-controlled press brakes to bend sheet metal into highly accurate, repeatable shapes. Unlike manual bending, CNC bending eliminates operator variability by using programmed instructions to control the position, force, angle, and sequence of each bend. This allows for complex geometries and multi-bend parts to be produced with consistent accuracy across both prototypes and full production runs.

At Rollyu Precision, CNC bending is a key process in our sheet metal fabrication workflow, ensuring that every part we produce fits precisely into its intended assembly — whether for medical devices, semiconductor tools, photonics equipment, or industrial automation systems.



#### **2 Typical CNC Bending Capabilities at Rollyu Precision**

<b>Parameter</b>	<b>Capability</b>
<b>Material Thickness</b>	0.5 mm – 12.0 mm (depending on material type and bend radius)
<b>Bend Length</b>	Up to 3000 mm (118")
<b>Bend Accuracy</b>	<b>Angle</b> ±0.25°
<b>Typical Tolerance</b>	±0.20 mm
<b>Materials</b>	Aluminum, Stainless Steel, Mild Steel, Copper, Titanium, Specialty Alloys

### 3 Key Factors Influencing Bending Accuracy

- **Material Type & Thickness:** Thicker or harder materials require larger bend radii and more tonnage.
- **Bend Radius:** Tight radii may risk cracking; proper tooling selection is critical.
- **Springback Compensation:** CNC software automatically compensates for material springback to achieve target angles.
- **Tooling Setup:** Precision ground punches and dies ensure tight dimensional control.
- **Bend Sequencing:** Complex parts may require optimized bend sequences to avoid deformation or collision.

At Rollyu Precision, our experienced engineers analyze each design to optimize tooling setup, bending sequence, and minimize cumulative dimensional errors.

### 4 Industries & Applications for CNC Bending

- **Medical Enclosures & Housings**
- **Semiconductor Chassis & Frames**
- **Photonics Mounts & Brackets**
- **Automation Panels & Machine Guards**
- **Robotic Arms & Structures**
- **Aerospace Brackets & Covers**

### 5 Why CNC Bending Matters for Precision Assembly

- ✓ Consistent dimensional accuracy for tight-tolerance assemblies
- ✓ High repeatability for production volumes
- ✓ Smooth, cosmetic-quality bends with minimal tool marks
- ✓ Reduced downstream assembly issues due to dimensional fit-up

### Rollyu Precision — Total Sheet Metal Fabrication Control

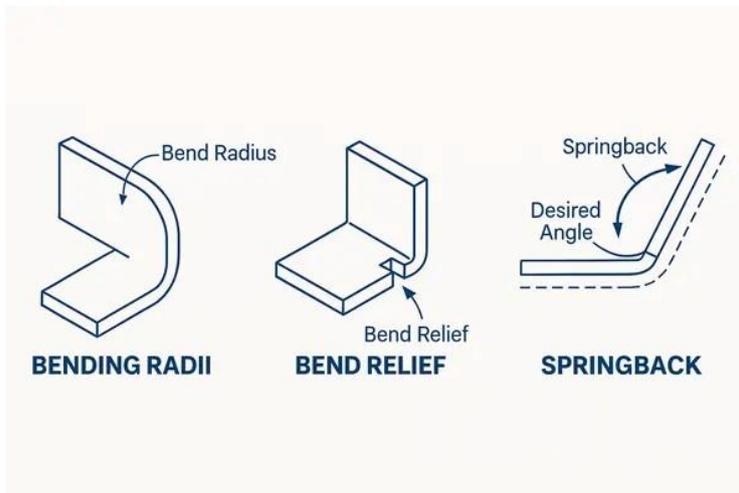
With ISO 9001 and ISO 13485 certified quality systems, Rollyu Precision integrates CNC bending with laser cutting, welding, assembly, and finishing — ensuring every fabricated part is delivered with superior precision, cosmetic appearance, and functional performance.

✉ **For CNC bending and complete sheet metal fabrication solutions, contact us at [info@rymachining.com](mailto:info@rymachining.com)**

○ **Bending radii, bend relief, springback**

**Bending Radii, Bend Relief & Springback — Key Factors in Precision CNC Bending**

At Rollyu Precision, achieving tight-tolerance, high-quality bends requires more than simply programming angles — it requires full control of **bending radii, bend relief, and springback compensation**. These factors directly affect dimensional accuracy, part fit, structural integrity, and long-term performance, particularly for industries like medical devices, photonics, semiconductors, and industrial automation.



**1 Bending Radii (Inside Bend Radius)**

The **inside bend radius** is the radius measured at the interior of the bend. It is one of the most critical design parameters in sheet metal bending because it directly affects:

- Part strength
- Dimensional stability
- Appearance (especially for cosmetic parts)
- Risk of cracking (particularly in harder or thinner materials)

**✓ General Best Practices:**

Material Type	Minimum Recommended Inside Bend Radius
Aluminum (5052, 6061)	1.0 × material thickness
Stainless Steel (304, 316)	1.5 × material thickness
Mild Steel (SPCC, A36)	1.0 × material thickness
Titanium & Specialty Alloys	1.5–2.0 × material thickness

Designing with proper bend radii minimizes material stress, prevents cracking, and allows for consistent repeatable bends in production.

**2 Bend Relief**

**Bend relief** is a small notch or cutout placed at the ends of a bend to:

- Prevent tearing or distortion at the bend corner
- Eliminate material bulging in tight areas
- Improve dimensional control during bending
- Allow adjacent flanges to form correctly without interference

### ✓ Design Guidelines:

- Relief width:  $\geq$  material thickness
- Relief length: slightly longer than bend radius + material thickness

Bend relief becomes particularly important for **tight corner bends, enclosed flanges, or when multiple bends are located close together.**

### 3 Springback Compensation

**Springback** occurs because metal naturally tries to return to its original flat shape after bending. The amount of springback depends on:

- Material type (harder materials have more springback)
- Thickness
- Bend angle
- Bend radius

### ✓ How Rollyu Precision Controls Springback:

- **CNC Programming:** Automatic compensation calculated into the programmed bend angle.
- **Test Bends:** Sample bends to verify exact springback for each material lot.
- **Material Lot Traceability:** Consistent material sourcing ensures predictable springback behavior.
- **Tooling Adjustments:** Precision tooling allows fine-tuning of punch/die combinations to control bend radius and angle.

### ✓ Typical Springback by Material:

Material Type	Springback Range
Aluminum (5052)	~0.5° – 2.0°
Stainless Steel (304, 316)	~1.5° – 4.0°
Mild Steel (SPCC)	~1.0° – 3.0°

### Why These Details Matter

- For **medical devices**, incorrect bend radii or uncontrolled springback can prevent proper assembly and cause field failures.
- For **semiconductor equipment**, even slight dimensional deviations may lead to improper fit within cleanroom tools.
- For **photonics and automation frames**, perfect corner alignment ensures optical stability and machine repeatability.

### Rollyu Precision — Expert Control of Every Bend

By carefully managing bending radii, reliefs, and springback, Rollyu Precision consistently delivers CNC bent parts that meet exacting functional, cosmetic, and regulatory requirements. Our CNC press brakes, precision tooling, and experienced engineers ensure dimensional stability even in complex multi-bend designs.

**Contact Rollyu Precision for your CNC bending and fabrication needs:**  
[info@rymaching.com](mailto:info@rymaching.com)

- **K-factor and design tips**

CNC bending is one of the most critical processes in precision sheet metal fabrication. At Rollyu Precision, we optimize every stage of the CNC bending process — from flat pattern development to final dimensional verification — using advanced knowledge of **K-Factor, bend allowances, springback, and forming principles** to ensure each part is produced accurately, repeatably, and cost-effectively.

#### **What is the K-Factor in CNC Bending?**

The **K-Factor** is a material property constant used to calculate how much sheet metal stretches during bending. It directly impacts flat pattern dimensions and final bend accuracy.

- When sheet metal is bent, the outer surface stretches while the inner surface compresses.
- Between these two layers is the **neutral axis**, which experiences no change in length.
- The **K-Factor** defines the location of this neutral axis relative to the material thickness.

#### **K-Factor Formula:**

$$K=T/t$$

- **t** = Distance from inner surface to neutral axis
- **T** = Total material thickness

Correct K-Factor selection is essential for accurate flat pattern development and consistent bend results.

#### **Typical K-Factor Values by Material (CNC Bending)**

<b>Material</b>	<b>Typical K-Factor Range</b>
Aluminum (5052, 6061)	0.33 – 0.40
Stainless Steel (304, 316)	0.35 – 0.45
Mild Steel (SPCC, A36)	0.40 – 0.50
Titanium & Nickel Alloys	0.40 – 0.50
Copper & Brass Alloys	0.30 – 0.40

⚠ **Note:** At Rollyu Precision, we validate K-Factors per material batch using test bends to ensure exact flat pattern accuracy before full-scale production.

#### **Why K-Factor Accuracy Matters**

- Ensures the **correct blank size** before bending.
- Prevents **dimensional deviation** after forming.
- Reduces first-article failures and rework.
- Essential for CNC press brake programming and tool selection.

#### **CNC Bending Design Tips for Better Manufacturability**

At Rollyu Precision, we work closely with customers during the design phase to optimize bendability, accuracy, and long-term part performance. Below are essential design guidelines:

## 1 Minimum Inside Bend Radius

Material Type	Recommended Inside Radius
---------------	---------------------------

Aluminum	$\geq 1 \times$ material thickness
----------	------------------------------------

Stainless Steel	$\geq 1.5 \times$ material thickness
-----------------	--------------------------------------

Mild Steel	$\geq 1 \times$ material thickness
------------	------------------------------------

Titanium / High Alloys	$\geq 1.5 - 2 \times$ material thickness
------------------------	--

- Avoid sharp corners to prevent cracking or thinning.
- Proper radius minimizes material stress and improves repeatability.

## 2 Springback Control

Springback occurs as metal attempts to return to its original shape after bending.

### Material Type Typical Springback Range

Aluminum	0.5° – 2.0°
----------	-------------

Stainless Steel	1.5° – 4.0°
-----------------	-------------

Mild Steel	1.0° – 3.0°
------------	-------------

- Rollyu Precision compensates for springback through:
  - CNC angle programming
  - Precision tool selection
  - Controlled material sourcing

## 3 Bend Relief Design

Bend relief prevents tearing at corners during forming:

- Relief width  $\geq$  material thickness
- Relief length  $\geq$  bend radius + thickness
- Essential for tight corner or multi-bend geometries

## 4 Flange Length Guidelines

- Minimum flange length:  $\geq 3 \times$  material thickness
- Prevents deformation and ensures proper tool clearance

## 5 Tolerances

Feature	Typical Tolerance
---------	-------------------

Bend Angle	$\pm 0.25^\circ$
------------	------------------

Dimensional Accuracy	$\pm 0.20$ mm
----------------------	---------------

- Tighter tolerances possible depending on geometry and application.
- Medical, semiconductor, and photonics parts may require custom tolerance studies.

## 6 Bend Sequencing

- Sequence bends to avoid tool collisions and maintain part stability.
- Optimize for minimal handling and fixture changeovers.

- **Welding (TIG/MIG/Spot)**

### **Welding Processes at Rollyu Precision: TIG, MIG & Spot Welding**

At Rollyu Precision, welding plays a critical role in our sheet metal fabrication, CNC assemblies, and structural frame production. Depending on material type, part geometry, thickness, and application requirements, we apply the most suitable welding process to ensure structural integrity, cosmetic quality, and manufacturing efficiency.

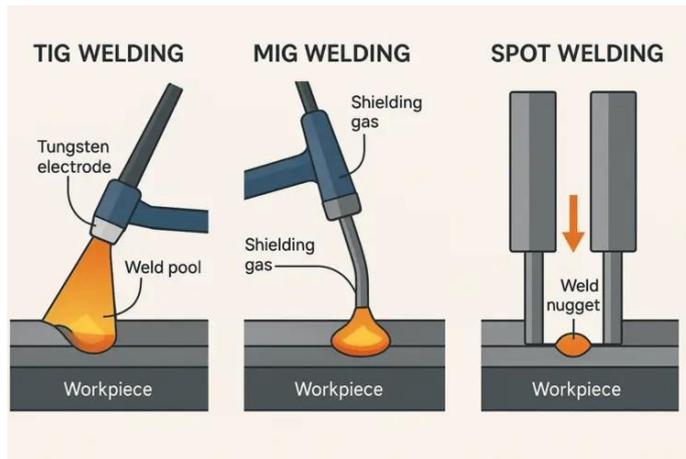


**TIG Welding (Gas Tungsten Arc Welding, GTAW)** delivers exceptionally clean, high-quality welds using a non-consumable tungsten electrode and inert shielding gas. This method excels in joining thin materials, stainless steels, and precision components where appearance, minimal distortion, and superior weld integrity are critical.

**MIG Welding (Gas Metal Arc Welding, GMAW)** offers high deposition rates and excellent productivity by feeding a consumable wire electrode through the welding gun while shielding gas protects the weld zone. MIG welding is ideal for thicker materials, larger assemblies, and high-throughput production where speed and versatility are important.

**Spot Welding (Resistance Welding)** is widely used for joining overlapping sheet metal sections, especially in high-volume production of thin-gauge parts. Heat generated by electrical resistance quickly fuses the metal surfaces, producing consistent and repeatable welds with minimal cycle times and low material distortion.

At Rollyu Precision, our certified welders, controlled processes, and in-house fixturing capabilities ensure each weld meets demanding specifications for strength, consistency, and cosmetic finish—whether for medical devices, automation systems, semiconductor equipment, or aerospace assemblies.



## 1 TIG Welding (Gas Tungsten Arc Welding – GTAW)

### Overview:

TIG welding uses a non-consumable tungsten electrode and an inert gas (typically Argon) to shield the weld area from atmospheric contamination. It produces precise, clean welds with minimal spatter — ideal for thin-gauge metals and parts requiring high cosmetic appearance.

### Applications:

- Stainless steel enclosures
- Aluminum frames and brackets
- Medical device housings
- Semiconductor chamber assemblies
- Aerospace structural components

### Advantages:

- High precision, excellent control
- Clean welds with low contamination
- Suitable for thin and thick materials
- Excellent for dissimilar metals (with proper technique)

### Limitations:

- Slower than other welding processes
- Requires highly skilled welders
- Less cost-effective for high-volume production

## 2 MIG Welding (Gas Metal Arc Welding – GMAW)

### Overview:

MIG welding uses a continuously fed consumable wire electrode and shielding gas. It is faster and more efficient for thicker materials or high-volume production.

### Applications:

- Structural frames
- Automation equipment components

- Industrial enclosures
- Agricultural and heavy equipment parts

**Advantages:**

- Faster welding speed
- Easier to automate for production runs
- Lower operator skill threshold
- Good for thicker gauge metals

**Limitations:**

- More spatter than TIG
- Less precise for thin materials
- May require more post-weld cleanup

**3 Spot Welding (Resistance Spot Welding)****Overview:**

Spot welding is widely used for joining overlapping sheet metal pieces, particularly in high-volume production of thin gauge metal parts. It relies on pressure and electric current to create localized heat that forms the weld nugget.

**Applications:**

- Sheet metal enclosures
- Automotive panels
- Electrical cabinets
- HVAC and appliance components

**Advantages:**

- Extremely fast cycle times
- Low material distortion
- No filler material required
- Consistent, repeatable weld quality for thin sheets

**Limitations:**

- Primarily limited to thin sheet metals
- Less effective for complex geometries
- Requires good surface preparation and fit-up

 **Rollyu Precision Welding Capabilities**

- Materials: Stainless steel, aluminum, carbon steel, titanium (selective), copper alloys
- Thickness range: 0.5 mm to 12 mm (depending on process)
- In-house fixture design for repeatability
- ISO 9001 and ISO 13485 certified welding processes
- Cosmetic welding for medical and semiconductor applications
- Weld inspections: Visual, dimensional, dye-penetrant (upon request)

**Visual Summary**

Process	Best for	Advantages	Limitations
<b>TIG</b>	Precision, thin-walled, high-finish parts	High quality, clean welds	Slower, skilled labor
<b>MIG</b>	Thicker parts, frames, automation	Fast, good for production	More spatter, thicker sections
<b>Spot</b>	Sheet metal overlapping joints	Fast, repeatable, low distortion	Thin sheets only, simple joints

### Why Rollyu Precision?

With certified welding capabilities and a full-service machining & fabrication workflow, we deliver high-precision welded assemblies for industries where cosmetic quality, mechanical integrity, and compliance are non-negotiable.

- o **Suitable materials, heat-affected zones**

#### Suitable Materials for Welding at Rollyu Precision

The selection of welding process depends heavily on the material type and thickness. At Rollyu Precision, we routinely handle a wide range of metals to meet the specific requirements of medical devices, semiconductor equipment, automation systems, and industrial applications.

Material Type	TIG Welding	MIG Welding	Spot Welding
Stainless Steel (304, 316, 17-4PH, etc.)	☑ Excellent	☑ Good	☑ Excellent (thin sheets)
Aluminum (5052, 6061, 7075, MIC-6, etc.)	☑ Excellent	☑ Excellent	⚠ Limited (thin only)
Carbon Steel (Mild, CR, HR, A36)	☑ Excellent	☑ Excellent	☑ Excellent
Titanium	☑ Excellent	⚠ Limited	✗ Not Recommended
Copper Alloys	☑ Good (with skill)	⚠ Limited	☑ Good
Specialty Alloys (Inconel, Hastelloy)	☑ Excellent	⚠ Limited	✗ Not Recommended

Excellent = optimal choice; ⚠ Limited = possible but process-sensitive; ✗ Not Recommended = process generally unsuitable.

#### Heat-Affected Zone (HAZ) Considerations in Welding

In precision welding, the **heat-affected zone (HAZ)** plays a crucial role in determining the final quality and performance of the welded component. The HAZ is the area of the base material surrounding the weld bead that undergoes thermal cycles during welding or cutting. This localized exposure to elevated temperatures alters the material's microstructure,

potentially impacting its mechanical, chemical, and corrosion-resistant properties.

For materials such as **carbon steel, stainless steel, aluminum alloys, titanium, and specialty alloys**, even minor changes within the HAZ can lead to significant variations in:

- **Strength and Hardness:** Localized softening or hardening may occur depending on the alloy and heat input.
- **Ductility:** Excessive heat may reduce ductility, increasing the risk of cracking under stress or vibration.
- **Corrosion Resistance:** Stainless steels, for example, may experience chromium depletion in the HAZ, leading to sensitization and intergranular corrosion if not properly controlled.
- **Residual Stresses:** Uneven heating and cooling can introduce internal stresses, leading to distortion, warping, or premature part failure.
- **Fracture Toughness:** Certain alloys may become more brittle within the HAZ, reducing their ability to absorb impact or cyclic loading.

Because many of Rollyu Precision's welded components serve in **critical applications — such as medical devices, semiconductor processing equipment, photonics assemblies, and aerospace structures — HAZ management is a key part of our welding process control.**

#### Key HAZ Considerations:

- **Material Softening or Hardening:** Certain alloys, such as 6061-T6 aluminum or precipitation-hardened stainless steels, may lose strength in the HAZ.
- **Corrosion Resistance Changes:** Improper heat control may degrade corrosion resistance, especially in stainless steels.
- **Dimensional Stability:** Heat distortion may introduce warping or stress in thin or complex parts.
- **Microstructural Changes:** In aerospace, medical, and semiconductor parts, precise control of HAZ is critical to maintain functional integrity.

#### Rollyu Precision Welding Controls:

- Controlled heat input through optimized parameters.
- Custom fixtures for precise positioning and heat dissipation.
- Post-weld treatments such as annealing, stress relief, passivation, or surface finishing.
- ISO 9001 and ISO 13485 compliant welding processes for traceability and process validation.

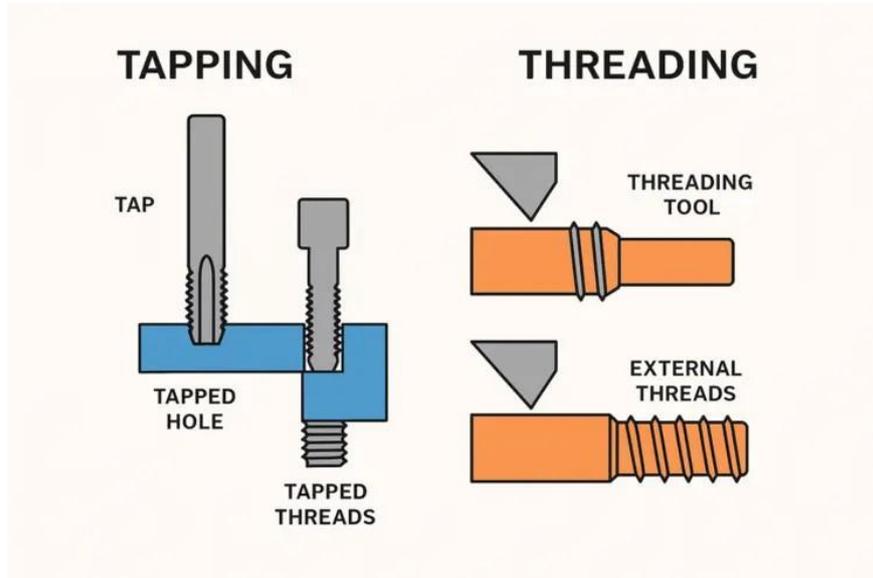
#### ✔ Why It Matters for Rollyu's Customers:

Whether producing thin-wall semiconductor chambers, robotic assemblies, or surgical equipment frames, Rollyu Precision's advanced welding controls minimize heat distortion, preserve material properties, and deliver consistent, specification-compliant parts every time.

## • Tapping & Threading

### Tapping and Threading in Sheet Metal Fabrication

In sheet metal fabrication, creating internal threads allows for secure assembly of enclosures, brackets, panels, and structural frames. Depending on material type, thickness, and application, two primary methods are used:



#### 1 Cut Tapping (Conventional Tapping)

- A cutting tap is used to remove material and create internal threads, suitable for most metals.
- Suitable for most metals, including aluminum, carbon steel, stainless steel, titanium, and copper alloys.
- Delivers precise threads for thin and thick materials alike.
- Commonly used for precision enclosures, mounting plates, and robotic frames where assembly strength and repeatability are critical.

#### 2 Thread Forming (Roll Tapping)

- Cold-forms threads without removing material; improves strength in ductile materials like aluminum, brass, and soft steels. Cold-forms the threads by displacing material without cutting.
- Ideal for ductile materials like aluminum alloys, soft steels, brass, and copper.
- Produces stronger threads due to work-hardening and uninterrupted grain structure.
- Reduces the risk of chip contamination, making it well-suited for **medical, semiconductor, and cleanroom environments** where loose chips are unacceptable.
- Excellent for thin-wall sheet metal parts where thread strength must be maximized in limited material thickness.

### Suitable Materials for Tapping & Threading

Material	Cut Tapping	Form Tapping	Thread Milling
Aluminum Alloys	☑ Excellent	☑ Excellent	☑ Excellent
Stainless Steels	☑ Excellent	⚠ Limited (only ductile grades)	☑ Excellent
Carbon Steels	☑ Excellent	☑ Excellent	☑ Excellent
Titanium Alloys	☑ Good (special taps)	✗ Not Recommended	☑ Preferred
Copper Alloys	☑ Excellent	☑ Excellent	☑ Excellent
Plastics (Delrin, PEEK, Ultem)	☑ Excellent	☑ Excellent	☑ Excellent

### Threading Standards & Capabilities

- Metric Threads (M1.0 – M50)
- Unified Threads (UNC, UNF, UNEF)
- NPT, BSP, and custom pipe threads
- Helicoil (thread insert) preparation and installation
- Thread tolerances per ISO, ANSI, ASME, and DIN standards
- Machine screw sizes down to #0-80

### Quality Control for Threads

- Go/No-Go thread plug gauges
- Thread ring gauges for external threads
- Visual inspection under magnification
- Class 2B / 3B / 2A / 3A tolerances for critical threads
- Material-specific process controls to avoid galling or thread tearing

### Why Tapping & Threading Matter

Precision threads are essential for:

- Surgical device assemblies
- Semiconductor fixture components
- Automation brackets and adjustment mechanisms
- Aerospace sensor mounts
- Medical robotics housings

Improper thread quality can lead to fastener failure, torque inconsistencies, misalignment, or long-term fatigue issues — especially in industries where every component must meet strict reliability, cleanliness, and assembly repeatability requirements.

### Rollyu Precision Advantages



Multi-process CNC threading integration (turning, milling, tapping)  
In-house tool management for micro-threads and special pitches  
Full documentation & traceability under ISO 9001 & ISO 13485  
Specialized tapping for medical-grade aluminum, stainless, titanium  
High repeatability for both prototype and production runs

**Contact Rollyu Precision**

For complex threading projects, high-precision tapped holes, or consulting on thread design for manufacturability, reach out at:

[info@rymachining.com](mailto:info@rymachining.com)

- **Deburring & Edge Treatment**

### **Deburring & Edge Treatment in Sheet Metal Fabrication**

In precision sheet metal fabrication, deburring and edge treatment are essential post-processing steps that directly impact the safety, functionality, and appearance of finished components. These processes are especially critical for industries that demand tight tolerances and flawless surface finishes, such as medical devices, photonics, semiconductors, automation, and robotics.

**Deburring** involves the removal of sharp edges, burrs, and unwanted material left behind after cutting, punching, forming, or machining operations. Without proper deburring, leftover burrs can create numerous issues, including:

- Misalignment during assembly
- Surface finish failures in downstream processes like anodizing, powder coating, or plating
- Safety hazards due to sharp edges
- Fatigue failures initiated at burr sites
- Non-compliance with quality standards such as ISO 9001 and ISO 13485

**Edge treatment** goes a step further by refining and shaping the part's edges to meet specific application needs. Techniques such as chamfering, radiusing, or rounding enhance assembly fit, improve coating adhesion, prevent damage during handling, and meet strict cosmetic or ergonomic requirements.

At **Rollyu Precision**, deburring and edge finishing are fully integrated into both prototype and full-scale production workflows. Every part undergoes controlled edge treatment based on customer specifications, ensuring dimensional consistency, cosmetic perfection, and long-term performance. Our multi-step approach guarantees that parts not only meet functional and regulatory standards, but also deliver superior visual and tactile quality.

With ISO 9001 and ISO 13485 certified processes, combined with a wide range of deburring technologies—from manual hand deburring for complex geometries to automated brush and vibratory deburring for high-volume production—Rollyu Precision delivers the precision edge quality that industries rely on.

### **1. What are Burrs?**

**Burrs** are small, unwanted material projections that remain attached to the workpiece after cutting, punching, laser cutting, or machining processes.

#### **Common burr types:**

<b>Burr Type</b>	<b>Description</b>	<b>Common Causes</b>
Roll-over burr	Metal folds over at the edge	Shearing, punching
Tear burr	Tear at the edge from excessive force	Dull tools, excessive clearance
Poisson burr	Raised edge due to material flow	Punching, forming
Micro burr	Microscopic sharp points	Laser cutting, fine blanking

## 2. Why Deburring is Critical

- **Safety:** Remove sharp edges that pose injury risk during handling or assembly.
- **Assembly Fit:** Avoid misalignment or interference fits caused by leftover burrs.
- **Surface Finishing:** Ensure uniform coatings (anodizing, powder coating, electropolishing).
- **Functional Integrity:** Avoid stress concentrations and fatigue failure initiation points.
- **Aesthetic Quality:** Meet cosmetic standards, especially for medical or consumer products.
- **Compliance:** Required for industries following ISO 9001, ISO 13485, aerospace standards, etc.

## 3. Key Deburring & Edge Treatment Methods

Method	Process Description	Best For	Limitations
<b>Manual Deburring (Hand tools, Files, Brushes)</b>	Skilled operators remove burrs manually	Prototypes, small batches, complex geometries	Labor-intensive, not suitable for high volume
<b>Mechanical Deburring (Grinding, Tumbling, Vibratory)</b>	Machines use abrasives or tumbling media	Flat parts, high volumes, batch processing	May not reach internal features
<b>Laser Deburring</b>	Laser ablation to melt away burrs	Micro-deburring, precision parts	Limited for thick or non-metallic materials
<b>Electrochemical Deburring (ECD)</b>	Electrochemical dissolution at edges	Internal features, complex geometries	Requires conductive materials, costly setup
<b>Thermal Deburring (TEM)</b>	Gas explosion burns off burrs	Internal burrs, complex assemblies	High setup cost, limited for thin parts
<b>Brush Deburring / Planetary Head Machines</b>	Rotating abrasive brushes remove sharp edges	Consistent edge rounding on flat parts	Flat parts only, higher initial equipment cost
<b>Edge Rounding (Chamfering, RADIUSING)</b>	Controlled removal of sharp edges	Safety critical parts, cosmetic parts	Requires tight process control to maintain dimensions

## 4. Common Edge Finishes in Sheet Metal Fabrication

Edge Treatment	Typical Radius / Chamfer	Notes
Sharp Edge	0 mm	Usually avoided for safety
Broken Edge	0.1 – 0.3 mm radius	Minimum standard deburring
Chamfer	0.2 – 1.0 mm 45°	Easier assembly, better fit
Radius Edge	0.5 – 3.0 mm radius	High-end medical or consumer products
Rounded / Soft Edge	>3 mm	Required for touch-safe or ergonomic designs

## 5. Deburring Considerations for Different Fabrication Processes

Process	Typical Burr Issues	Deburring Notes
Laser Cutting	Micro-burrs, heat-affected edges	Light mechanical or brush deburring often sufficient
Punching / Stamping	Roll-over burrs, tear burrs	Manual or mechanical deburring; edge conditioning
Waterjet Cutting	Minimal burrs	Typically minor or no deburring needed
Shearing	Roll-over burrs	Edge smoothing or grinding
CNC Machining	Sharp edges, minor burrs	Chamfering, manual deburring, media blasting

## 6. Deburring for Critical Industries

### Medical Devices (ISO 13485)

- No sharp edges allowed (patient & technician safety).
- Smooth edge transitions important for cleaning and sterilization.
- Consistency across production batches critical.

### Semiconductor / Photonics

- Burrs may cause contamination in cleanrooms.
- Edge rounding prevents chipping in wafer or optical handling.
- Often requires under 0.1mm edge break.

### Automation & Robotics

- Burrs interfere with assembly fit.
- Edge quality affects sensor accuracy, movement smoothness.
- Rounded edges minimize snagging on cabling.

## 7. Inspection and Quality Control

- **Visual Inspection:** 100% inspection for safety-critical parts.
- **Tactile Testing:** Fingernail or cotton swab tests for sharp edges.
- **Edge Radius Measurement:** Optical comparators, profilometers.
- **Documentation:** Deburring and edge break specs called out on part drawings.

### Typical Drawing Callouts:

"Break all sharp edges 0.3mm max"

"Edges to be free of burrs and sharpness"

### Summary Statement for Customers

At Rollyu Precision, deburring is not an afterthought — it's an engineered process fully integrated into every stage of fabrication, ensuring your parts meet the highest standards of safety, performance, and finish quality.

# EDGE TREATMENT PROCESS IN SHEET METAL FABRICATION



**ROLLYU PRECISION**

# Surface Finishing

## Surface Finishing in Sheet Metal Fabrication

In high-precision sheet metal fabrication, surface finishing is far more than just a cosmetic upgrade — it plays a vital role in ensuring the performance, longevity, and compliance of the final product. The right finishing process transforms raw fabricated parts into fully functional components, ready for integration into medical devices, semiconductor equipment, industrial automation, and other demanding applications.

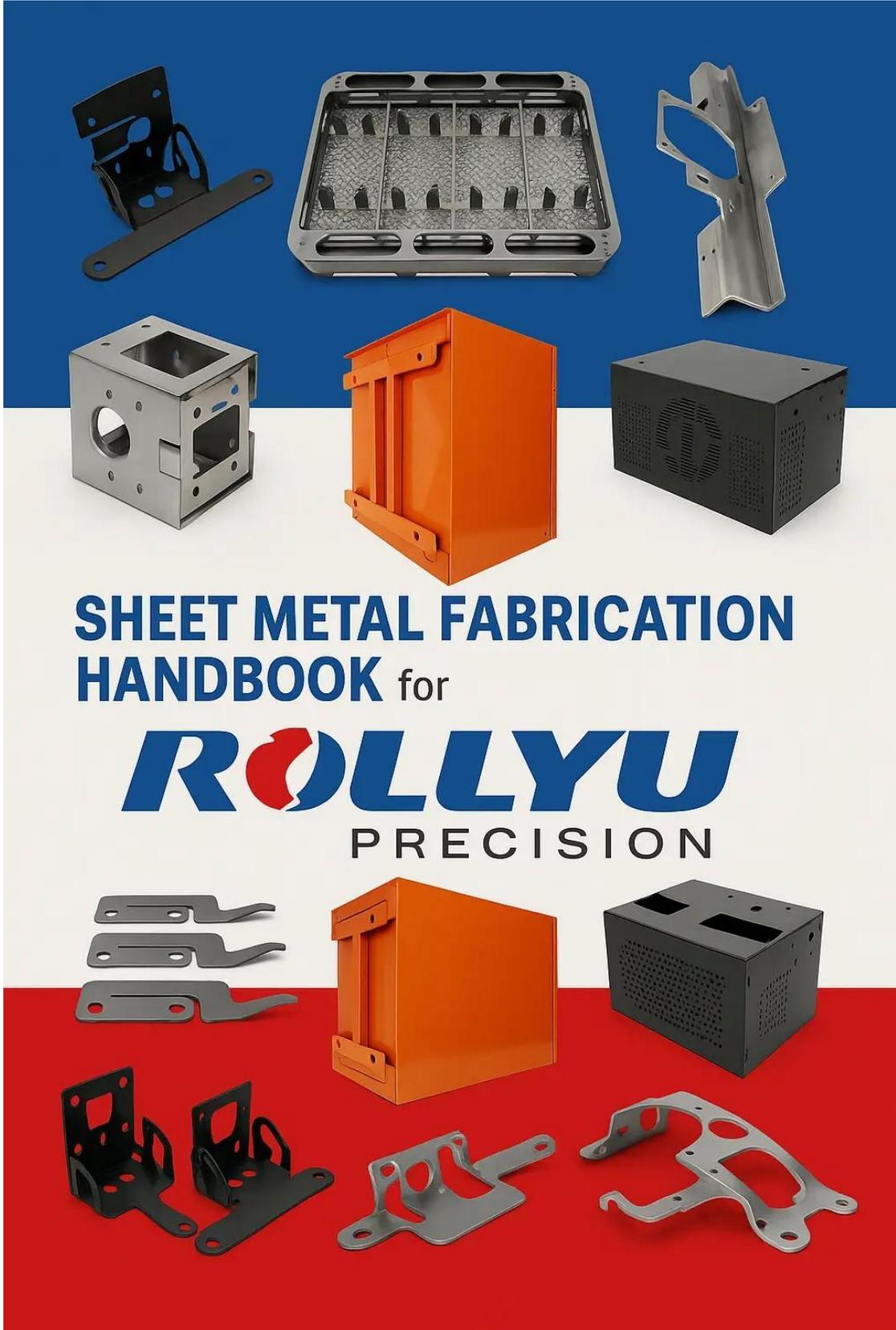
At **Rollyu Precision**, surface finishing is seamlessly integrated into every stage of our tightly controlled manufacturing workflow. This approach guarantees that each part we deliver not only meets strict dimensional and cosmetic standards but also complies with the specific industry regulations our customers operate under.

Surface finishing in sheet metal fabrication involves modifying the surface of metal components to achieve precise functional and visual characteristics. Depending on the application, these processes may either add a protective or functional layer to the surface or refine it by removing imperfections, burrs, or contaminants. As one of the final stages in the production cycle, finishing ensures that parts are fully prepared for downstream processes such as assembly, sterilization, coating, or direct end-use.

Whether it's anodizing for corrosion resistance, electropolishing for cleanroom compatibility, powder coating for color consistency, or fluorocarbon spraying for extreme weather durability, **Rollyu Precision** delivers surface finishes that meet the exacting standards of industries where precision is non-negotiable.

### Why Surface Finishing Matters

Benefit	Description
<b>Corrosion Resistance</b>	Protects metal surfaces from oxidation, wear, and environmental degradation.
<b>Aesthetic Quality</b>	Improves surface appearance for consumer products, medical housings, and visible panels.
<b>Functional Performance</b>	Enhances properties like friction, wear resistance, or conductivity.
<b>Coating &amp; Adhesion Prep</b>	Provides a uniform surface for anodizing, powder coating, or plating.
<b>Sterilization Readiness</b>	Smooths surfaces for medical devices that require cleaning and sterilization.
<b>Regulatory Compliance</b>	Supports ISO 9001, ISO 13485, and industry-specific certifications.



# SHEET METAL FABRICATION HANDBOOK for

# **ROLLYU** PRECISION

## Common Surface Finishing Processes in Sheet Metal Fabrication

### 1 Deburring & Edge Treatment (Pre-Finish Step)

- Remove burrs, sharp edges, and micro-defects.
- Essential for safety, assembly fit, and proper coating adhesion.

### 2 Anodizing

- Electrochemical oxide layer primarily for aluminum.
- Increases corrosion resistance, hardness, and appearance.
- **Common Types:**
  - Type II: Decorative, dyeable anodizing
  - Type III (Hard Anodizing): High wear resistance

**Industries:** Medical devices, electronics, aerospace, automation panels.

### 3 Powder Coating

- Dry powder applied electrostatically, then cured.
- Excellent chemical, corrosion, and impact resistance.
- Wide range of colors, textures, and gloss levels.
- Common for enclosures, control panels, automation frames.

### 4 Electropolishing

- Electrochemical removal of surface material.
- Produces ultra-smooth, clean surfaces.
- Ideal for stainless steel medical devices and semiconductor components.

### 5 Plating (Nickel, Chrome, Zinc, Gold)

- Thin metallic layer added for conductivity, wear resistance, or appearance.
- Can improve solderability and corrosion protection.

### 6 Passivation

- Chemical treatment to remove free iron from stainless steel surfaces.
- Enhances corrosion resistance, important for medical and food-grade components.

### 7 Bead Blasting / Media Blasting

- Abrasive media cleans, smooths, or textures surfaces.
- Prepares parts for downstream coatings.
- Creates uniform matte or satin finishes.

### 8 Brushing / Grinding

- Mechanical surface preparation to create directional grain or aesthetic patterns.
- Common in architectural and visible medical device parts.

## Surface Finish Parameters (Ra Values)

Process	Typical Roughness (Ra, $\mu\text{m}$ )
As-Fabricated	3.2 – 6.3 $\mu\text{m}$
Deburred & Polished	1.6 – 3.2 $\mu\text{m}$
Bead Blasted	1.2 – 2.5 $\mu\text{m}$
Electropolished	0.2 – 0.8 $\mu\text{m}$

Fine Grinding / Brushing 0.4 – 1.6  $\mu\text{m}$

**Note:** Many medical, semiconductor, and photonics parts require Ra < 0.8  $\mu\text{m}$  for optimal performance.

## Industry-Specific Surface Finishing Needs

Industry	Special Surface Requirements
Medical Devices (ISO 13485)	Sterilizable, corrosion resistant, smooth edges, electropolished
Semiconductor Equipment	Particle-free, ultra-smooth, electropolished or anodized
Photonics & Optics	Non-reflective, scratch-free, controlled Ra finish
Automation & Robotics	Powder-coated durability, scratch resistance
Aerospace	Lightweight anodized parts, hard anodizing, corrosion-resistant finishes

### ✓ Rollyu Precision Surface Finishing Capabilities

- ISO 9001 / ISO 13485 certified finishing processes
- In-house deburring, brushing, polishing, bead blasting
- Partner network for anodizing, plating, electropolishing, passivation
- Full traceability and process documentation
- Medical-grade and cleanroom-ready finishes

## The Complete Surface Finishing Workflow at Rollyu Precision

- 1 Fabrication complete
- 2 Edge treatment & deburring
- 3 Pre-finish surface prep (grinding, brushing)
- 4 Primary finishing (anodizing, powder coating, plating, etc.)
- 5 Post-finish inspection & documentation
- 6 Packaged for shipment or cleanroom assembly

### Summary

In high-precision industries, surface finishing is far more than appearance — it directly determines part performance, safety, and long-term reliability. At **Rollyu Precision**, we engineer surface finishing as part of the full manufacturing solution, ensuring that every part delivered is fully compliant, fully functional, and fully finished.

- **Anodizing, powder coating, bead blasting, plating**

### **Anodizing, Powder Coating, Bead Blasting & Plating in Precision Sheet Metal Fabrication**

In precision **sheet metal fabrication**, surface finishing is a critical step that goes far beyond aesthetics. The right finish can improve corrosion resistance, wear protection, electrical insulation, and even enhance downstream assembly and sterilization performance — particularly in industries like **medical devices, photonics, semiconductor manufacturing, automation, robotics, and aerospace**.



Here's a technical breakdown of four commonly applied surface finishing techniques for sheet metal components:

#### **1 Anodizing**

In **precision sheet metal fabrication**, anodizing remains one of the most important and widely specified surface finishing processes — especially for industries where both **corrosion resistance** and **cosmetic appearance** are mission-critical.

At **Rollyu Precision**, anodizing is fully integrated into our controlled production workflow to support industries such as **medical devices, photonics, semiconductor manufacturing, aerospace, robotics, and industrial automation**.

#### **What Is Anodizing?**

Anodizing is an **electrochemical process** that converts the surface of aluminum into a stable, durable, corrosion-resistant oxide layer. Unlike coatings or plating that add material on top of the surface, anodizing creates a controlled oxidation layer that becomes part of the metal itself.

- Non-conductive surface
- Strong adhesion for dyes and coloring

-  Excellent wear resistance
-  Superior corrosion protection
-  Minimal dimensional impact (compared to plating or powder coating)

## Types of Anodizing Used in Sheet Metal Fabrication

### 1 Type II (Decorative Anodizing)

- Oxide Thickness: 5–25  $\mu\text{m}$
- Wide color options: clear, black, red, blue, gold, etc.
- Smooth, semi-gloss to matte finish
- Used heavily for **medical, photonics, and consumer electronics**

### 2 Type III (Hardcoat Anodizing)

- Oxide Thickness: 25–100  $\mu\text{m}$
- Extremely wear-resistant surface
- Darker appearance (often black or gray)
- Used for **robotic arms, mechanical frames, wear-critical components**

**Process Type:** Electrochemical oxidation (aluminum primarily)

**Thickness:** 5–25  $\mu\text{m}$  (Type II); up to 100  $\mu\text{m}$  (Type III - Hard Anodizing)

**Typical Materials:** Aluminum alloys (6061, 5052, 7075, MIC6, etc.)

#### Benefits:

- Excellent corrosion resistance
- Improved surface hardness (especially hard anodizing)
- Electrical insulation (non-conductive layer)
- Dyeing capability for colored finishes (black, red, blue, etc.)
- Chemically stable for medical and semiconductor environments
- Excellent for cosmetic parts requiring color consistency

#### Typical Applications:

- Medical housings, enclosures, surgical components
- Photonics brackets and light baffles
- Semiconductor machine covers
- Aerospace structural panels
- Robotic frames and arms

#### Key Note (Rollyu Precision Practice):

Anodizing is frequently specified for **medical and photonics industries**, where both cosmetic appearance and chemical stability are essential.

## Why Anodizing Is Ideal for Precision Sheet Metal Parts

Benefit	Explanation
<b>Corrosion Resistance</b>	Excellent protection against moisture, chemicals, and sterilization processes
<b>Wear Resistance</b>	Type III hardcoat provides superior abrasion resistance for <a href="http://www.rollyu.com">www.rollyu.com</a> <a href="mailto:info@rymachining.com">info@rymachining.com</a>

<b>Benefit</b>	<b>Explanation</b>
	moving parts
<b>Dimensional Stability</b>	Minimal buildup compared to plating or powder coating
<b>Aesthetic Consistency</b>	Uniform color and appearance for external visible parts
<b>Biocompatibility</b>	Non-toxic and widely accepted for <b>medical devices and surgical instruments</b>
<b>Cleanroom Compatibility</b>	Stable, non-shedding surface for <b>semiconductor and photonics equipment</b>
<b>Excellent Dyeing Capabilities</b>	Wide range of colors for cosmetic or functional purposes

### Common Applications of Anodized Sheet Metal Components

#### ✔ Medical Devices

- Surgical enclosures, housings, instrument panels
- Highly corrosion-resistant and sterilization-stable

#### ✔ Photonics & Optics

- Optical mounts, alignment brackets, light baffles
- Matte black anodizing for anti-reflective surfaces

#### ✔ Semiconductor Equipment

- Vacuum chamber covers, robot arms, fixture frames
- Non-contaminating, cleanroom stable

#### ✔ Robotics & Automation

- Structural arms, enclosures, and guide rails
- Wear-resistant and corrosion-stable

#### ✔ Aerospace

- Lightweight panels and brackets
- Excellent fatigue resistance and UV stability

### Anodizing vs Other Finishes

Finish	Thickness	Best For
<b>Anodizing</b>	5–100 µm	Corrosion, wear, cleanroom, cosmetics
<b>Powder Coating</b>	50–150 µm	Impact resistance, thick coatings, outdoor
<b>Bead Blasting</b>	Minimal	Matte texture preparation
<b>Plating</b>	2–25 µm	Electrical, wear, decorative

### Rollyu Precision: Full-Service Anodizing Expertise

At **Rollyu Precision**, anodizing is carefully controlled as part of our complete sheet metal fabrication process:

- ✔ CNC laser cutting, punching, bending, welding, assembly → anodizing in controlled workflow
- ✔ ISO 9001 & ISO 13485 certified processes

-  Engineering support for **DFM** (Design for Manufacturability)
-  Full traceability and documentation for regulated industries

Whether you're manufacturing the next generation of surgical robotics, photonics equipment, or semiconductor tooling, our team ensures your anodized components meet the highest technical and cosmetic standards.



## **2 Powder Coating**

In modern **precision sheet metal fabrication**, **powder coating** is one of the most versatile, cost-effective, and durable finishing options — widely adopted across industries such as **medical devices, laboratory equipment, photonics, semiconductor manufacturing, industrial automation, robotics, and aerospace**.

At **Rollyu Precision**, powder coating is fully integrated into our sheet metal fabrication workflow, ensuring both **cosmetic consistency** and **performance reliability** for every part we deliver.



### **What Is Powder Coating?**

Powder coating is a **dry finishing process** that uses finely ground pigment and resin particles that are electrostatically charged and sprayed onto the surface of sheet metal parts. Once applied, the coated parts are placed into an oven where the powder melts, flows, and chemically cures into a hard, protective coating.

Unlike liquid paints, powder coating contains no solvents and offers superior mechanical, chemical, and cosmetic performance.

### Why Powder Coating Is Ideal for Sheet Metal Fabrication

Benefit	Details
<b>Exceptional Durability</b>	High impact, scratch, and abrasion resistance
<b>Corrosion Protection</b>	Forms a strong, moisture-resistant barrier
<b>Wide Color Options</b>	Available in thousands of colors, gloss levels, and textures
<b>Uniform Coating</b>	Smooth, consistent coverage on edges, corners, and complex geometries
<b>Eco-Friendly</b>	No VOC emissions, minimal waste
<b>Cost-Effective</b>	Ideal for batch runs and scalable production
<b>Minimal Preparation</b>	Compatible with a wide range of sheet metal alloys

### Typical Powder Coating Thickness

- **Standard Coating:** 50–100 µm (0.002–0.004 inch)
- **Heavy Duty Coating:** Up to 150 µm for high-wear or outdoor components

### Materials Commonly Powder Coated

- **Aluminum (6061, 5052, 7075)**
- **Stainless Steel (304, 316)**
- **Mild Steel / Carbon Steel (SPCC, CRS, HRPO)**

Proper pretreatment (such as phosphate coating, chemical cleaning, or bead blasting) is performed prior to powder coating to ensure maximum adhesion and durability.

### Typical Applications of Powder Coated Sheet Metal Components

#### ✓ Medical Devices & Lab Equipment

- Instrument panels, enclosures, mobile carts, diagnostic systems
- Smooth, easy-to-clean surfaces that resist sterilization chemicals

#### ✓ Industrial Automation & Robotics

- Control boxes, machine guards, brackets, frames
- Resistant to mechanical wear and daily operational impact

#### ✓ Photonics & Optical Equipment

- Outer housings, protective covers
- Available in low-glare matte finishes for optical systems

#### ✓ Semiconductor Manufacturing

- Equipment panels, access doors, control enclosures
- Cleanable, non-particulating surfaces compatible with cleanroom environments

#### ✓ Aerospace & Defense

- Instrument housings, control panels

- Lightweight, durable, corrosion-resistant for extreme environments

### Powder Coating vs Other Surface Finishes

Finish	Best For	Key Advantage
<b>Powder Coating</b>	High durability, outdoor, industrial	Excellent mechanical strength & color stability
<b>Anodizing</b>	Precision, color stability, medical	Thin, corrosion-resistant oxide layer
<b>Bead Blasting</b>	Texture prep, cosmetic matte	Pre-treatment for coatings
<b>Plating (Zinc/Nickel)</b>	Wear resistance, conductivity	Functional surface properties

For fabricated sheet metal parts, powder coating offers unique advantages compared to wet painting or other finishes:

Property	Powder Coating	Liquid Painting	Anodizing
Solvent-Free	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
High Thickness Build	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Uniform Coating	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Wide Color Selection	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Limited
Excellent Corrosion Resistance	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Impact Resistance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
UV Stability	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Limited

### Powder Coating Process Flow at Rollyu Precision

At Rollyu Precision, powder coating for sheet metal parts follows a controlled multi-step workflow:

#### 1 Surface Preparation

- Degreasing and cleaning to remove oils and contaminants.
- Media blasting or chemical pre-treatment (zinc phosphate, chromate conversion for aluminum).
- Thorough drying.

#### 2 Powder Application

- Electrostatic spray guns apply powder particles.
- Uniform coverage across flat and complex geometries.

#### 3 Curing

- Parts enter a curing oven at 160°C to 220°C (320°F to 430°F).
- Powder melts, flows, and chemically cross-links into a durable coating.

#### 4 Inspection & Quality Control

- Visual inspection for coverage and color consistency.
- Adhesion, thickness, hardness, and gloss measurements.

#### 5 Packaging

- Fully cured parts are packaged with protective wrapping to avoid surface damage during shipment.

Each part is inspected to ensure **uniform coverage, color consistency, coating thickness, and cosmetic appearance** meets the customer's exact specifications.

### Industries Trusting Powder Coating in Precision Manufacturing

-  Medical Devices
-  Laboratory & Scientific Equipment
-  Semiconductor Tools
-  Photonics Systems
-  Automation & Robotics
-  Aerospace Components
-  Telecommunications

### Industry Applications

At Rollyu Precision, powder coating is used across many of the industries we serve:

- **Medical Devices**
  - Equipment frames, housings, enclosures requiring cleanable and durable surfaces.
  - Antimicrobial powders available for hospital environments.
- **Semiconductor & Photonics**
  - Precision enclosures and racks requiring ESD-safe coatings and smooth non-particulating surfaces.
- **Robotics & Automation**
  - Machine guards, panels, and chassis subject to impact, abrasion, and handling.
- **Industrial Equipment**
  - Cabinets, junction boxes, electrical enclosures needing corrosion resistance and insulation properties.
- **Telecommunications**
  - Racks and outdoor enclosures requiring UV and weather protection.

And more.

### Advantages of Powder Coating for Sheet Metal

#### **Durability**

Powder coating offers excellent resistance to chipping, scratching, fading, and corrosion — essential for parts exposed to wear, cleaning, and outdoor conditions.

#### **Consistency**

The electrostatic process ensures uniform coating thickness, even on complex shapes, holes, and edges.

#### **Environmental Friendliness**

Powder coating contains no VOCs (volatile organic compounds), overspray can be recycled, and no hazardous waste is generated.

#### **Cost-Effectiveness**

Minimal rework, fast cycle times, and lower reject rates make powder coating a highly

economical finishing method.

✔ **Aesthetic Flexibility**

Wide range of gloss levels, colors, metallics, textures, and special effects (e.g., wrinkle, matte, or anti-microbial finishes).

### **Design Considerations for Powder Coating**

If you're designing sheet metal parts to be powder coated, consider the following:

- **Edge Treatments:** Sharp edges should be deburred and radiused to allow full powder coverage.
- **Holes and Slots:** Avoid very small holes that can trap powder and lead to defects.
- **Grounding Points:** Ensure conductive grounding points are available for electrostatic attraction.
- **Masking:** Threads or critical surfaces may need masking during application.
- **Assembly After Coating:** Account for coating thickness (typically 60–120 µm) when designing fits and tolerances.

### **Why Choose Rollyu Precision for Powder Coating?**

- ✓ ISO 9001 & ISO 13485 certified
- ✓ In-house sheet metal fabrication + finishing integration
- ✓ Cleanroom-compliant powder coating options
- ✓ Full traceability & inspection documentation
- ✓ Fast-turnaround prototyping and production
- ✓ Industry-specific powder formulations (medical, ESD, outdoor-rated)

At Rollyu Precision, powder coating is fully integrated into our **sheet metal fabrication workflow**, eliminating hand-offs and delivering fully finished parts with superior consistency, cosmetic appearance, and functional durability.

### **Contact Rollyu Precision for Your Next Sheet Metal Project**

From prototype to production, we deliver precision sheet metal parts ready for assembly — fully powder coated, inspected, and packaged to your requirements.

[info@rymaching.com](mailto:info@rymaching.com)

### 3 Bead Blasting (Sandblasting / Glass Bead Blasting)

**Process Type:** Mechanical abrasive blasting

#### What Is Bead Blasting?

**Bead blasting** is a mechanical surface treatment that uses high-pressure air to propel small, round media (glass beads, ceramic beads, or stainless steel shots) against the surface of the workpiece.

Unlike aggressive sandblasting or shot blasting, bead blasting is a **non-destructive, gentle process** that refines the surface without removing significant base material. It produces a uniform, matte or satin finish — highly desirable for many industries requiring both aesthetic consistency and functional surface performance.



#### Why Bead Blasting Is Used in Sheet Metal Fabrication

Surface Preparation Process	Surface Removal	Aggressiveness	Typical Finish
Bead Blasting	Very Low	Gentle	Satin / Matte
Sandblasting	Moderate to High	Aggressive	Rough
Shot Blasting	High	Heavy	Peened Surface
Grinding/Polishing	Variable	Manual	Shiny/Smooth

Bead blasting is typically used:

- Before anodizing (to improve dye uniformity)
- Before powder coating (to enhance adhesion)
- For cosmetic matte finishes (non-glare surfaces)
- To eliminate micro-burrs or surface imperfections

#### The Bead Blasting Process at Rollyu Precision

Here's how bead blasting is integrated into our sheet metal workflow:

- 1 CNC Cutting
- 2 Bending/Forming
- 3 Welding (if applicable)
- 4 Deburring & Edge Treatment
- 5 Bead Blasting (Surface Preparation)

- 6 Post-Blast Inspection
- 7 Final Finishing (Anodizing, Powder Coating, etc.)
- 8 Final Inspection & Packaging

Our controlled process ensures uniformity across production runs, even on complex geometries, tight corners, and internal cavities.

### Advantages of Bead Blasting for Sheet Metal Parts

#### ✓ Uniform Appearance

Removes minor tool marks, discoloration, and inconsistencies, creating a consistent surface for aesthetic and functional purposes.

#### ✓ Improved Adhesion

Increases surface area microscopically, improving powder coating or anodizing adhesion.

#### ✓ Non-Aggressive

Won't distort thin sheet metal parts or alter critical dimensions — critical for medical devices, enclosures, and precision parts.

#### ✓ Clean & Non-Contaminating

Glass or ceramic media leaves no embedded residue, making it suitable for sensitive industries like medical, semiconductor, and aerospace.

#### ✓ Versatile

Effective on aluminum, stainless steel, titanium, and various alloys.

### Industry Applications of Bead Blasting at Rollyu Precision

#### Medical Devices

- Surgical housings, covers, panels, and brackets with uniform matte finishes.
- Pre-anodizing surface preparation for color consistency.
- Biocompatible and cleanroom-friendly processes.

#### Semiconductor & Photonics

- Optical alignment frames and chambers requiring non-reflective surfaces.
- Clean, particulate-free surfaces for vacuum or cleanroom environments.

#### Robotics & Automation

- Machine covers, panels, and safety guards where cosmetic appearance and finish uniformity are important.

#### Aerospace & Defense

- Lightweight aluminum or titanium parts requiring controlled surface roughness for coating and performance.

#### Industrial Equipment & Electronics

- Enclosures, racks, control boxes with uniform matte finishes and improved corrosion resistance.

### Design Considerations for Engineers

- **Material Selection:** Aluminum, stainless, and titanium respond best.
- **Geometry Access:** Avoid deep internal recesses that may block media flow.
- **Masking:** Critical surfaces, threads, or sealing faces may require masking.

- **Surface Finish Specs:** Typical Ra surface roughness after bead blasting: 0.8–3.2  $\mu\text{m}$  (32–125  $\mu\text{in}$ ).
- **Post-Blasting Finishes:** Ensure compatibility with downstream anodizing or coating processes.

### **Why Rollyu Precision for Bead Blasting?**

- ✓ ISO 9001 & ISO 13485 certified
- ✓ Cleanroom-compatible processes
- ✓ Controlled bead blasting booths with dedicated media types
- ✓ Full traceability and in-process inspection
- ✓ Integrated finishing workflow — from raw sheet metal to finished product

At **Rollyu Precision**, bead blasting is not a standalone process. It is fully integrated into our fabrication and finishing operations to ensure that each part meets both aesthetic and functional specifications — every time.

**Typical Materials:** Aluminum, stainless steel, titanium

#### **Benefits:**

- Creates uniform matte or satin finish
- Removes machining marks, scratches, or oxidation
- Excellent pretreatment for anodizing or coating
- Enhances visual texture without significantly altering dimensions
- Low-cost, fast process

### **Contact Rollyu Precision for Your Next Sheet Metal Project**

Looking for perfectly finished sheet metal parts ready for medical, semiconductor, or automation applications? Contact us today to discuss your precision fabrication and finishing needs.

**[info@rymachining.com](mailto:info@rymachining.com)**

#### 4 Plating (Zinc, Nickel, Chrome, Tin, etc.)

**Process Type:** Electroplating or Electroless plating

### Plating in Sheet Metal Fabrication: Precision Finishing for High-Performance Applications

In precision sheet metal fabrication, plating is a critical finishing process that involves depositing a thin, uniform layer of metal onto the surface of a fabricated part. Unlike coatings such as paint or powder, plating delivers both aesthetic and functional enhancements that are often essential to the part's long-term performance. Depending on the chosen material, plating can offer superior corrosion resistance, wear protection, improved solderability, enhanced electrical conductivity, and even biocompatibility for medical-grade components. At **Rollyu Precision**, plating is carefully integrated into our controlled manufacturing workflows to meet the demanding specifications of industries such as **medical devices, semiconductor equipment, robotics, telecommunications, and aerospace**. Each plated component undergoes strict process control and inspection to ensure consistent thickness, adhesion, and surface integrity, supporting both visual appearance and critical functional requirements. Whether it's gold plating for high-reliability connectors, nickel plating for wear resistance, or zinc plating for corrosion protection, Rollyu delivers plating solutions engineered to match your application's needs.

#### Why Use Plating in Sheet Metal Fabrication?

Benefit	Description
<b>Corrosion Resistance</b>	Protects metal substrates (especially steel, copper, aluminum alloys) from oxidation, moisture, and chemicals.
<b>Wear Resistance</b>	Adds surface hardness, reduces friction, and extends part life in high-wear applications.
<b>Electrical Conductivity</b>	Critical for EMI shielding, grounding, and contact surfaces in electronics and semiconductor applications.
<b>Solderability</b>	Essential for PCB enclosures and connector housings where good solder joints are required.
<b>Aesthetics</b>	Provides smooth, shiny, or matte finishes suitable for visible surfaces in consumer, medical, or high-end industrial equipment.
<b>Biocompatibility</b>	Certain plated finishes (e.g. gold, nickel) are compatible with medical and dental applications.

#### Common Plating Types Used in Sheet Metal Fabrication

##### 1 Electroplating

A process where the part is submerged in an electrolyte solution and an electric current deposits metal ions onto the surface.

- **Materials:** Nickel, Gold, Silver, Copper, Tin
- **Applications:** Medical connectors, semiconductor housings, electronic shielding enclosures
- **Advantages:** Excellent cosmetic finish, controlled thickness, functional coatings

##### 2 Electroless Plating

A chemical reduction process without external current; provides uniform coverage, even on complex geometries.

- **Materials:** Nickel-Phosphorus (ENP), Copper
- **Applications:** High-precision medical parts, optical systems, aerospace housings
- **Advantages:** Excellent uniformity, even thickness on internal surfaces

### 3 Zinc Plating

One of the most common forms of protective plating for steel parts.

- **Types:** Clear (Blue), Yellow (Chromate), Black Zinc
- **Applications:** Industrial enclosures, brackets, fasteners
- **Advantages:** Cost-effective corrosion resistance

### 4 Black Oxide (for steel)

A conversion coating rather than true plating, but often categorized together.

- **Applications:** Tooling, aesthetic parts, non-reflective surfaces
- **Advantages:** Mild corrosion protection, attractive matte finish

### 5 Anodizing (for Aluminum)

While technically not plating, anodizing creates an oxide layer that can be dyed for color.

- **Applications:** Medical housings, semiconductor panels, robotics covers
- **Advantages:** Excellent corrosion resistance, wear resistance, electrical insulation

### 6 Gold Plating

Used for high-end applications requiring excellent conductivity, corrosion resistance, or biocompatibility.

- **Applications:** Medical sensors, high-frequency connectors, semiconductor vacuum parts
- **Advantages:** Exceptional surface properties, low contact resistance



## The Plating Process Flow in Sheet Metal Fabrication

At **Rollyu Precision**, plating is carefully integrated into the overall manufacturing workflow to ensure precision and consistency:

- 1 **CNC Cutting / Forming**
- 2 **Deburring / Surface Prep**
- 3 **Cleaning & Pre-Treatment**
- 4 **Plating (Electroplating or Electroless)**

- 5 Rinsing & Neutralization
- 6 Post-Plating Treatments (e.g. passivation, sealing, baking for hydrogen embrittlement relief)
- 7 Final Inspection (plating thickness, adhesion, visual, corrosion tests)
- 8 Packaging & Delivery

Parameter	Inspection Method
Thickness	X-ray Fluorescence (XRF), Micrometer
Adhesion	Tape Test, Bend Test
Corrosion Resistance	Salt Spray Test (ASTM B117)
Appearance	Visual Inspection (surface defects, uniformity, color)
Certification	RoHS, REACH, ISO 13485, ISO 9001

### Industries That Rely on Plating in Sheet Metal

- ✓ Medical Devices & Surgical Instruments
- ✓ Semiconductor Processing Equipment
- ✓ Telecommunications & 5G Infrastructure
- ✓ Robotics & Automation Systems
- ✓ Aerospace & Defense Electronics
- ✓ Industrial Control Panels & Housings

Plating is not simply an aesthetic finishing step—it is a **critical functional layer** that can define a product’s performance, longevity, and reliability. At **Rollyu Precision**, our plating partners and in-house finishing teams work under strict quality control to ensure every part meets the high standards required by our customers in highly regulated industries.

### Rollyu Precision — Full Surface Finishing Integration

At **Rollyu Precision**, we don’t treat finishing as an afterthought — it’s engineered into every step of our precision sheet metal fabrication workflow. Our in-house finishing solutions support industries where surface quality directly impacts:

- Assembly fit-up
- Cosmetic appearance
- Functional reliability
- Regulatory compliance (ISO 9001, ISO 13485)

Whether you require tight-tolerance anodizing for surgical robotics, powder coating for laboratory enclosures, bead-blasted optical mounts, or plated brackets for semiconductor systems — we have the expertise to deliver consistent, production-quality parts.

✓ **Let’s collaborate on your next precision project.**

✉ Contact us: [info@rymaching.com](mailto:info@rymaching.com)

## Chapter 5: Design for Manufacturability (DFM)

### Design for Manufacturability (DFM) for Sheet Metal Fabrication: How to Engineer Cost-Effective, High-Quality Parts

Design for Manufacturability (DFM) in sheet metal fabrication is a crucial process that optimizes the design of sheet metal parts for efficient and cost-effective production. It aims to bridge the gap between design concepts and real-world manufacturing, resulting in higher quality parts and shorter lead times.

In precision sheet metal fabrication, brilliant designs are only as good as their manufacturability. Many companies design beautiful 3D models that are difficult — or even impossible — to produce efficiently on real-world fabrication floors. This is where **Design for Manufacturability (DFM)** becomes a critical discipline.

At Rollyu Precision, we work closely with our customers to optimize part designs early in development, ensuring that every bend, cut, hole, and weld can be fabricated to spec, on time, and within budget — without sacrificing functional performance.

In this article, we'll explore how DFM principles apply specifically to sheet metal fabrication, and how proper DFM can lower costs, improve yields, reduce lead times, and minimize production risk.

### Design for Manufacturability (DFM) for Sheet Metal Fabrication: Turning Designs into Scalable, Efficient Production

**Design for Manufacturability (DFM)** in sheet metal fabrication is not just an engineering concept—it is a critical process that transforms complex part designs into practical, repeatable, and cost-effective production solutions. In today's precision manufacturing environment, DFM helps close the gap between theoretical CAD models and real-world manufacturing capabilities, resulting in more stable production processes, higher-quality components, and shorter lead times.

In precision sheet metal fabrication, outstanding designs mean very little if they cannot be produced efficiently and consistently. Many companies invest heavily in sophisticated 3D models that, when transferred to the shop floor, present unforeseen manufacturing challenges: unworkable bend radii, impossible geometries, excessive secondary operations, or costly custom tooling. This is where Design for Manufacturability becomes essential.

At **Rollyu Precision**, we partner with our customers from the earliest stages of product development. Our DFM approach focuses on engineering each design for real-world fabrication: ensuring that every bend, cut, hole, weld, and finish is optimized for

manufacturability, performance, and scalability — all while controlling cost and protecting functional integrity.

In this article, we will explore how DFM directly applies to sheet metal fabrication, and how an effective DFM process helps to reduce manufacturing costs, improve production yields, minimize risks, and accelerate delivery schedules — especially for industries that demand precision, such as **medical devices, semiconductor equipment, robotics, telecommunications, aerospace, and photonics.**

## The Role of DFM in Sheet Metal Fabrication

Sheet metal fabrication involves a highly interconnected set of processes:

- Laser cutting
- CNC punching
- Bending & forming
- Welding
- Fastening
- Finishing (anodizing, powder coating, plating, bead blasting)

Each of these stages comes with unique constraints. Even minor design oversights can lead to:

- Excessive setup and fixturing costs
- Deformation during bending
- Complex weld assemblies
- Higher rejection rates during inspection
- Delayed lead times

By applying DFM early, design teams can avoid these pitfalls — engineering parts that are straightforward to fabricate, assemble, and finish, while still meeting functional and cosmetic requirements.

## Core DFM Guidelines for Sheet Metal Fabrication

### 1 Material Selection: Use Industry-Standard Sheet Stock

- **Choose readily available gauges:** 0.8mm, 1.0mm, 1.5mm, 2.0mm, 3.0mm, etc.
- **Match materials to function and finish:**
  - *Aluminum 5052, 6061* (excellent for forming, anodizing)
  - *Stainless Steel 304, 316L* (corrosion resistance, medical grade)
  - *Cold Rolled Steel* (cost-effective for powder coated parts)
  - *Copper, Brass, Titanium* (specialized conductivity or biocompatibility)
- **Avoid over-specifying exotic alloys unless truly required.**

👉 *Rollyu Precision maintains a wide inventory of certified materials to support both prototype and volume runs.*

### 2 Bend Radius: Simplify Forming and Avoid Cracking

- Minimum inside bend radius:  $\geq$  material thickness (1T rule).
- Tight radii may require special tooling or risk cracking.

- Use consistent bend radii across part to streamline tooling setups.
- Leave sufficient straight length between bends ( $\geq 3x$  material thickness).

👉 *Rollyu engineers routinely review bend simulations to prevent cracking or springback issues before production begins.*

### **3 Hole Placement & Edge Distances**

- Keep holes at least 2x material thickness from edges and bends.
- Avoid placing holes directly on bend lines.
- For cluster hole patterns, maintain adequate material webbing to preserve structural integrity.

👉 *Improper hole placement is one of the most common sources of deformation — and one of the easiest to fix during DFM reviews.*

### **4 Tolerancing: Balance Precision and Manufacturability**

- Apply functional tolerances only where necessary.
- Avoid default tight tolerances like  $\pm 0.05\text{mm}$  unless essential.
- Control critical dimensions with datums and GD&T where applicable.

👉 *At Rollyu Precision, we regularly help customers relax non-critical tolerances to reduce inspection time, machining cost, and scrap rates — without compromising function.*

### **5 Assembly Features: Use Tabs, Slots, and Self-Locating Designs**

- Incorporate tab-and-slot joints to simplify alignment during welding or fastening.
- Minimize fixture requirements during assembly.
- Reduce cumulative tolerance stack-ups.

👉 *Self-fixturing features are a proven DFM technique that improves yield, reduces labor cost, and shortens assembly cycle times.*

### **6 Weld Optimization: Simplify and Strengthen**

- Use fillet welds over full-penetration welds where possible.
- Design for weld accessibility (avoid deep or obstructed cavities).
- Minimize unnecessary weld length.

👉 *Welding adds heat, distortion, and inspection complexity — smart weld design during DFM directly improves part quality.*

### **7 Surface Finish: Account for Post-Fabrication Coatings**

- Plan for anodizing, powder coating, plating, or bead blasting.

- Allow for coating thickness in fit and clearance features.
- Avoid sharp internal corners where finish uniformity is difficult.

👉 *Rollyu Precision integrates finishing process knowledge directly into our DFM reviews to ensure final appearance and performance.*

### Common DFM Mistakes (and How to Avoid Them)

Common Error	DFM Correction
Specifying unnecessary tight tolerances	Apply functional tolerances only
Designing tight bend radii	Maintain $\geq 1T$ inside bend radius
Holes too close to bends or edges	Move holes away from deformation zones
Complex weld locations	Use accessible, self-aligning joints
Ignoring finish buildup	Adjust clearances for coating thickness
Over-complicated geometry	Simplify forms for flat pattern processing

### Case Study: DFM in Action at Rollyu Precision

#### The Challenge:

A medical robotics client submitted a multi-component stainless steel housing assembly with multiple bends, weld seams, tight cosmetic requirements, and powder coating finish.



#### Initial Issues Identified:

- Inconsistent bend radii across parts.
- Weld seams placed in obstructed internal corners.
- Hole locations intersecting with bend lines.
- Tolerances unnecessarily tight across all features.

#### DFM Solutions Implemented:

- Standardized all bend radii to 1.5mm across components.
- Relocated weld seams to accessible external joints.
- Repositioned holes 3mm away from bends.

- Relaxed tolerances on non-critical features to  $\pm 0.2\text{mm}$ .
- Added tabs and slots for self-locating assembly.

#### The Results:

- 18% total cost savings.
- 35% faster production lead time.
- 99.6% first-pass yield.
- Improved cosmetic appearance post powder-coating.

👉 *DFM optimization directly improved both cost and product quality, while maintaining full compliance with the client's ISO 13485 medical requirements.*

#### Rollyu Precision's DFM-First Approach

At Rollyu Precision, we don't simply build to print — we collaborate with our customers to **engineer success into every design**:

- ✓ Early-stage design consultation
- ✓ Full DFM review with actionable feedback
- ✓ In-house CAD/CAM support for manufacturability adjustments
- ✓ Fast-turn prototyping to validate design changes
- ✓ Smooth transition to volume production

Whether you are developing medical enclosures, photonics brackets, semiconductor shields, or robotic assemblies — our DFM expertise ensures your sheet metal parts are built for both performance and profitability.

#### Industries That Rely on Rollyu DFM Expertise

- Medical Devices & Surgical Robotics
- Semiconductor & Photonics Equipment
- Aerospace & UAV Structures
- Robotics & Industrial Automation
- Telecommunications & 5G Infrastructure
- Renewable Energy & Power Systems
- Laboratory & Life Sciences Instrumentation

And more.

#### DFM is the Key to Scalable Sheet Metal Manufacturing

Design for Manufacturability isn't a luxury — it's a competitive advantage. Applying DFM early reduces cost, minimizes risk, improves delivery speed, and strengthens product quality. When you work with **Rollyu Precision**, you gain not only a precision fabrication partner — but a proactive engineering collaborator dedicated to making your designs fully production-ready.

#### Partner with Rollyu Precision on your next sheet metal fabrication project.

We turn complex designs into precision-fabricated parts — on time, on budget, and built for real-world performance.

**Contact us today:** [info@rymachining.com](mailto:info@rymachining.com)

- **Optimal bend radius guidelines**

**Optimal Bend Radius Guidelines for Sheet Metal Fabrication**

The bend radius is one of the most important — and often underestimated — variables in precision sheet metal fabrication. Selecting the correct bend radius has a direct impact on part quality, dimensional stability, cosmetic appearance, structural strength, and manufacturing consistency.

At its core, **optimal bend radius selection is always a balance between the material type, thickness, and forming process.** While many designs start with the rule of thumb where the inside bend radius equals the material thickness (1T), this guideline doesn't apply universally. Harder alloys, brittle materials, or thicker gauges often require a larger bend radius — sometimes 2–3 times material thickness — to avoid cracking, excessive thinning, or unpredictable springback.



<b>BENDING RADII</b>	
<b>Minimum Recommended Inside Bend Radius</b>	<b>Minimum R Recommended thickness</b>
Aluminum (5052, 6061)	1.0 × material
Stainless Steel (304, 316)	1.5 × material
Mild Steel (SPCC, A36)	1.0 × 2.0 ×
Titanium & Specialty Alloys	1.5–2.0 ×

In high-precision industries such as **medical devices, photonics, semiconductor, robotics, and aerospace**, these bending tolerances become even more critical. Cosmetic finishes like anodizing, powder coating, or plating can exaggerate any surface imperfections caused by improper forming.

At **Rollyu Precision**, we integrate bend radius optimization directly into our **DFM (Design for Manufacturability)** reviews. Our engineering team works closely with customers early in development to ensure that every bend, form, and angle is manufacturable, stable, and repeatable — protecting both functional integrity and production efficiency.

In this article, we will outline the key bend radius guidelines for different sheet metal materials, explain why proper bend design matters, and show how early optimization can prevent costly manufacturing issues down the line.

**Why Bend Radius Optimization Matters**

Every sheet metal bend stretches the outer fibers of the material while compressing the inner

fibers. If the bend radius is too small for the selected material:

- The outer surface may crack or fracture.
- Excessive thinning may occur along the bend line.
- Springback becomes unpredictable.
- Cosmetic finishes may show deformation or ripples.

If the bend radius is too large:

- The part may require more space than necessary.
- Fitment with mating parts may be compromised.
- The design may not fully leverage the forming capabilities of modern CNC press brakes.

Optimal bend radius strikes a balance — allowing clean, repeatable bending without sacrificing part functionality or introducing unnecessary manufacturing cost.

### General Bend Radius Rule of Thumb

#### ✔ Minimum Inside Bend Radius = Material Thickness (1T Rule)

This 1T rule serves as a reliable starting point for most ductile materials and common sheet metal parts. However, harder alloys, thicker gauges, or specialty finishes often require bend radii larger than 1T.

### Material-Specific Bend Radius Guidelines

Material Type	Recommended Minimum Inside Bend Radius	Notes
Aluminum 5052-H32	1T – 1.5T	Highly formable, good for tight bends
Aluminum 6061-T6 / 7075-T6	1.5T – 3T	Harder alloys prone to cracking
Stainless Steel 304 / 316L	1T – 2T	High strength; larger radii reduce cracking risk
Cold Rolled Steel (CRS)	1T	Very formable for standard applications
Copper / Brass	0.8T – 1T	Excellent ductility; allows tighter bends
Titanium Alloys	2T – 3T	Higher cracking risk; larger radii advised
Spring Steel / HSLA	3T – 5T	High springback; requires larger bend radii

Note: These values assume 90° bends formed with standard air bending methods.

### How Forming Methods Affect Bend Radius

Different forming processes influence how tight a bend radius can be achieved:

#### 1 Air Bending (Most Common in CNC Press Brakes)

- Most widely used for precision sheet metal.
- Allows flexible bend angles and radii.
- Requires consideration for springback.
- Most DFM guidelines above assume air bending.

**2 Bottom Bending (Coining)**

- Forces material fully into die bottom.
- Reduces springback dramatically.
- Allows tighter radii but requires higher tonnage.
- More tool wear, higher setup costs.

**3 Roll Bending / Rotary Bending**

- Used for very large radius curves.
- Minimal material thinning.
- Common for larger panels and cosmetic forms.

At Rollyu Precision, our engineering team selects the appropriate bending method depending on material, design intent, and production volume.

**Key DFM Best Practices for Bend Radius Design**

Design Mistake	DFM Recommendation
Specifying sharp bends smaller than 1T	Apply 1T or larger depending on material
Inconsistent bend radii across part	Standardize radii to minimize tooling changes
Holes too close to bend lines	Maintain $\geq 2x$ thickness from bend line
Adjacent bends too close together	Allow $\geq 3x$ thickness between bends
Ignoring post-bend finishing	Adjust dimensions to account for coating buildup

**Bonus Tip:** The earlier these corrections are made during design reviews, the more cost savings can be captured downstream.

## Rollyu Precision Case Study: Medical Enclosure Optimization

### The Challenge:

A medical equipment customer submitted an aluminum 6061-T6 enclosure design with inside bend radii specified at 0.5mm on 1.5mm thick material — significantly below safe limits for this hard aluminum grade.

### The Risks Identified:

- Cracking during bending
- Thinning along bend lines
- Visible surface defects after anodizing

### Rollyu Precision's DFM Adjustments:

- Increased inside bend radius to 1.5mm (1T rule for 6061-T6)
- Validated changes through prototype forming trials
- Achieved flawless bends with no cracking or thinning
- Anodized parts met full cosmetic and functional specifications

### Results:

- Scrap rate reduced by 95%
- Stable production repeatability
- Faster production cycles due to reduced rework



•

### How Rollyu Precision Supports Bend Radius Optimization

At **Rollyu Precision**, bend radius optimization is fully integrated into our customer collaboration process:

- ✓ Early design reviews during quotation
- ✓ In-house CAD/CAM simulation of bend performance
- ✓ Material-specific forming recommendations
- ✓ Prototyping and first-article validation
- ✓ Manufacturing process alignment with industry certifications (ISO 9001, ISO 13485)

Whether you're developing medical housings, robotic brackets, or semiconductor enclosures, our team applies real-world forming expertise to protect both product integrity and manufacturing profitability.

### Industries That Depend on Precision Forming

- Medical Devices & Surgical Equipment
- Semiconductor & Photonics Equipment
- Robotics & Industrial Automation
- Telecommunications Hardware
- Aerospace & UAV Systems
- Renewable Energy Equipment
- Life Sciences Instruments

And more.

In each of these sectors, bend radius optimization is critical to achieving high-precision, high-yield, and cost-efficient production.

### **Conclusion: Optimize Early, Manufacture Smoothly**

Selecting proper bend radii is not just about avoiding cracking — it's about stabilizing your entire production process.

At **Rollyu Precision**, we help customers:

- Avoid forming defects
- Control production costs
- Improve yield rates
- Protect cosmetic finishes
- Accelerate time-to-market

 *Bend radius optimization is one small adjustment that delivers significant long-term manufacturing advantages.*

### **Work with Rollyu Precision on your next precision sheet metal project.**

We transform your complex designs into stable, scalable production — with fully optimized bends, clean finishes, and high-yield results.

**Contact us:** [info@rymachining.com](mailto:info@rymachining.com)

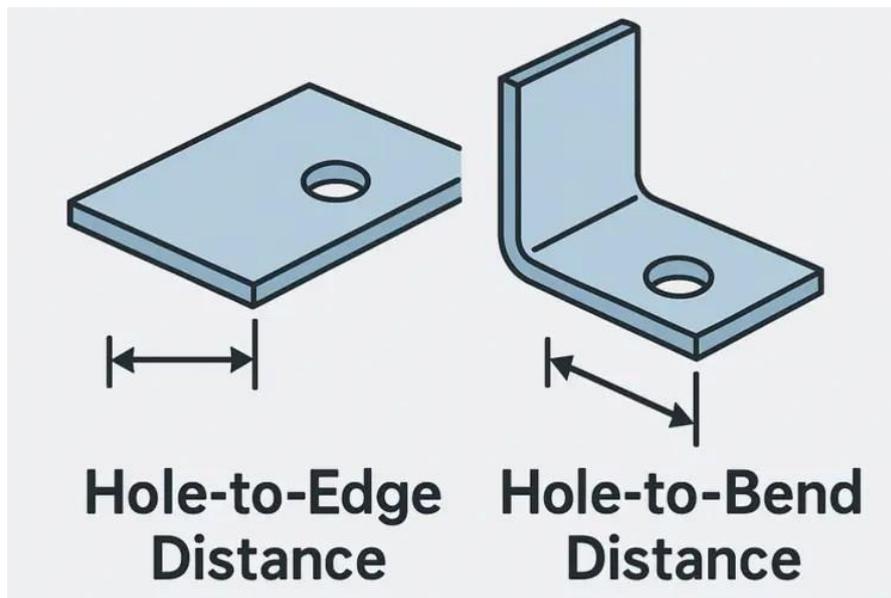
**Visit:** [www.rollyu.com](http://www.rollyu.com)

- **Hole-to-edge and hole-to-bend distance**

### Hole Placement DFM for Sheet Metal Fabrication: How Proper Design Prevents Cracking, Distortion, and Rework

In precision sheet metal fabrication, hole placement isn't just a small detail — it's one of the most critical DFM (Design for Manufacturability) factors that determine whether your parts bend cleanly, assemble correctly, and maintain dimensional stability through production.

At **Rollyu Precision**, we routinely help customers resolve manufacturing challenges caused by poorly positioned holes. Without proper clearance to bends and edges, holes can distort, elongate, tear, or shift out of tolerance during forming — compromising both function and appearance.



This article will break down **practical hole placement rules** for sheet metal DFM that protect forming quality, improve yields, and stabilize production — especially for industries where precision is non-negotiable: medical devices, semiconductor equipment, robotics, aerospace, and telecommunications.

### Why Hole Placement Is So Critical in Sheet Metal Forming

During bending, metal stretches and compresses along the bend line. Holes too close to these stressed regions will:

- **Distort shape:** round holes become oval or elongated.
- **Shift position:** hole centers move off location.
- **Crack edges:** holes near edges may tear during forming.
- **Compromise threads:** distorted holes create poor thread alignment for fasteners.
- **Cause cosmetic defects:** visible deformities after coating or plating.

By applying simple DFM guidelines, most of these defects can be fully prevented — protecting both quality and cost.

## Key DFM Rules for Hole Placement

Design Rule	DFM Recommendation	Why It Matters
Hole-to-Edge Distance	$\geq 2 \times$ Material Thickness (2T)	Prevents edge tearing or weakening
Hole-to-Bend Distance	$\geq 2 \times$ Material Thickness (preferably 3T)	Prevents hole distortion during bending
Hole-to-Hole Spacing	$\geq 2 \times$ Material Thickness	Prevents material web thinning
Minimum Hole Diameter	$\geq 1 \times$ Material Thickness	Avoids punch distortion or tearing
Multiple Holes Near Bends	Stagger holes further from bend	Minimizes distortion risk

These guidelines assume standard 90° bends using CNC press brakes and air bending processes.

### Visualizing Hole Distortion Near Bend Lines

Distance from Bend Line	Distortion Risk
< 1T	Severe elongation or collapse
1T	High risk of distortion
2T	Minimal distortion
3T	Nearly distortion-free forming

#### ✅ Rollyu Precision Pro Tip:

If functional holes must be near a bend, we often recommend adding those holes *after forming* through secondary machining or drilling.

### Real-World DFM Case Study at Rollyu Precision

#### The Challenge:

A medical device OEM submitted a stainless steel sheet design for an electronic enclosure. Several mounting holes (M3) were placed just 0.5mm from a 90° bend line on 1.0mm thick stainless steel.

#### The Problems:

- Holes distorted into ovals after bending.
- Screw threads misaligned during assembly.
- Cosmetic defects visible after powder coating.
- High scrap rate due to failed inspections.

#### Rollyu Precision's DFM Solution:

- Relocated holes to 3.0mm (3T) from bend lines.
- Confirmed stable forming through forming simulations.
- Parts bent cleanly with zero hole distortion.

- 98% first-pass yield achieved in production.
- Fully functional threads passed torque tests after plating.

**Result:** Small design adjustment = major cost and yield improvement.

### Why Hole-to-Edge Distance Also Matters

While bending introduces distortion risks, edge proximity creates additional challenges:

- **Material tearing:** Holes too close to edges may tear during punching.
- **Weakening structure:** Thin edges may deform under fastening loads.
- **Plating defects:** Thin metal near edges may create inconsistent coating.

**Safe rule:** Maintain hole centers at least 2T away from all edges.

### The Hidden Cost of Poor Hole Placement

Ignoring DFM hole placement rules leads to:

- Increased scrap and rework
- Cosmetic rejects after coating
- Expensive secondary operations (reaming, drilling, reshaping)
- Delays in production due to non-conforming parts
- Assembly line problems due to fit-up issues

**Early DFM review eliminates these costs before production begins.**

### How Rollyu Precision Supports DFM for Hole Placement

At **Rollyu Precision**, hole placement is fully integrated into our design review process:

- ✓ Early DFM feedback on customer CAD files
- ✓ Simulation of bend behavior near holes
- ✓ Recommendations to optimize hole spacing and sequencing
- ✓ Secondary machining strategies for unavoidable close-to-bend holes
- ✓ Prototyping to verify stability before production launch

Our DFM support helps customers avoid common forming mistakes and achieve stable, repeatable production runs — even for complex medical, semiconductor, and aerospace assemblies.

### Industries That Require Tight Hole Placement Control

- **Medical Device Enclosures**
- **Semiconductor Shielding Components**
- **Robotics and Automation Brackets**
- **Aerospace Sensor Mounts**
- **Telecommunications Chassis**
- **Photonics and Optical Device Frames**

In these industries, hole distortion is not simply cosmetic — it directly affects product function, assembly fit, and downstream regulatory compliance.

### Optimize Hole Placement, Protect Production Stability

Hole placement may seem minor — but poor hole location can easily compromise your entire

sheet metal fabrication process.

At **Rollyu Precision**, our DFM-first approach helps customers:

- Eliminate hole distortion
- Improve first-pass yield
- Prevent forming failures
- Ensure stable cosmetic finishes
- Reduce costly secondary operations

✔ *Small DFM adjustments during design reviews create long-term production success.*

**Partner with Rollyu Precision on your next precision sheet metal project.**

We proactively identify manufacturability risks and help optimize designs — ensuring every hole stays round, stable, and functional through bending, finishing, and assembly.

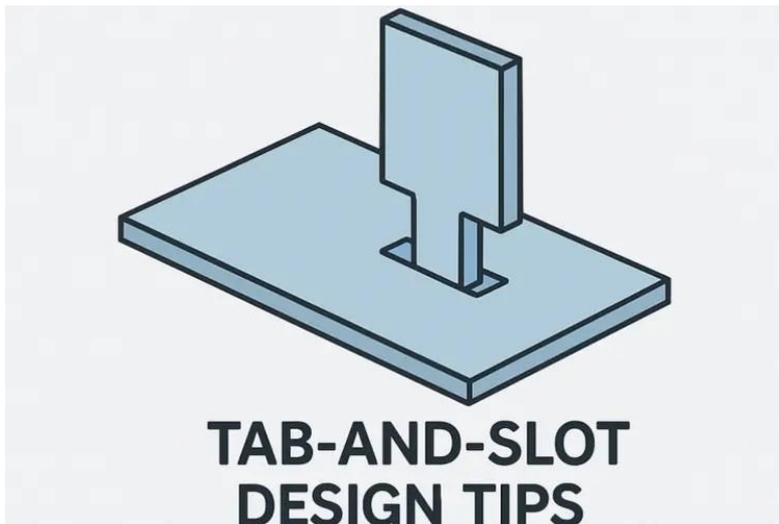
✉ **Contact us:** [info@rymachining.com](mailto:info@rymachining.com)

🌐 **Visit:** [www.rollyu.com](http://www.rollyu.com)

- **Tab-and-slot design tips**

### **Tab-and-Slot Design for Sheet Metal Fabrication: How Precision Assembly Starts with Smarter Features**

In the world of precision sheet metal fabrication, seemingly small design decisions have a major impact on assembly accuracy, manufacturing speed, and long-term product reliability. Among these design strategies, **tab-and-slot design** has emerged as one of the most effective methods for controlling assembly fit-up, reducing fixture needs, and ensuring dimensional consistency — especially for industries where even fractions of a millimeter can affect final product performance.



At **Rollyu Precision**, we routinely apply tab-and-slot features to help our customers build complex assemblies with confidence. From **medical devices** and **semiconductor manufacturing equipment** to **robotics, aerospace structures, and industrial automation systems**, tab-and-slot design supports the accuracy, stability, and repeatability that these industries demand.

#### **What Is Tab-and-Slot Design?**

In simple terms, tab-and-slot design involves adding protruding tabs on one component that fit precisely into corresponding slots on another. This creates a self-aligning joint that locks components together during assembly, minimizing human error and eliminating the need for expensive fixtures or jigs. Once positioned, the parts can be permanently joined by welding, riveting, bolting, or adhesive bonding.

The result: parts go together faster, straighter, and with greater consistency — all of which translate to better quality and lower manufacturing costs.

#### **Why Tab-and-Slot Works in Sheet Metal DFM**

- ✓ Self-locates parts during assembly
- ✓ Reduces tolerance stack-up issues
- ✓ Simplifies welding or fastening operations

- ✓ Minimizes or eliminates assembly jigs and fixtures
- ✓ Improves repeatability across production batches
- ✓ Reduces operator dependency during assembly

## Best Practices for Tab-and-Slot Design in Sheet Metal

### 1 Slot Size & Tab Clearance

- Always allow clearance between tab and slot.
- Recommended clearance: **0.1mm – 0.2mm** total (depending on cutting process).
- For laser cutting or CNC punching:
  - 0.15mm total clearance is a safe starting point.
- Avoid zero-clearance press fits (can bind due to cutting tolerances, burrs, or thermal distortion).

*Rule of thumb: Slot width = Tab width + clearance.*

### 2 Tab Dimensions

- **Tab Width:** 3–5 times material thickness for stability.
- **Tab Length:** 1–2 times material thickness inserted into the slot.
- Keep tab length short enough to avoid interference with adjacent bends.
- Avoid excessively long tabs which may bend or distort during insertion.

### 3 Slot Shape

- Use **rectangular slots** for most standard applications.
- Consider **rounded ends** (slot corners radius = material thickness) to minimize stress concentration and prevent cracking.
- Rounded slots also improve cut quality and reduce thermal distortion during laser cutting.

### 4 Bend Proximity

- Keep slots and tabs at least **2× thickness away from any bend lines**.
- This avoids deformation during bending and preserves slot geometry.

### 5 Stack-Up Control

- Use multiple tabs and slots for larger assemblies to control parallelism and flatness.
- Stagger tabs to guide assembly sequence where necessary.
- Consider adding **"lead-in" chamfers** on tabs to make manual insertion easier.

### 6 Welding Integration

- Place tabs in locations that minimize weld seam length.
- Tabs can serve dual function: alignment + weld target.
- Ensure access for weld tools when placing tabs in corners or flanges.

### 7 Cutting Process Consideration

Cutting Process	Recommended Clearance
-----------------	-----------------------

Laser Cutting	0.10 – 0.15mm
CNC Punching	0.15 – 0.20mm
Waterjet Cutting	0.15 – 0.25mm

Cutting method directly affects achievable clearance tolerances.

### Common Mistakes to Avoid

Mistake	Impact
No clearance between tab & slot	Difficult or impossible assembly
Tabs too narrow	Weak alignment; prone to bending
Tabs too close to bend lines	Distortion during forming
Sharp corners on slots	Stress risers; cracking risk
Excessive tab length	Misalignment; interference during assembly

### Case Study: Medical Device Assembly at Rollyu Precision

#### The Challenge:

A medical device housing with complex sheet metal enclosures required accurate alignment during welding without costly fixtures.

#### Original Issue:

- Manual fixture setup consumed excessive assembly time.
- High operator dependency.
- Weld distortion causing assembly variation.

#### Rollyu Precision Solution:

- Integrated tab-and-slot features across sub-assemblies.
- Applied 0.15mm clearance for laser-cut slots.
- Staggered tabs to create a self-locking assembly sequence.
- Weld seams shortened by 25% due to natural alignment.
- Assembly time reduced by 40%.
- Weld distortion and cosmetic issues fully eliminated.

### Industries Where Tab-and-Slot DFM Excels

- **Medical Device Enclosures**
- **Semiconductor Process Equipment**
- **Photonics Optical Frames**
- **Robotics & Automation Structures**
- **Aerospace Sheet Metal Subassemblies**
- **Telecommunications Chassis**

In these industries, tab-and-slot design is often a key differentiator for consistent assembly quality, faster production, and lower manufacturing cost.

## Summary Design Table for Tab-and-Slot Features

Feature	Recommended Guideline
Slot Clearance	0.1 – 0.2mm
Tab Width	3 – 5 × Thickness
Tab Length	1 – 2 × Thickness
Corner Radius (Slot)	≥ Material Thickness
Distance from Bend	≥ 2 × Thickness
Cutting Process Adjustment	Laser (0.1–0.15mm), Punch (0.15–0.20mm), Waterjet (0.15–0.25mm)

### Conclusion: Tab-and-Slot DFM Simplifies Fabrication at Every Stage

Integrating tab-and-slot features into sheet metal designs can dramatically improve manufacturability, alignment, and production repeatability. With proper DFM planning, you reduce:

- Assembly time
- Operator errors
- Fixturing requirements
- Weld distortion
- Dimensional variation

At **Rollyu Precision**, our DFM-first approach helps customers incorporate these features early — resulting in **higher yield, faster delivery, and more stable production** across industries where precision matters.

### Partner with Rollyu Precision on your next precision sheet metal project.

We actively support our customers with real-world DFM recommendations that translate designs into scalable, efficient production.

**Contact us:** [info@rymachining.com](mailto:info@rymachining.com)

- **Tolerance recommendations**

**Tolerance Recommendations in Sheet Metal Fabrication: A Practical Guide for Engineers and Buyers**

In precision sheet metal fabrication, managing tolerances is far more than just meeting dimensional requirements. It's the key to ensuring part functionality, smooth assembly, reliable performance, and cost-effective production. Compared to CNC machining, where parts are rigidly fixtured, sheet metal parts are more dynamic — affected by bending, forming, heat input, springback, and material variability. Designing with realistic and manufacturable tolerances is crucial to achieving production stability.

At **Rollyu Precision**, we apply strict, experience-based tolerance guidelines that balance precision, function, and manufacturability — helping our customers consistently receive parts that meet both engineering intent and practical manufacturing capability.

**The Typical Range of Sheet Metal Tolerances**

Unlike fully machined parts, sheet metal tolerances vary depending on whether you're dealing with flat profiles, formed features, or secondary operations:

<b>Feature Type</b>	<b>Recommended Tolerance</b>
Laser Cutting / CNC Punching	$\pm 0.005'' - \pm 0.010''$ ( $\pm 0.13 - 0.25\text{mm}$ )
Hole-to-Hole, Hole-to-Edge Distances	$\pm 0.005'' - \pm 0.010''$ ( $\pm 0.13 - 0.25\text{mm}$ )
Bend Line Position	$\pm 0.010'' - \pm 0.020''$ ( $\pm 0.25 - 0.50\text{mm}$ )
Bend Angles	$\pm 1^\circ$
Flange Height	$\pm 0.010'' - \pm 0.020''$ ( $\pm 0.25 - 0.50\text{mm}$ )
Flatness	$\leq 0.020''$ ( $\leq 0.5\text{mm}$ ) per 12" (300mm)
Overall Part Size	$\pm 0.020'' - \pm 0.030''$ ( $\pm 0.5 - 0.76\text{mm}$ )

In many cases, **tolerances between  $\pm 0.005''$  to  $\pm 0.030''$  ( $\pm 0.13\text{mm}$  to  $\pm 0.76\text{mm}$ )** cover the majority of sheet metal features depending on geometry, material, and complexity.

**Why Sheet Metal Tolerance Control Is More Complex Than Machining**

Sheet metal fabrication introduces several additional sources of dimensional variability that design engineers must consider:

- **Material springback** after bending can alter angles and flange dimensions.
- **Grain direction** affects bend consistency.
- **Tool wear** may influence hole size and edge quality during punching.
- **Heat input** from welding or thermal cutting can distort flatness.
- **Part handling and stacking** during fabrication can shift features if not fixtured properly.
-

By understanding how sheet metal behaves during fabrication, you can design tolerances that fit the process, rather than fighting against it.

### Hole Spacing & Bend Guidelines: DFM Best Practices

To ensure good forming results and minimize distortion, proper hole spacing and bend design rules are essential:

Design Rule	Recommended Value
Hole to Edge Distance	$\geq 2 \times$ material thickness
Hole to Bend Distance	$\geq 2.5 \times$ material thickness + bend radius
Hole to Hole Distance	$\geq 3 \times$ material thickness
Bend Radius (Aluminum)	$\geq 1 \times$ material thickness
Bend Radius (Stainless)	$\geq 1.5 \times$ material thickness
Bend Radius (Copper/Brass)	$\geq 0.75 \times$ material thickness

Following these rules reduces risks of hole elongation, cracking, edge tearing, and assembly misalignment.

### Tolerancing for Different Industries

At **Rollyu Precision**, we serve industries where tolerance requirements vary significantly depending on application criticality:

Industry	Typical Tolerance Ranges
Medical Devices	$\pm 0.005'' - \pm 0.010''$ ( $\pm 0.13 - 0.25\text{mm}$ )
Semiconductor Equipment	$\pm 0.005'' - \pm 0.010''$ ( $\pm 0.13 - 0.25\text{mm}$ )
Photonics & Optical	$\pm 0.002'' - \pm 0.005''$ ( $\pm 0.05 - 0.13\text{mm}$ , CNC machined after forming)
Aerospace & Defense	$\pm 0.010'' - \pm 0.015''$ ( $\pm 0.25 - 0.38\text{mm}$ )
Robotics & Automation	$\pm 0.010'' - \pm 0.020''$ ( $\pm 0.25 - 0.50\text{mm}$ )

We work closely with customers in these industries to fine-tune tolerances based on functional needs, downstream assembly conditions, and regulatory compliance.

### The Cost of Over-Tolerancing: A Common Design Mistake

Specifying unnecessarily tight tolerances can:

- Increase fabrication cost
- Extend lead times
- Drive up rejection rates
- Require secondary machining or rework

#### Rule of thumb:

Design tolerances to be as tight as necessary — but no tighter — for function and fit.

At Rollyu Precision, our engineering team proactively reviews customer prints and suggests DFM adjustments that reduce cost while maintaining quality and functionality.

### **How Rollyu Precision Controls Tolerances**

Tolerance control at Rollyu Precision is built on process discipline:

-  DFM review during quoting and design stages
-  Controlled bending with CNC press brakes and springback compensation
-  CMM (Coordinate Measuring Machine) inspection on critical dimensions
-  Statistical process control (SPC) for production stability
-  Full dimensional inspection reports available upon request
-  ISO 9001 and ISO 13485 certified quality system

### **Summary: Precision Is a Process, Not a Guess**

Tolerances in sheet metal fabrication aren't about simply holding numbers — they're about understanding how sheet metal moves, forms, and reacts to processing. By combining proper DFM design, controlled manufacturing processes, and rigorous inspection standards, **Rollyu Precision** delivers precision sheet metal components that meet exacting customer requirements across the medical, semiconductor, photonics, aerospace, and automation industries.

**If you're looking for a partner who understands both precision and real-world manufacturability, contact us at:**

**[info@rymachining.com](mailto:info@rymachining.com)**

## • Countersinks

### Countersinking in Sheet Metal Fabrication: Design Guidelines for Precision Assemblies

Countersinking in sheet metal fabrication is the process of creating a conical recess at the edge of a hole, allowing a screw or bolt head to sit flush with the surface. This is essential for both aesthetic purposes and to ensure fasteners do not protrude from the finished part, especially in precision assemblies where clearance, appearance, and safety are important.

In precision sheet metal fabrication, adding countersinks allows flat-head fasteners to sit flush with the part surface, improving both the assembly fit and the cosmetic appearance of the finished product. However, unlike in CNC machining where countersinks are produced in thicker, rigid parts with full tool control, applying countersinks in thin sheet metal introduces unique challenges that require careful design and process control.

At **Rollyu Precision**, we routinely work with customers to optimize countersink features across industries where both appearance and functionality are critical — including **medical devices, photonics hardware, semiconductor equipment, automation systems, and aerospace structures**.

### Why Countersinks Are Used in Sheet Metal

- ✓ Ensure flush mounting of flat-head fasteners
- ✓ Prevent fastener heads from interfering with adjacent parts
- ✓ Improve cosmetic appearance for customer-facing surfaces
- ✓ Reduce snag points for moving assemblies or operators
- ✓ Meet clearance requirements in compact, multi-layer assemblies

### The Challenges of Countersinking Sheet Metal

Sheet metal differs from machined parts due to its thin material thickness, which limits how deep a countersink can be made without compromising strength or distorting the surrounding area. Some of the key challenges include:

- **Material deformation** from excessive countersink depth
- **Loss of structural integrity** if too much material is removed
- **Difficulty in controlling angle and depth** with punching methods
- **Positional inaccuracy** if not properly fixtured during forming
- **Increased risk of cracking** in hard or brittle materials

### Recommended Design Guidelines for Sheet Metal Countersinks

To achieve both precision and manufacturability, the following design rules should be followed when applying countersinks in sheet metal parts:

Design Element	Recommendation
Minimum Sheet Thickness	At least 2× the countersink depth
Maximum Countersink Depth	No more than 50% of material thickness
Countersink Angle	Match fastener standard (typically 82°, 90°, or 100°)

Design Element	Recommendation
Flat-to-Countersink Clearance	At least 0.5× material thickness
Hole Center Tolerance	±0.005" (±0.13mm)
Countersink Depth Tolerance	±0.005" (±0.13mm)
Avoid Near Bends / Edges	Keep countersinks clear of formed features

## COUNTERSINKING PROCESS FLOW FOR SHEET METAL FABRICATION

ROLLYU PRECISION



### Tolerance Recommendations for Countersinks in Sheet Metal

Since countersinks are highly sensitive to depth and angle variations, the following tolerances are typically applied in precision sheet metal work:

Feature	Recommended Tolerance
Hole Diameter	±0.005" (±0.13mm)
Countersink Diameter	±0.010" (±0.25mm)

**Feature Recommended Tolerance**

Countersink Angle	±1°
Countersink Depth	±0.005" (±0.13mm)
Hole Position (Location)	±0.005" (±0.13mm)

At Rollyu Precision, these tolerances are achievable across a wide range of sheet metal materials including stainless steel, aluminum, titanium, and specialty alloys used in regulated industries.

**How Countersinks Are Manufactured in Sheet Metal**

Depending on the production volume, required precision, and part geometry, several manufacturing methods may be used to create countersinks:

<b>Process</b>	<b>Application Details</b>
CNC Punching with Countersink Tool	Efficient for high volumes; limited depth control
Post-Forming CNC Machining	Highest precision for critical applications
Manual Countersinking	Used for prototypes or very small batches
Multi-Step Forming	Occasionally applied for large countersinks or softer materials

**Industries Where Countersink Precision Matters**

At **Rollyu Precision**, we apply countersinking expertise across industries where tolerance control directly impacts product functionality:

<b>Industry</b>	<b>Application Examples</b>
Medical Devices	Sterile enclosures, surgical equipment
Photonics	Optical frames, light path alignment plates
Semiconductor Equipment	Vacuum chambers, cleanroom panels
Aerospace	Interior structures, lightweight brackets
Automation & Robotics	Control panels, moving enclosures

In each case, controlling both depth and angle of the countersink ensures secure fastening, repeatable assembly, and proper surface alignment.

**Common Design Pitfall Example**

 **Problem:**

Designer specifies full-depth countersink on 0.8mm stainless steel for M3 fastener.

 **Outcome:**

The thin metal deforms, surface flatness is compromised, and fastener heads do not sit

properly.

 **Solution:**

At Rollyu Precision, we recommended reducing the countersink depth, switching to a reduced-head fastener, and adding local material reinforcement — resulting in stable, flush mounting without sacrificing part integrity.

### **How Rollyu Precision Controls Countersink Quality**

To ensure countersink precision, we apply:

- CNC-machined countersinks for critical assemblies
- High-accuracy **optical comparators** for angle verification
- Digital micrometers for countersink depth inspection
- CMM (Coordinate Measuring Machine) for positional accuracy
- ISO 9001 & ISO 13485 certified quality processes for traceability

### **Summary: Precision Countersinks Require DFM Collaboration**

Countersinking in sheet metal is a highly effective way to meet both cosmetic and functional design goals — but only if properly engineered for manufacturability. At **Rollyu Precision**, our team works closely with customers during the design phase to ensure that countersink features are properly sized, located, and produced to meet both tolerance and production cost objectives.

**For expert DFM support on your next sheet metal project, contact our engineering team at:**

**[info@rymachining.com](mailto:info@rymachining.com)**

- **Fastener options: PEMs, rivet nuts, welding studs**

### Fastener Options: PEMs, Rivet Nuts, and Welding Studs in Sheet Metal Fabrication

In precision sheet metal fabrication, integrating fasteners directly into the sheet metal is critical for achieving reliable assembly, structural strength, and efficient downstream integration. Selecting the right fastener system depends on several key factors, including:

- Sheet metal thickness
- Load-bearing and torque requirements
- Assembly access (single-side or double-side)
- Long-term corrosion protection
- Required production volume and cost targets

At **Rollyu Precision**, we collaborate with customers to evaluate fastener types that meet both functional performance and manufacturability requirements — especially across high-precision industries such as medical devices, photonics equipment, semiconductor tools, automation systems, and aerospace assemblies.

In most sheet metal applications, three primary fastener types dominate:

- **PEMs (Self-Clinching Fasteners):** Provide strong, permanent threads in thin sheet metal with high load retention and flush finishes.
- **Rivet Nuts (Blind Threaded Inserts):** Offer versatile thread reinforcement across a wide range of material thicknesses, with blind-side installation capability for difficult-to-access assemblies.
- **Welding Studs:** Deliver robust, permanent attachment for high-load structural applications where maximum strength and direct weld bonding are required.

Each solution carries distinct advantages depending on design specifications, production volumes, and long-term durability needs.



### Why Embedded Fasteners Are Essential in Sheet Metal

- ✓ Create strong, reliable threaded connections in thin materials
- ✓ Simplify high-speed assembly and production

- ✓ Reduce part count and eliminate secondary machining
- ✓ Support blind-side assembly where access is limited
- ✓ Improve overall product appearance and safety
- ✓ Enable field serviceability for long-term maintenance

### The 3 Core Fastener Options in Sheet Metal Fabrication

#### 1 PEMs — Self-Clinching Fasteners

##### How PEMs Work:

PEMs are press-fit into pre-punched holes using controlled insertion force. As the fastener is pressed into the sheet metal, the surrounding material flows into an undercut groove in the PEM, permanently locking it in place.

##### Why Use PEMs:

- Ideal for thin sheet metal ( $\geq 0.5\text{mm}$ )
- Create permanent, high-strength threads
- Flush or near-flush installation for clean appearance
- Fully automated insertion possible for high-volume production
- Reliable and repeatable installation

##### Common PEM Applications:

- Medical device enclosures and surgical equipment
- Semiconductor tool access panels
- Photonics alignment frames
- Aerospace interior panels and lightweight structures
- Robotic automation control housings

##### PEM Design Considerations:

Parameter	PEM Rule-of-Thumb
Min Sheet Thickness	$\geq 0.5\text{mm}$ (depending on fastener type)
Hole Size Tolerance	$\pm 0.05\text{mm}$ (tight tolerance required)
Installation Access	Both sides needed
Materials	Steel, stainless, aluminum sheets

#### 2 Rivet Nuts — Blind Threaded Inserts

##### How Rivet Nuts Work:

Rivet nuts are installed into pre-drilled holes from one side of the sheet. A mandrel pulls the rivet nut body, deforming it behind the sheet metal to securely anchor the fastener, even in blind locations.

##### Why Use Rivet Nuts:

- Allow blind-side installation where access is limited
- Adaptable to various material thicknesses
- Cost-effective for small-to-medium volume production
- Suitable for field repairs or retrofit installations
- Require minimal insertion equipment

##### Common Rivet Nut Applications:

- Industrial automation control boxes
- Robotic system frames
- Telecommunications cabinets
- Medical device carts and stands
- Field-serviceable panels and access doors

#### **Rivet Nut Design Considerations:**

<b>Parameter</b>	<b>Rivet Nut Rule-of-Thumb</b>
Min Sheet Thickness	$\geq 0.5\text{mm}$
Hole Size Tolerance	$\pm 0.10\text{mm}$
Installation Access	Single-side (blind access)
Materials	Steel, stainless, aluminum

### **3 Welding Studs — Projection Weld Studs**

#### **How Weld Studs Work:**

Weld studs are permanently fused to the sheet metal using resistance welding or capacitor discharge welding. The stud becomes an integral part of the metal structure.

#### **Why Use Weld Studs:**

- Provide superior tensile and shear strength
- Permanent structural attachment
- Ideal for load-bearing components
- Allow fast one-side installation
- Zero fastener spin-out risk

#### **Common Weld Stud Applications:**

- Aerospace structural panels
- Semiconductor tool frames
- Heavy-duty automation bases
- Robotic machine frames
- Transport systems and enclosures

#### **Weld Stud Design Considerations:**

<b>Parameter</b>	<b>Weld Stud Rule-of-Thumb</b>
Min Sheet Thickness	$\geq 1.0\text{mm}$ (for proper weld strength)
Surface Prep	Clean surface required
Installation Access	One side only
Materials	Steel, stainless, limited aluminum

#### **Quick Selection Summary**

<b>Design Requirement</b>	<b>Recommended Fastener</b>
Thin sheet ( $\leq 1\text{mm}$ ), high strength PEM (Self-Clinching Fastener)	
Blind-side assembly	Rivet Nut
Heavy load, structural strength	Weld Stud

Design Requirement	Recommended Fastener
Cosmetic surface priority	PEM or Countersunk Rivet Nut
Field repair or serviceability	Rivet Nut
High-volume automation	PEM with automated press insertion

### Quality Control at Rollyu Precision

At **Rollyu Precision**, our fastener installation processes include:

- Tight hole diameter control (pre-installation inspection)
- Force-monitored PEM insertion for consistent press-fit
- Visual and mechanical pull-out testing on rivet nuts
- Weld nugget integrity inspection for weld studs
- Full dimensional verification of fastener position and perpendicularity
- ISO 9001 & ISO 13485 certified quality documentation for regulated industries

### Industries Served

- ✓ **Medical Devices** — Enclosures, surgical carts, diagnostic frames
- ✓ **Semiconductor Equipment** — Access panels, vacuum enclosures
- ✓ **Photonics Hardware** — Optical frames, light path shields
- ✓ **Aerospace Structures** — Lightweight panels, avionics enclosures
- ✓ **Automation & Robotics** — Control boxes, robotic covers, motion system frames

### The Bottom Line: Fastener Selection is a DFM Decision

Fastener selection in sheet metal isn't just about which part fits the hole — it's about optimizing manufacturability, strength, long-term durability, and production cost. At **Rollyu Precision**, our engineering and DFM team helps customers specify fastener solutions that balance strength, assembly ease, appearance, and cost — while fully meeting industry requirements for quality, compliance, and reliability.

**For engineering review of your next sheet metal fastener design, contact our team:**  
[info@rymaching.com](mailto:info@rymaching.com)

# Chapter 6: Quality Control & Inspection

## Quality Assurance in Sheet Metal Operations

In precision sheet metal fabrication, **quality assurance** is not simply a final step; it's a fully integrated system embedded throughout the entire production process. Effective quality control ensures that every fabricated part consistently meets its dimensional, cosmetic, and functional requirements — protecting both product performance and customer confidence.

### Quality control and inspection in sheet metal fabrication are essential for:

- Preventing dimensional non-conformances and assembly issues
- Ensuring each part complies with customer drawings and specifications
- Supporting ISO 9001 and ISO 13485 regulatory compliance
- Protecting cosmetic surfaces for customer-facing components
- Reducing costly scrap, rework, or downstream failure
- Enabling long-term consistency in high-volume manufacturing

At **Rollyu Precision**, quality assurance is not treated as a final checkpoint. Instead, inspection and verification protocols are applied at every stage of fabrication — from material receipt to final packaging — ensuring each part satisfies both engineering tolerances and industry standards.

## Multi-Stage Quality Control in Sheet Metal Fabrication

### 1 Material Qualification

- Verify material certifications (MTRs) and lot traceability
- Confirm sheet thickness, alloy specifications, and surface condition

### 2 Laser Cutting & CNC Punching Inspection

- Measure hole diameters, patterns, and edge quality
- Check cut-edge integrity to avoid downstream forming issues
- Confirm machine alignment for consistent feature positioning

### 3 Forming & Bending Inspection

- Verify bend angles, flange lengths, and springback correction
- Check hole-to-bend distances after forming
- Control flatness, parallelism, and squareness post-bending

### 4 Welding & Assembly Inspection

- Visually inspect weld penetration, bead uniformity, and Heat-Affected Zone (HAZ)
- Perform weld strength pull-testing when required
- Monitor for weld distortion or warpage

### 5 Fastener Installation Verification

- Confirm hole sizing prior to PEM, rivet nut, or weld stud installation
- Monitor insertion force and seating accuracy
- Conduct torque and pull-out testing for fasteners
- Inspect weld nugget integrity for projection welded studs

**6 Surface Finishing Inspection**

- Verify anodizing, powder coating, plating, or bead blasting coverage
- Check surface uniformity, color consistency, and defect-free finish
- Measure coating thickness and surface roughness where applicable

**7 Dimensional Inspection (Final QC)**

- Use CMM (Coordinate Measuring Machine) for full 3D verification
- Apply optical comparator for non-contact hole and countersink measurement
- Confirm flatness, parallelism, and warpage limits
- Inspect threads for depth, pitch, and class tolerance compliance

**8 Packaging & Final Inspection**

- Perform cosmetic inspection before packaging
- Verify part counts, labeling, and protective packaging application
- Prepare inspection reports and traceability documentation for customer release



### Incoming Material Inspection

- Verify material certifications (MTRs)
- Cross check sheet thickness
- Assign lol traceability codes 1/taper, dross)
- Inspect surface finish condition



### Cutting Stage Inspection

- Verify hole diameters after laser cutting / CNC punching
- Inspect cut edge condition (burrs, taper, dross)
- Confirm hole pattern alignment
- Monitor cutting machine calibration



### Forming & Bending Inspection

- Check bend angles and flange dimensions
- Monitor springback compensation
- Verify hole-to-bend position shift
- Control part squareness after forming



### Fastener Installation Inspection

- Measure hole size prior to PEM/rive. weld stud insertion
- Monitor insertion forces for PEM press-fit
- Torque and pull-out testing for five nuts
- Weld nugget integrity checks for studs



### Surface Finishing inspection

- Verify coating thickness (anodizing, powder coat, plating)
- Inspect surface. uniformity, color consistency
- Detect scratches, pinholes, coating defects
- Measure surface roughness where required



### Final Dimensional Inspection

- Full dimensional verification against CAD-drawings
- CMM SD coordinate measurement of critical features
- Optical comparator for hole, countersink, and slot checks
- Flatness and parallelism confirmation
- Thread pitch and depth inspection



### Packaging Inspection

### QC Tools Used at Rollyu Precision

Inspection Tool	Purpose
CMM	Full dimensional accuracy verification
Optical Comparator	Hole diameter & countersink angle measurement
Torque Testers	Fastener strength validation
Surface Roughness Testers	Finish quality control
Coating Thickness Gauges	Anodize & plating verification
Pull Testers	Fastener pull-out strength checks

### Industries Served with High QC Demands

Industry	QC Focus
Medical Devices	Surface finish, dimensional repeatability, traceability
Semiconductor Equipment	Vacuum-sealing surfaces, tight hole locations
Photonics Assemblies	Alignment plate tolerances, cosmetic finishes
Aerospace Structures	Lightweight assemblies, weld integrity, panel flatness
Automation Systems	Assembly fit-up, hole repeatability, fastener strength

### The Result: Process-Driven Consistency

At **Rollyu Precision**, quality assurance is deeply integrated into every fabrication step to ensure dimensional repeatability, cosmetic perfection, and functional performance — even for industries where zero-defect manufacturing is mandatory.

By embedding inspection into every operation — not simply final QC — we help our customers achieve stable, compliant, and repeatable production outcomes that reduce risk, improve yield, and protect product reputation.

**Need precision sheet metal fabrication with fully documented QC processes? Contact our engineering team:**

**[info@rymaching.com](mailto:info@rymaching.com)**

- **Tools used: CMMs, height gauges, pin gauges**

### **Precision Measuring Tools in Sheet Metal Fabrication: CMMs, Height Gauges, and Pin Gauges**

In precision sheet metal fabrication, measurement is not just a checkpoint — it's the foundation of product consistency, reliability, and downstream assembly performance. As part designs become increasingly complex for industries like medical devices, semiconductor equipment, photonics assemblies, automation systems, and aerospace structures, tight dimensional control becomes non-negotiable.

At **Rollyu Precision**, dimensional inspection is fully integrated into every stage of our manufacturing workflow. Multiple precision measurement tools are deployed to ensure that every part consistently meets customer tolerances, industry standards, and regulatory compliance requirements.

#### **Why Precision Measurement Matters in Sheet Metal Fabrication**

- Validates dimensional accuracy before parts reach downstream assembly
- Ensures fastener locations, holes, bends, and features align to CAD models
- Controls flatness, warpage, and surface finish on functional assemblies
- Enables stable, repeatable high-volume production
- Supports ISO 9001 and ISO 13485 compliance for regulated industries
- Minimizes scrap, rework, and customer returns

### **Primary Measurement Tools Used at Rollyu Precision**

#### **1 Coordinate Measuring Machines (CMMs)**

##### **Core Function:**

3D dimensional verification of hole positions, flatness, parallelism, and complex geometry relationships.

##### **Common Use Cases in Sheet Metal:**

- Verifying hole-to-hole true position after forming
- Checking fastener locations for PEMs and weld studs
- Confirming flatness across large formed panels
- Validating complex multi-bend assemblies for medical enclosures and semiconductor tool panels

##### **Why CMM is Critical:**

- $\pm 0.002\text{mm}$  accuracy typical
- Fully automated inspection programs for batch consistency
- Non-contact or touch probe options for fragile parts

## 2 Height Gauges

### Core Function:

Quick vertical measurements for features with flat reference surfaces.

### Common Use Cases:

- Measuring flange heights after bending
- Verifying countersink depths
- Inspecting PEM seating height post-installation
- Spot-checking flatness across panels

### Why Height Gauges Are Used:

- Fast, reliable, highly repeatable
- Ideal for both in-process and final QC
- Efficient for flat parts with consistent datum surfaces

## 3 Pin Gauges (Go/No-Go Gauges)

### Core Function:

Direct hole diameter verification for rapid pass/fail inspection.

### Common Use Cases:

- Validating laser cut or punched hole diameters
- Checking PEM and rivet nut hole sizes prior to fastener insertion
- Monitoring production hole size consistency

### Why Pin Gauges Remain Essential:

- Simple, fast operator-level feedback
- Immediate non-conformance detection
- Low cost and no setup required

## Supporting Measurement Tools for Sheet Metal QC

Tool	Application
Optical Comparator	Countersink angles, slot widths, profile accuracy
Torque & Pull Testers	Fastener seating strength & pull-out validation
Surface Roughness Testers	Cosmetic surface finish validation
Coating Thickness Gauges	Anodizing, plating, powder coat thickness checks

## Integrated Measurement Throughout the Fabrication Workflow

Fabrication Stage	Key Inspection
Material Receiving	Thickness verification, lot traceability
Laser Cutting / Punching	Hole diameter & position validation
Forming / Bending	Flange height, bend angles, hole positional shifts
Welding	Weld seam penetration, HAZ distortion control
Fastener Insertion	Hole size, insertion force, PEM seating accuracy
Surface Finishing	Surface quality, coating uniformity, roughness
Final Inspection	CMM full dimensional reports, flatness, hole alignment

<b>Fabrication Stage</b>	<b>Key Inspection</b>
Packaging	Cosmetic visual checks prior to shipment

### **Industries Demanding High-Precision Sheet Metal Measurement**

<b>Industry</b>	<b>Key QC Focus</b>
Medical Devices	Biocompatibility, cosmetic fit, hole locations
Semiconductor Equipment	Vacuum chamber sealing surfaces, positional accuracy
Photonics	Optical alignment plates, parallelism, countersink angles
Aerospace	Lightweight structures, weld seam quality, flatness
Automation Systems	Control panels, robotic covers, consistent hole patterns

### **Precision Measurement Is Non-Negotiable**

At **Rollyu Precision**, precision measurement tools are not simply part of inspection — they are fully embedded in our fabrication process. By combining multiple technologies — CMMs, height gauges, pin gauges, optical comparators, fastener testers, and finish testers — we ensure that every part we ship is compliant, consistent, and production-ready for the most demanding industries we serve.

Dimensional stability is engineered into every stage, from incoming material verification to final packaging — ensuring repeatable, certifiable performance part after part, batch after batch.

 **For precision sheet metal manufacturing with full dimensional inspection capabilities, contact:**  
**[info@rymachining.com](mailto:info@rymachining.com)**

## • Critical dimension checks

### Critical Dimension Checks in Sheet Metal Fabrication

In precision sheet metal fabrication, dimensional accuracy isn't simply about holding nominal tolerances — it's about controlling the critical dimensions that directly impact part functionality, assembly fit, long-term performance, and regulatory compliance.

At **Rollyu Precision**, we systematically identify and verify these critical dimensions at every fabrication stage, ensuring that parts consistently meet tight specifications for industries such as **medical devices, semiconductor equipment, photonics, automation, and aerospace** — where failures are not acceptable.

#### What Is a Critical Dimension?

A **critical dimension** is any feature that:

- Controls assembly fit between mating parts
- Impacts structural strength, safety, or long-term function
- Directly affects downstream assembly or final system integration
- Is non-reworkable after fabrication
- Falls under regulatory requirements or customer audits

Failure to control these dimensions leads to part rejection, costly rework, misaligned assemblies, or non-compliance in regulated markets.

#### Key Critical Dimensions in Sheet Metal Fabrication

##### **1** Material Thickness

- Controls structural strength, stiffness, and weight
- Thickness is verified to micron-level accuracy using calibrated micrometers and thickness gauges
- Variations impact hole sizes, bend behavior, fastener retention, and weld quality

##### **2** Flatness & Warpage

- Flatness is essential for assembly fit and sealing surfaces, particularly in:
  - Semiconductor vacuum plates
  - Photonics optical mounting assemblies
  - Medical device enclosures
- Verified using surface plates, CMMs, dial indicators, and laser measurement systems
- Warpage control after welding or bending is critical to avoid downstream functional failures

##### **3** Hole Diameters & Locations

- Hole-to-hole positional tolerances (true position)
- Hole-to-edge and hole-to-bend spacing
- PEM and rivet nut installation holes require precise Go/No-Go verification
- Countersink depth, angle, and concentricity for fastener seating

#### General Guidelines:

- Hole diameter  $\geq$  material thickness (standard materials)
- For strong materials (e.g. stainless steel): diameter  $\geq$  2x thickness
- Hole-to-edge spacing  $\geq$  2x material thickness
- Hole-to-bend distance  $\geq$  2.5x material thickness + bend radius

#### **4 Bend Angles & Flange Dimensions**

- Bend angle accuracy directly affects final geometry and fit-up
- Hole shift after bending must be closely monitored
- Minimum flange length typically  $\geq$  4x material thickness
- Bend radius should match or exceed material thickness to avoid cracking

#### **Standard Tolerance:**

$\pm 1^\circ$  on bend angles using digital protractors or 3D angle measurement systems

#### **5 Surface Finishes & Coating Thickness**

- Anodizing, powder coating, plating, and bead blasting must meet thickness and cosmetic standards
- Coating thickness verified with coating thickness gauges
- Surface roughness measured using profilometers

#### **6 Fastener Seating Depth**

- PEM insertion depth and flushness control
- Rivet nut installed depth uniformity
- Weld stud perpendicularity and penetration integrity

#### **7 Surface Feature Alignment**

- Slot width, tab alignment, and panel edge parallelism
- Essential for robotic assembly and photonics alignment plates

### **Inspection Tools Applied to Critical Dimensions**

<b>Critical Feature</b>	<b>Inspection Tools</b>
Material Thickness	Micrometers, Thickness Gauges
Hole Positions	CMM, Optical Comparator
Hole Diameters	Pin Gauges (Go/No-Go)
Bend Angles	Digital Protractors, Forming Gauges
Flange Heights	Height Gauges
Flatness	CMM, Surface Plates, Dial Indicators
Fastener Seating	Micrometers, Height Gauges
Surface Finish	Coating Thickness Gauges, Profilometers

### **Dimensional Control Embedded in Rollyu Precision's Workflow**

### **Fabrication Stage Critical Dimension Focus**

Laser Cutting	Hole diameter and pattern accuracy
Forming & Bending	Bend angle accuracy, hole shift control
Welding	Weld warpage, heat-affected zone (HAZ) distortion
Fastener Insertion	Hole size, seating accuracy, pull-out strength
Surface Finishing	Coating thickness, cosmetic flatness
Final QC	Full CMM dimensional inspection & reporting

### **Industry Applications Requiring Strict Critical Dimension Control**

<b>Industry</b>	<b>Typical Critical Features</b>
Medical Devices	Enclosure fit-up, surface smoothness, hole location
Semiconductor Equipment	Vacuum sealing surfaces, hole alignment
Photonics	Flatness control, optical component mounting
Aerospace	Lightweight structures, weld distortion management
Automation	Fastener positioning, robotic system fit-up

### **Why Controlling Critical Dimensions Reduces Risk**

By embedding dimensional verification at every stage, **Rollyu Precision** delivers:

-  Repeatable part consistency
-  Regulatory compliance (ISO 9001 & ISO 13485)
-  Minimized rework, scrap, and delays
-  Confident downstream assembly fit for customer systems
-  Long-term part performance and functional reliability

 **For precision sheet metal fabrication with full critical dimension control, contact Rollyu Precision at:**  
**[info@rymachining.com](mailto:info@rymachining.com)**

- **Weld integrity inspection**

**Weld Integrity Inspection in Sheet Metal Fabrication**

In precision sheet metal fabrication, welding is often the final stage that secures complex assemblies into rigid, functional structures. However, welding also introduces localized heat, internal stresses, dimensional instability, and potential defects that can compromise structural performance if not properly controlled.

**Weld integrity inspection** plays a critical role in ensuring that each weld meets both structural and cosmetic requirements, maintaining long-term reliability across industries such as **medical devices, semiconductor equipment, photonics assemblies, automation systems, and aerospace structures.**

At **Rollyu Precision**, weld inspection is fully integrated into our manufacturing process, delivering consistent weld quality for highly regulated, mission-critical applications.

**Why Weld Integrity Inspection is Essential**

- Ensures structural strength of the assembly
- Detects weld defects that can lead to failure under load
- Controls post-weld distortion and dimensional stability
- Verifies cosmetic appearance for customer-facing parts
- Complies with ISO 9001, ISO 13485, and industry-specific welding standards
- Minimizes costly rework and scrap

**Common Welding Processes in Sheet Metal Fabrication**

<b>Welding Method</b>	<b>Typical Application</b>
<b>TIG Welding</b>	Precision frames, medical enclosures, thin-wall assemblies
<b>MIG Welding</b>	Automation frames, larger structural panels
<b>Spot Welding</b>	Electrical enclosures, thin sheet joining, mass production panels
<b>Stud Welding</b>	Fastener mounting points, structural bases
<b>Laser Welding (optional)</b>	High-precision seams for specialized thin parts

**Common Weld Defects That Require Inspection**

<b>Defect Type</b>	<b>Potential Failure Mode</b>
Lack of Fusion	Incomplete bonding → weak joint
Porosity	Trapped gas pockets → crack initiation
Cracks	Fracture propagation under load
Undercut	Loss of cross-sectional strength
Burn-Through	Excessive heat → holes and voids
Misalignment	Poor joint fit → dimensional shift

**Defect Type    Potential Failure Mode**

Warpage            Post-weld deformation → fit-up problems

**Weld Inspection Techniques at Rollyu Precision**

**1 Visual Weld Inspection (First Line Defense)**

- Uniform bead width and height
- Smooth, consistent weld appearance
- No visible porosity, cracking, or undercut
- Cosmetic standards for medical, photonics, semiconductor assemblies

**2 Dimensional & Distortion Inspection**

- Post-weld flatness verification using CMM and surface plates
- Warpage and shrinkage control measurements
- Hole position verification after welding

**3 Non-Destructive Testing (NDT)**

<b>NDT Method</b>	<b>Application</b>
<b>Dye Penetrant Testing (PT)</b>	Detects surface cracks and open defects
<b>Ultrasonic Testing (UT)</b>	Identifies internal weld flaws (for thicker or structural parts)
<b>Magnetic Particle Inspection (MPI)</b>	Shallow subsurface defect detection
<b>X-Ray (Radiographic Inspection)</b>	High-integrity weld validation (primarily aerospace use)

**4 Mechanical Testing (Sample-Based)**

- Weld pull testing (tensile strength validation)
- Bend testing (ductility assessment)
- Fatigue cycling (load endurance evaluation)

**Heat-Affected Zone (HAZ) Monitoring**

- Monitors grain structure changes caused by welding heat
- Controls embrittlement risk near the weld seam
- Manages HAZ width to prevent downstream warpage
- Critical for thin materials and cosmetic sheet metal assemblies

**Weld Integrity Inspection in Rollyu Precision Workflow**

<b>Stage</b>	<b>Weld Control Focus</b>
<b>Joint Preparation</b>	Edge fit-up, gap control, pre-cleaning
<b>Welding Process</b>	Controlled parameters: amperage, voltage, feed rate, shielding gas
<b>In-Process Visual Checks</b>	Continuous monitoring during welding
<b>Post-Weld Checks</b>	<b>Dimensional</b> Flatness, hole locations, weld alignment
<b>Final NDT Testing</b>	(as PT, UT, or MPI based on application <a href="http://www.rollyu.com">www.rollyu.com</a> info@rymaching.com)



- **Surface finish standards**

**Surface Finish Standards in Sheet Metal Fabrication**

In precision sheet metal fabrication, surface finish is far more than just appearance. The level of smoothness, texture, and coating quality achieved on fabricated parts plays a direct role in their **functionality, durability, and long-term reliability**. In many industries, surface finish standards are strictly defined because they directly influence how well parts fit, assemble, resist corrosion, bond, or meet downstream processing requirements.

At Rollyu Precision, surface finish control is fully integrated into our production and quality systems, ensuring every fabricated part consistently meets both technical and cosmetic specifications.

**Why Surface Finish Standards Matter**

Surface finish standards exist to ensure fabricated sheet metal parts not only look correct, but also function properly throughout their service life. Surface finish directly affects:

- **Cosmetic Appearance**  
Visual aesthetics, gloss levels, color uniformity, and surface texture.
- **Assembly Fit**  
Ensures flatness, dimensional stability, and repeatable mating of components.
- **Corrosion Protection**  
Improves long-term part stability in challenging environments.
- **Cleanliness & Sterility**  
Critical for medical devices and semiconductor equipment, where contamination is unacceptable.
- **Coating Adhesion**  
Ensures uniform application and long-term durability of powder coat, plating, or anodizing.
- **Electrical Properties**  
Key for parts requiring conductivity, shielding, or insulation performance.
- **Friction & Wear Resistance**  
Essential for moving components, enclosures, or mechanisms where parts interface.

**Industry-Specific Surface Finish Expectations**

Surface finish standards vary based on the part's end-use industry:

Industry	Surface Finish Focus
Medical Devices	Smooth, non-porous, sterile surfaces; electropolishing; passivation; burr-free edges.
Semiconductors	Ultra-clean, particle-free, low Ra (<0.2 μm); contamination-free; vacuum-compatible finishes.
Photonics	Flawless surface flatness; no scratches; uniform anodizing for optical consistency.
Aerospace	Corrosion protection; anodized or plated; high fatigue resistance;

<b>Industry</b>	<b>Surface Finish Focus</b>
	controlled edge finishes.
<b>Telecom Electronics</b>	<b>&amp;</b> Conductive coatings; EMI shielding; cosmetic uniformity; solderability.
<b>Automation Robotics</b>	<b>&amp;</b> Durable coatings; wear resistance; clean aesthetics; functional edges.

### **Common Surface Finishing Processes in Sheet Metal Fabrication**

Several finishing processes are used to meet specific functional and visual standards:

#### **1 Bead Blasting**

Creates a matte, uniform surface finish, removing minor imperfections and tool marks. Used extensively for pre-coating preparation or cosmetic control.

#### **2 Brushing**

Applies controlled grain patterns for aesthetic appeal or functional alignment with housing assemblies.

#### **3 Anodizing**

Forms a hard, corrosion-resistant oxide layer with optional color finishes. Widely used for aluminum parts in medical, aerospace, and optical equipment.

#### **4 Powder Coating**

Applies a durable, uniform colored finish with excellent mechanical protection, used extensively across automation, robotics, and enclosure industries.

#### **5 Plating (Zinc, Nickel, Gold, Silver)**

Enhances corrosion protection, solderability, and electrical performance for electronics, telecommunications, and cleanroom assemblies.

#### **6 Electropolishing**

Removes microscopic peaks from metal surfaces, producing extremely smooth finishes critical for medical, semiconductor, and high-purity applications.

#### **7 Passivation**

Chemically removes surface iron to improve corrosion resistance on stainless steel, while preserving appearance.

#### **8 Deburring & Edge Treatment**

Removes sharp edges and burrs after cutting and forming to improve part safety, coating adhesion, and assembly performance.

## Typical Surface Roughness Standards

Surface finish is commonly quantified by surface roughness (Ra), measured in micrometers ( $\mu\text{m}$ ):

Process	Typical Surface Roughness (Ra $\mu\text{m}$ )
Laser Cutting	3.2 – 12.5 $\mu\text{m}$
Waterjet Cutting	1.6 – 6.3 $\mu\text{m}$
CNC Shearing	0.8 – 6.3 $\mu\text{m}$
Bending/Forming	0.8 – 3.2 $\mu\text{m}$
Grinding	0.4 – 1.6 $\mu\text{m}$
Bead Blasting	1.6 – 3.2 $\mu\text{m}$
Brushing	0.8 – 1.6 $\mu\text{m}$
Anodizing/Plating	< 0.8 $\mu\text{m}$
Electropolishing	0.1 – 0.4 $\mu\text{m}$

*Note: Specific customer requirements may exceed these general ranges depending on application.*

## International Surface Finish Standards & Compliance

Rollyu Precision operates under fully traceable quality systems aligned with global standards:

- **ISO 1302** (Surface finish symbols for drawings)
- **ISO 4287 / ISO 4288** (Surface texture measurement methods)
- **ASME B46.1** (US surface texture standards)
- **ISO 9001 / ISO 13485** (Quality management system certifications)
- **AMS / MIL-STD Specifications** (Aerospace and defense finish standards)
- **FDA / GMP Requirements** (Medical device cleanliness and finish standards)

## Surface Finish Inspection & Quality Control at Rollyu Precision

Every surface finish is inspected and documented to ensure compliance:

- **Profilometer Testing:** Ra surface roughness verification
- **Visual Inspection:** Under controlled lighting for cosmetic defects
- **Microscopic Inspection:** For micro-defects, pitting, or embedded contaminants
- **Coating Thickness Testing:** Non-destructive verification of plating and powder coat thickness
- **Cleanliness Testing:** Wipe tests and particulate analysis for medical/semiconductor parts
- **Adhesion Testing:** Cross-hatch and pull-off tests for coatings and platings

## Conclusion

Surface finish standards are not an afterthought—they are an essential part of precision sheet metal fabrication. By controlling surface quality at every step, Rollyu Precision ensures our fabricated parts meet **both functional performance and world-class cosmetic standards**, fully compliant with customer requirements across the most demanding industries.

- **Full traceability with ISO certification**

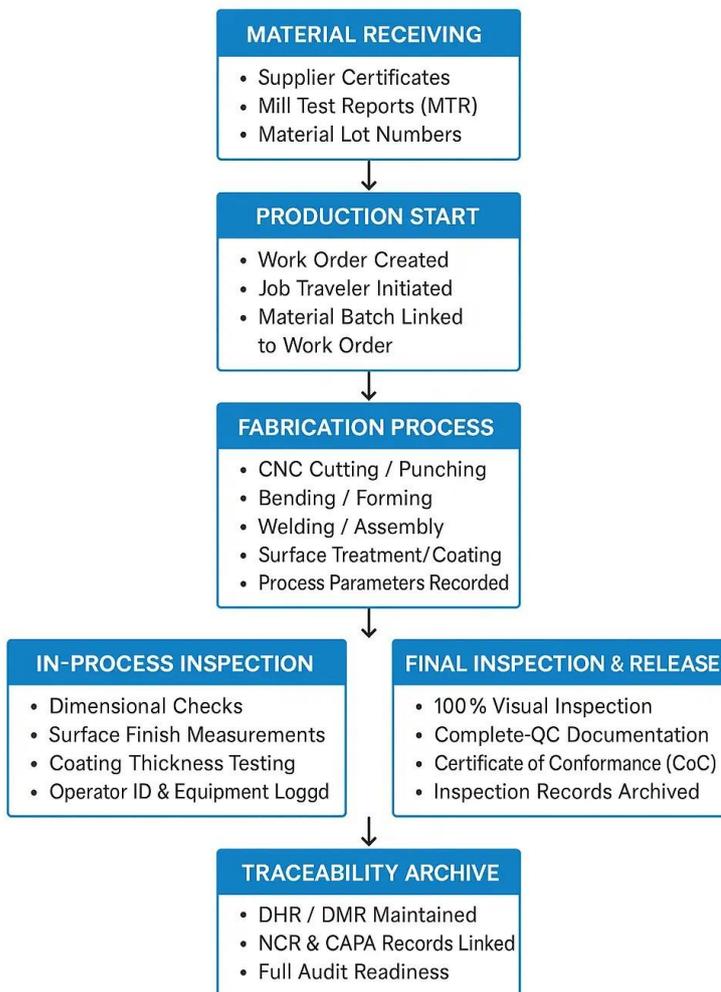
**Full Traceability with ISO 9001 & ISO 13485 Certification in Sheet Metal Fabrication**

In precision sheet metal fabrication, **full traceability is not optional — it is a core requirement** for industries where safety, functionality, and regulatory compliance are directly tied to how each part is produced, inspected, and documented.

At Rollyu Precision, full traceability is fully integrated into every stage of our manufacturing process — from incoming raw materials to finished product delivery — in full compliance with both **ISO 9001:2015** and **ISO 13485:2016** certifications.

## TRACEABILITY FLOWCHART

ISO 9001 & 134855



## ISO 9001 and Traceability in Sheet Metal Fabrication

ISO 9001:2015, the globally recognized standard for quality management systems, addresses traceability requirements under **Clause 8.5.2 – Identification and Traceability**. While ISO 9001 allows for flexibility depending on customer and industry needs, full traceability systems in sheet metal fabrication typically include:

- **Product Identification:** Each part, batch, or work order carries unique identifiers (lot codes, serial numbers, job travelers).
- **Material Traceability:** Mill certifications (MTRs), supplier certificates, and batch records link raw material batches to each fabricated part.
- **Process Documentation:** Every step in the production sequence — cutting, bending, welding, finishing, coating — is recorded with operator ID, machine ID, and timestamp.
- **Inspection Records:** Dimensional checks, surface finish inspections, coating measurements, and final quality control results are documented for each batch.
- **Non-Conformance Tracking:** Any deviations are logged, investigated, and resolved under documented corrective action procedures (NCR, CAPA).
- **Audit-Ready Documentation:** Complete traceability packages are maintained for customer audits, internal reviews, and regulatory inspections.

While ISO 9001 applies across many industries, this level of traceability provides the foundation for highly regulated sectors that demand even stricter process control.

## ISO 13485 and Traceability for Medical Device Components

For medical device applications, **ISO 13485:2016** establishes far more rigorous traceability standards, as required by FDA regulations, EU MDR, and other global health authorities. In precision sheet metal fabrication, ISO 13485 compliance ensures that fabricated components meet strict regulatory expectations for:

- **Device-Level Traceability:** Each component can be traced not only to its material and manufacturing process but also to its final device assembly.
- **Component Lot Control:** All material batches, process records, and inspection data are tied to specific device lots or serial numbers.
- **Process Validation:** Critical manufacturing processes such as welding, surface finishing, and coating are validated, controlled, and monitored.
- **Device History Records (DHR):** Complete documentation files are maintained for each device lot, including materials, processes, inspections, and certifications.
- **Risk Management:** Full documentation ensures that any product issues can be rapidly investigated and contained, with full transparency across the entire supply chain.
- **Corrective and Preventive Action (CAPA):** ISO 13485 requires that all non-conformances are systematically analyzed, root causes identified, and permanent corrective actions implemented.

## The Value of Implementing Full Traceability

For companies operating under ISO 9001 and ISO 13485 certifications, full traceability delivers clear, measurable benefits:

- **✓ Regulatory Compliance** — Satisfies FDA, EU MDR, and global customer requirements.
- **✓ Rapid Problem Resolution** — Immediate lot-level tracking for root cause analysis and containment.
- **✓ Supply Chain Confidence** — Enables end-to-end documentation from raw material supplier to finished product delivery.
- **✓ Audit Readiness** — Traceability packages are always prepared for both customer and regulatory audits.
- **✓ Customer Satisfaction** — Builds trust by demonstrating full manufacturing control.
- **✓ Business Growth** — Opens access to regulated markets including medical devices, life sciences, semiconductors, photonics, and aerospace.

## Full Traceability in Action at Rollyu Precision

At Rollyu Precision, full traceability is not limited to documentation alone — it is embedded into every operational layer of our precision sheet metal fabrication process:

- Raw material batch control with MTR linkage
- Work order travelers linked to operator, equipment, and process history
- In-process inspection data capture at every critical stage
- Process validation files for coating, welding, surface finishing, and critical tolerances
- Surface finish inspection reports, Ra roughness measurements, coating thickness logs
- Full inspection record retention and customer access to certification packages
- Complete non-conformance investigation and corrective action tracking
- DHR and DMR archives for regulated device production
- ISO 9001:2015 and ISO 13485:2016 fully certified system oversight

## Conclusion

**Full traceability is not simply a document — it is a system-wide discipline.**

Through ISO 9001 and ISO 13485 certified processes, Rollyu Precision provides customers with the confidence that every fabricated part is built, inspected, and documented to meet the most demanding quality and regulatory requirements — across medical devices, photonics, semiconductors, aerospace, and automation industries.

## Chapter 7: Application Examples by Industry

Automate tasks in laboratories, such as moving samples, testing, and synthesizing compounds.

### Application Examples by Industry for Sheet Metal Fabrication

Sheet metal fabrication is one of the most versatile manufacturing processes, delivering high-precision, lightweight, durable, and cost-effective components across a wide range of industries. At **Rollyu Precision**, we serve highly regulated sectors where part performance, consistency, and full traceability are critical.

Below are detailed examples of how precision sheet metal fabrication supports each key industry:

#### 1 Medical Devices & Life Sciences

Precision sheet metal components are essential for medical devices where sterility, safety, and dimensional accuracy directly impact patient care.

##### Application Examples:

- Medical enclosures for diagnostic equipment (CT, MRI, X-ray machines)
- Surgical robot frames and panels
- Sterilization trays and instrument holders
- Cleanroom-compatible enclosures and fixtures
- Laboratory automation equipment housings
- Blood analyzers and laboratory testing instruments
- Medical laser equipment chassis

##### Key Process Requirements:

- ISO 13485 certified manufacturing
- Electropolishing, passivation, and anodizing
- Biocompatible materials (316L stainless, anodized aluminum)
- Burr-free edges for safety and cleanliness
- Ultra-smooth surface finishes (Ra control)

#### 2 Semiconductor Manufacturing

Semiconductor fabrication requires precision sheet metal parts that operate in ultra-clean, vacuum, and contamination-sensitive environments.

##### Application Examples:

- Wafer handling modules
- Load ports and transfer arms
- Vacuum chamber components
- Cleanroom carts, cabinets, and frames
- Tool enclosures for deposition, lithography, and metrology
- Chemical delivery panels

##### Key Process Requirements:

- Ultra-clean welding and finishing
- Contamination-free surface treatments
- Electropolishing and passivation for high-purity requirements
- Tight dimensional tolerances for critical assemblies
- ISO 9001-certified manufacturing and full traceability

### **3 Photonics & Optical Systems**

Precision sheet metal fabrication provides structural stability and optical alignment support for laser systems, sensors, and photonics equipment.

#### **Application Examples:**

- Laser system chassis and heat sink panels
- Optical table frames and mounts
- Photonics lab enclosures
- Fiber optic alignment modules
- Sensor housing assemblies
- Optical test instrument casings

#### **Key Process Requirements:**

- Controlled anodizing for light absorption/reflection
- Minimal thermal distortion during fabrication
- Flatness and parallelism for optical alignment
- Cosmetic surface finishes with no scratches or pits
- Shielding and EMI protection coatings

### **4 Space & Satellite**

In aerospace applications, weight, strength, fatigue life, and corrosion resistance drive demanding sheet metal fabrication requirements.

#### **Application Examples:**

- Avionics enclosures and instrument panels
- UAV (drone) structural components
- Satellite subsystem brackets and covers
- Communication and navigation system housings
- Ground support equipment panels
- Military-grade enclosure assemblies

#### **Key Process Requirements:**

- Aerospace-grade materials (7075 aluminum, titanium, high-strength stainless steels)
- Surface treatments: chromate conversion, anodizing, chemical film
- Weight reduction designs (lightweight panels, complex cutouts)
- Tight tolerances on hole patterns and fastener locations
- Full material certification and lot traceability

### **5 Industrial Automation & Robotics**

Precision sheet metal components are widely used in robotics, production equipment, and automated manufacturing systems where strength, accuracy, and repeatability are critical.

### Application Examples:

- Robotic arm covers and mounting plates
- AGV/AMR (autonomous robot) chassis and enclosures
- Conveyor system guides and brackets
- Industrial machine guards and safety enclosures
- Electrical control cabinets and operator panels
- Work cell frames and modular automation structures

### Key Process Requirements:

- Sturdy welded frame assemblies
- Powder coating and plating for corrosion resistance
- Precision hole locations for assembly repeatability
- Smooth surfaces for safe handling and operator interface
- Modular, scalable design for automation system flexibility

## 6 Telecommunications & Electronics

In telecom and electronics, sheet metal fabrication provides protective enclosures, heat management, and EMI shielding for sensitive equipment.

### Application Examples:

- Server rack panels and enclosures
- RF shielding housings
- Power distribution unit frames
- Communication switch cabinets
- Telecom tower structural brackets
- Cooling assemblies for high-density electronics

### Key Process Requirements:

- Precision cutouts for ports and connectors
- EMI/RFI shielding coatings (nickel plating, conductive gaskets)
- Heat dissipation designs
- Durable powder coat finishes
- Cosmetic panel uniformity for high-end electronic systems

## 7 Renewable Energy & Power Systems

Sheet metal fabrication supports the rapidly growing renewable energy and energy storage industries, delivering scalable, durable structures.

### Application Examples:

- Solar panel mounting structures
- Energy storage system enclosures
- Wind turbine electrical control cabinets
- Inverter housing assemblies
- Power distribution panels
- EV charging station enclosures

### Key Process Requirements:

- Outdoor corrosion resistance (powder coating, anodizing)

- Weatherproof enclosures with tight sealing
- Sturdy structural designs for wind and vibration loads
- Long-term durability under outdoor exposure
- Certified electrical safety panel fabrication

### **8 Scientific Research & Lab Equipment**

Precision sheet metal enables the construction of stable, clean, and precise structures for advanced research and laboratory instruments.

#### **Application Examples:**

- Analytical instrument casings
- Cleanroom-compatible frames and tables
- Vacuum chamber flanges and covers
- Cryogenic system components
- Microscopy system housings
- Biotech lab automation frames

#### **Key Process Requirements:**

- Low-particle finishes for cleanroom compatibility
- Stable flatness for alignment-sensitive assemblies
- Ultra-smooth surface preparation for sealing
- Contamination-controlled welding and finishing
- Full documentation for calibration traceability

### **✓ Summary**

Precision sheet metal fabrication is not a commodity — it's a critical manufacturing process that supports some of the most demanding industries in the world.

At **Rollyu Precision**, we combine advanced sheet metal fabrication expertise with ISO 9001 and ISO 13485 certified quality systems to deliver fully traceable, highly repeatable, and industry-compliant parts — from prototype to full-scale production.

---

**Contact us at [info@rymachining.com](mailto:info@rymachining.com) for your next precision sheet metal fabrication project.**

## Chapter 8: Case Studies

### Searching for a reliable sheet metal fabrication partner to support your business growth?

At **Rollyu Precision**, we understand that choosing a new metal manufacturing partner is a major business decision. You need confidence that your supplier can deliver precision, consistency, and on-time results — not just promises. That's why we proudly showcase real-world case studies from industries we serve every day.

These success stories demonstrate how we help global companies optimize their sheet metal fabrication processes, control costs, and scale their production — while meeting the most demanding industry requirements.

### Why Companies Trust Rollyu Precision for Sheet Metal Fabrication

At our advanced manufacturing facility in Shenzhen, China, we provide **full-service sheet metal fabrication solutions** under one roof:

- **✓ CNC Laser Cutting** for highly accurate and repeatable profiles
- **✓ Precision Sheet Metal Forming** for complex bends and tight tolerances
- **✓ Certified Welding Services** (TIG, MIG, Spot Welding)
- **✓ Powder Coating and Surface Finishing** for durability and aesthetics
- **✓ Assembly and Sub-Assembly** services to simplify your supply chain
- **✓ Complete In-House Quality Control** with full inspection reporting
- **✓ ISO 9001 & ISO 13485 Certified Processes** for regulated industries

Unlike many suppliers, we combine technology with lean manufacturing systems such as:

- **KanBan Inventory Control**
- **Dynamic Nesting for Material Optimization**
- **Custom Kitting and Packaging Solutions**

This allows us to provide highly efficient, cost-effective, and scalable manufacturing programs — customized for each customer's specific product needs.

### Industries We Serve with Precision Sheet Metal Fabrication

Rollyu Precision supports OEMs, contract manufacturers, and system integrators across multiple industries, including:

- Medical Devices & Life Sciences
- Dental Equipment
- Semiconductor Manufacturing
- Photonics & Optics
- Robotics & Automation
- Aerospace & Aviation
- Telecommunications & Electronics
- Renewable Energy & Power Systems

And more.

Our experience in these highly regulated sectors allows us to manage complex part geometries, tight dimensional tolerances, traceability requirements, and surface finishing standards with confidence.

- **Use real projects to showcase problem-solving and manufacturing excellence certified quality systems.**

### **Real Case Studies — Solving Customer Challenges**

Here are just a few examples of how our sheet metal fabrication services have delivered real, measurable results for our clients: **Medical Device Enclosure: Faster Production, Zero Cosmetic Defects**

**Challenge:** A medical OEM was experiencing high cosmetic reject rates on powder-coated sheet metal enclosures from their previous supplier.

**Solution:** Rollyu Precision optimized the forming and surface preparation process, applied controlled powder coating thickness, and introduced in-line inspections.

**Result:** Cosmetic rejects dropped to <0.5%, lead times reduced by 30%, full compliance with ISO 13485 standards.

### **Semiconductor Equipment Frame: Tight Tolerances, Improved Assembly Fit**

**Challenge:** A semiconductor customer required high-precision structural frames with complex welding and dimensional stability.

**Solution:** Our team implemented precision welding fixtures, controlled heat input during welding, and performed full CMM dimensional verification.

**Result:** Parts achieved  $\pm 0.1\text{mm}$  flatness across 1-meter frame assemblies, improving the customer's downstream assembly accuracy.

### **Automation Chassis: Inventory Reduction & Lean Supply Chain**

**Challenge:** An automation integrator was struggling with fluctuating demand and excess inventory buildup.

**Solution:** We implemented a KanBan production system with flexible weekly releases, combined with dynamic nesting for efficient material usage.

**Result:** The customer reduced on-hand inventory by 40%, while maintaining stable lead times and delivery reliability.

**More case studies are continuously being added. Please check back regularly or contact our team directly to discuss how we can help with your unique sheet metal fabrication project.**

# Chapter 9: FAQs for Sheet Metal Projects

## Frequently Asked Questions (FAQs) for Sheet Metal Projects

### 1 What industries does Rollyu Precision serve with sheet metal fabrication?

We serve a wide range of industries that demand precision, quality, and full traceability, including:

- Medical Devices & Life Sciences
- Dental Equipment
- Semiconductor Equipment
- Robotics & Automation
- Aerospace & Aviation
- Photonics & Optics
- Telecommunications
- Renewable Energy & Power Generation
- Industrial Equipment & Automation Systems

### 2 What sheet metal materials can you work with?

We routinely fabricate parts using a wide variety of metals, including:

- Aluminum (5052, 6061, 7075, MIC-6)
- Stainless Steel (304, 316, 430)
- Mild Carbon Steel (SPCC, CRS)
- Galvanized Steel
- Cold-Rolled & Hot-Rolled Steel
- Copper & Brass Alloys
- Titanium (limited thicknesses)

If you have special material requirements, we can also source and certify specialty alloys per your project specifications.

### 3 What fabrication processes do you offer in-house?

Our fully integrated facility provides complete in-house services including:

- CNC Laser Cutting
- Sheet Metal Forming & Bending
- Welding (MIG, TIG, Spot Welding)
- Surface Finishing (Powder Coating, Anodizing, Plating, Bead Blasting)
- Assembly & Sub-Assembly
- Quality Control & CMM Inspection
- Custom Kitting & Packaging

This full vertical integration helps us control lead times, quality, and cost for our customers.

### 4 What are your typical sheet metal tolerances?

For most precision sheet metal projects, our standard tolerances are:

- Laser Cutting:  $\pm 0.1\text{mm}$
- Bending/Forming:  $\pm 0.2\text{mm}$  (depending on material thickness & bend complexity)

- Welded Assemblies:  $\pm 0.3\text{mm}$  (post-weld machining can tighten this)
- Flatness:  $\leq 0.15\text{mm}$  per 300mm (depending on part size)

We can also achieve tighter tolerances upon request depending on part geometry, material, and application.

#### **5 Do you offer prototyping and low-volume sheet metal production?**

Yes. We support:

- Rapid prototyping
- Pre-production sampling
- Low-volume custom runs
- Bridge production prior to mass production

Our flexible production allows customers to validate designs before scaling up to mass production, minimizing risks and optimizing manufacturability.

#### **6 How do you handle quality control?**

Quality control is fully integrated throughout our manufacturing process. We offer:

- First Article Inspection (FAI)
- In-Process Inspection
- Final Dimensional Inspection
- CMM Verification (Coordinate Measuring Machine)
- Full inspection reports upon request
- ISO 9001 & ISO 13485 certified processes

#### **7 Can you handle international shipping and export compliance?**

Yes. We regularly ship globally. Our export team is experienced in handling:

- International freight coordination
- Export documentation
- Compliance with customer import regulations
- Careful packaging to prevent transit damage

We work with customers across North America, Europe, Australia, and Asia.

#### **8 What is your typical lead time for sheet metal projects?**

- Prototypes: 7–15 business days (depending on complexity)
- Standard production: 3–5 weeks
- Complex assemblies or high-volume production: 4–8 weeks

Lead time may vary based on part complexity, material availability, and customer schedule. Expedited production is available for urgent projects.

#### **9 Can you support KanBan or scheduled release programs?**

Absolutely. We offer:

- KanBan inventory management
- Blanket orders with scheduled releases
- Just-in-Time (JIT) deliveries

- Vendor-managed inventory (VMI) support

These programs help our customers reduce inventory holding costs and improve supply chain flexibility.

**10 How do I request a quote for my sheet metal project?**

Simply email your 2D drawings, 3D models (STEP, IGES, SolidWorks), material specs, quantity, and any special requirements to our sales team at:

**[info@rymachining.com](mailto:info@rymachining.com)**

Our engineering team will review your files and provide a detailed quote promptly.

## Chapter 10: Getting a Quote

### Getting a Quote for Sheet Metal Fabrication — Rollyu Precision

At **Rollyu Precision**, we make the quoting process for sheet metal fabrication simple, transparent, and highly responsive. Whether you're requesting a prototype, small batch run, or full production order, our experienced team will carefully review your project and provide a clear, detailed quotation tailored to your specific requirements.

### What Information Do We Need to Provide an Accurate Quote?

To ensure an efficient and accurate quote, please prepare the following information:

#### 1 Engineering Drawings

- 2D CAD drawings (PDF, DWG, DXF, etc.)
- 3D models (STEP, IGES, SolidWorks, etc.)
- Include all critical dimensions, tolerances, hole locations, and notes.

#### 2 Material Specifications

- Material type (e.g. Aluminum 5052-H32, Stainless Steel 304, CRS, etc.)
- Thickness and grade
- Any special certifications (RoHS, REACH, DFARS, etc.)

#### 3 Quantity

- Prototype quantity
- Production batch quantity
- Forecast volumes for blanket orders or KanBan programs

#### 4 Finishing Requirements

- Surface finish (Powder Coating, Anodizing, Plating, Polishing, Bead Blasting, etc.)
- Color codes (if applicable)
- Cosmetic or functional finish requirements

#### 5 Assembly or Sub-Assembly Details (if applicable)

- Bill of Materials (BOM)
- Hardware requirements (fasteners, PEM inserts, etc.)
- Welding or bonding details

#### 6 Delivery Information

- Required lead time
- Shipping destination (domestic or international)
- Special packaging or labeling requirements

### How We Process Your Quote Request

Our quoting process includes:

✓ **Engineering Review:** Our experienced engineering team evaluates manufacturability, DFM (Design for Manufacturability), and cost optimization opportunities.

✓ **Material Sourcing Check:** We verify raw material availability to ensure timely production.

✓ **Process Planning:** We determine the optimal cutting, forming, welding, finishing, and inspection processes.

✔ **Cost Breakdown:** We prepare a transparent quote including unit pricing, tooling (if required), lead time, and shipping costs.

#### Typical Quote Turnaround Time

- **Standard Quotes:** 1–2 business days
- **Complex Assemblies or Multi-Part Projects:** 3 business days

#### No CAD Files? No Problem.

If you only have hand sketches, photos, or concept drawings, our team can assist with design support and engineering reviews to help you prepare production-ready files.

#### Why Choose Rollyu Precision?

- ✔ In-house CNC laser cutting, bending, welding, assembly & finishing
- ✔ ISO 9001 & ISO 13485 certified
- ✔ Full quality control with inspection reports
- ✔ Fast, responsive communication
- ✔ Global export experience

#### Contact Our Quoting Team

✉ **Email:** [info@rymachining.com](mailto:info@rymachining.com)

🌐 **Website:** [www.rymachining.com](http://www.rymachining.com)  
[www.rollyu.com](http://www.rollyu.com)

📍 **Location:** Shenzhen, China (serving global customers worldwide)