finetubes / SuperiorTube

AMETEK
SPECIALTY METAL PRODUCTS

ENGINEERING SOLUTIONS **ABOVE INDUSTRY NORMS**



INSIDER'S GUIDE TO CHOOSING THE RIGHT PARTNER FOR SPACE MATERIALS

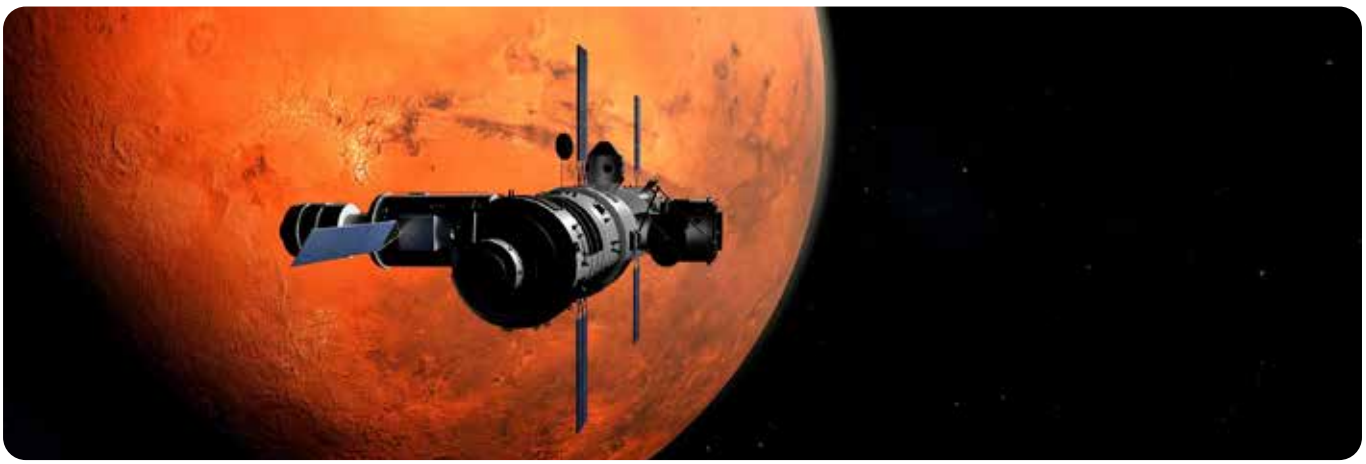
INTRODUCTION

Humanity has long demonstrated an innate need to explore and colonize. After a millennia of looking up at the stars and dreaming, space is no longer out of reach.

In our pursuit to deepen our understanding of the world around us, uncover untapped resources, and even consider the colonization of distant worlds, humanity is increasingly venturing beyond the life-sustaining safety of our home planet.

Science fiction has long been our inspiration to show us what space exploration might look like; and the International Space Station has helped us take those first tentative steps to living and working in space.

None of this is possible without the vision and expertise of the engineers. But how much thought do we give to the quality of the raw materials used to build space vehicles?



1/

Sustaining Life

Life support systems are the lifeline for astronauts delivering vital environmental conditions such as air supply, temperature regulation, water provision, and effective waste management.

Efficient removal of CO_2 and humidity is imperative to maintain a safe breathing environment for the crew. In parallel, controlling water condensation is key to preventing water intrusion into sensitive equipment and corrosion damage.

Engineered from corrosion-resistant alloys, the tubing within these systems must adhere to the highest standards of quality and cleanliness. This ensures the crew's survival and comfort in the unforgiving depths of space.

2

Propelling Spacecraft

Integral to every stage of a mission, propulsion systems play a pivotal role in accelerating the spacecraft for crucial maneuvers such as orbit insertion, station-keeping, collision avoidance, and altitude control.

After extended periods of inactivity in a hostile environment, the propulsion systems must perform on demand, without exception. This is a credit to both the engineering design and material selection. Collaborative efforts between companies ensure optimal quality and utilization of materials within specified design parameters.

A new generation of engineers is moving away from exotic materials, in favor of challenging how existing material specifications can be enhanced to meet the required performance characteristics. This can best be achieved by working in partnership with the technical teams from the manufacturing mills.

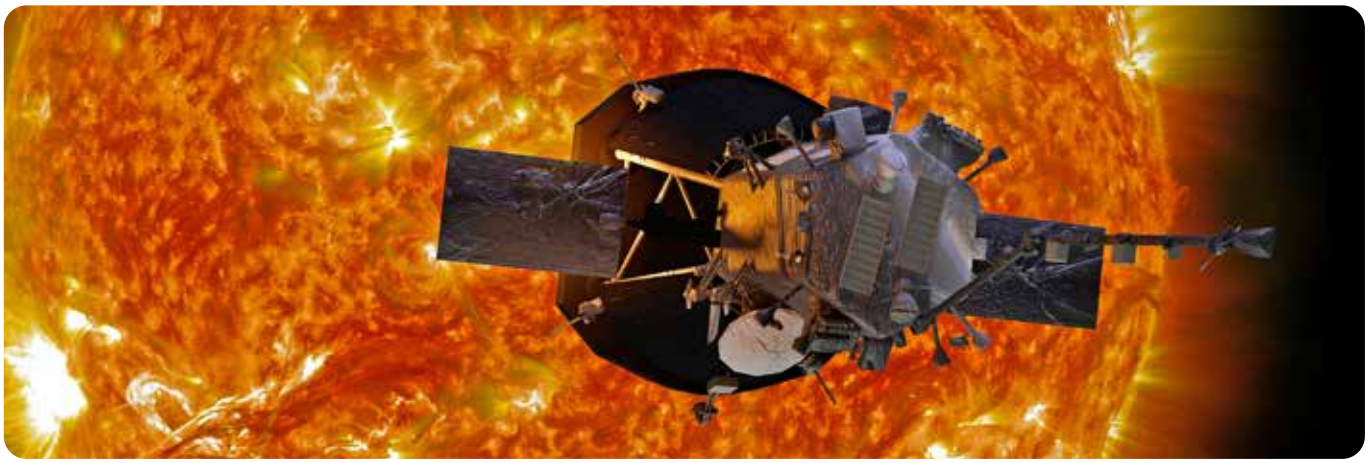
3

Driving Miniaturization

As technology progresses there has been a trend toward miniaturization in all aspects of life; and space is no exception.

If a satellite can be made smaller and lighter while maintaining the same level of performance, it opens up opportunities to capitalize on cost savings in launch expenditures.

This is not without its challenges. For example, at a time when systems are getting smaller, they can be designed for a longer life whilst operating at much higher parameters than ever before. Subsequently, material specifications are being upgraded to include tailored chemistries, improved mechanical properties, and tighter tube concentricity / dimensional tolerances.



4

The Extremes of Thermal Management

Space materials are engineered to endure a vast temperature range, spanning from cryogenic to blisteringly high temperatures.

This capability is paramount for spacecraft. Especially during re-entry into Earth's atmosphere, where speeds can reach up to 25,000 miles per hour, generating temperatures exceeding 3,000 degrees Fahrenheit.

Alloy selection and manufacture must exhibit very stable mechanical and fatigue properties at the temperatures experienced by a spacecraft during such conditions.

Materials engineered to the strictest aerospace standards undergo a rigorous manufacturing process, employing tailored material chemistry and specialized design routes. This precision engineering is essential to fulfill the stringent demands of space technology, particularly in managing heat and vibration during the intense re-entry procedure.

5

Qualifying the Right Supplier

When delivery performance, product quality, and cost are a given standard, what are your differentiating criteria that ensure you have the right partner for a successful launch?

- Technical expertise to modify current material specifications to exceed new and projected requirements.
- Engineering solutions that deliver exactly what design engineers have envisioned.
- Dedicated teams for technical support who continue to refine the product after delivery all the way through to the flight qualification standard.
- Collaborative engineering consisting of project teams from both mill and client who work in partnership consistently challenging what is possible and pushing the boundaries beyond existing 'can do' horizons.
- Experienced project and account management committed to delivering the project from concept to orbit on a tight schedule.

WHERE PERFORMANCE IS EVERYTHING AND MAINTENANCE IS IMPOSSIBLE

Fine Tubes and Superior Tube have a proud heritage of manufacturing precision-engineered tubes that require zero maintenance for current and next-generation space programs.

Space OEMs rely on our tubes to deliver the highest level of performance for decades without becoming compromised.

Let us help you launch to new horizons and deliver a safe and successful mission.

Out of This World Engineering

Innovation is part of our DNA at Fine Tubes and Superior Tube. With our extensive experience in both metallurgy and engineering, we welcome the opportunity to collaborate with customers.

Whatever the application or the challenge to solve, our experts will push the boundaries of manufacturing to deliver your custom-made tubes.

Materials Range

We work in partnership with our customers to find a material and engineering solution to best suit their requirements thus enabling maximum system performance.

Alloys include:

- Stainless steel
- Nickel
- Titanium

Superior Quality and Cleanliness

From rocket engines to satellite propulsion systems, our precision-engineered tubes deliver consistent performance even during extreme fluctuations in temperatures and pressures.

Inspection

Strict inspection processes and quality control are applied at every stage of our operations, enabling us to consistently achieve the highest standards. Our Quality Assurance System means we can offer full integrity and traceability for all our products and fulfill industry standards, as well as individual customer specifications.

PIONEERING SPACE PROGRAMS

Our involvement in the space industry goes back to the 1960s, when we contributed to Telstar 1, the world's first communications satellite. Since then, Fine Tubes and Superior Tube have been developing high-quality tubing solutions for innovative space exploration programs, including NASA's Space Shuttle, the Mars Exploration programs, and the Solar Orbiter project.

1962 **Telstar 1**

1966 **Surveyor 1**

1981 **NASA Space Shuttle**

2003 **Mars Exploration Rover**

2011 **Launch vehicles**

2018 **Space exploration programs**

2020 **Solar Orbiter**

202X* **Next-generation Space stations**

20XX* **Interplanetary exploration**

*202X: Demand for precision tubes for commercial space stations.
*20XX: Future interplanetary space exploration programs.

Telstar 1

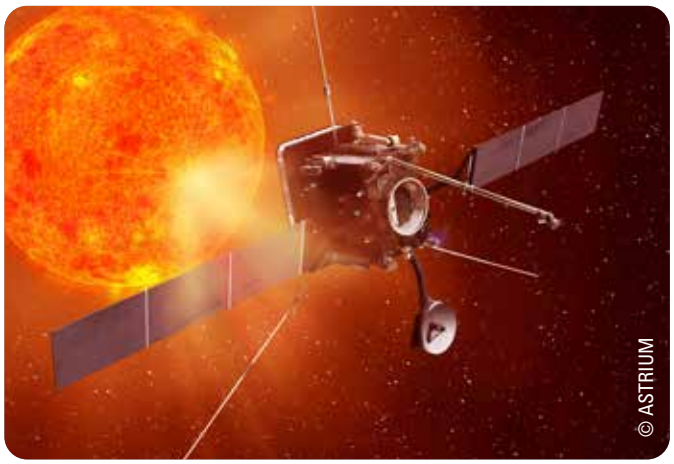
Superior Tube contributed to Telstar 1, the world's first communications satellite. This historic project sparked a new era of electronic communications and successfully relayed, through space, the first TV pictures, telephone calls and fax images.

NASA Space Shuttle

The NASA Space Shuttle program's life support system relied on high-pressure stainless steel tubing supplied by Superior Tube. The shuttle was the world's first reusable spacecraft.

Mars Exploration Rovers

The Spirit and Opportunity Mars rovers were launched with Superior Tube's tubing on board. These pioneering twin robots landed on Mars and discovered evidence that the red planet could have sustained microbial life.



Solar Orbiter

Fine Tubes was selected to engineer precision titanium tubing for the propulsion systems of the ground-breaking Solar Orbiter, the most complex scientific laboratory ever to have been sent to study the Sun.

SPACE APPLICATIONS

Resupply vehicles

Space Stations / Modules

Crew Transfer Vehicle

Satellite

Space Tug

Rocket fuel transfer

Fuel lines

Heat exchangers

Propulsion systems

ALLOYS

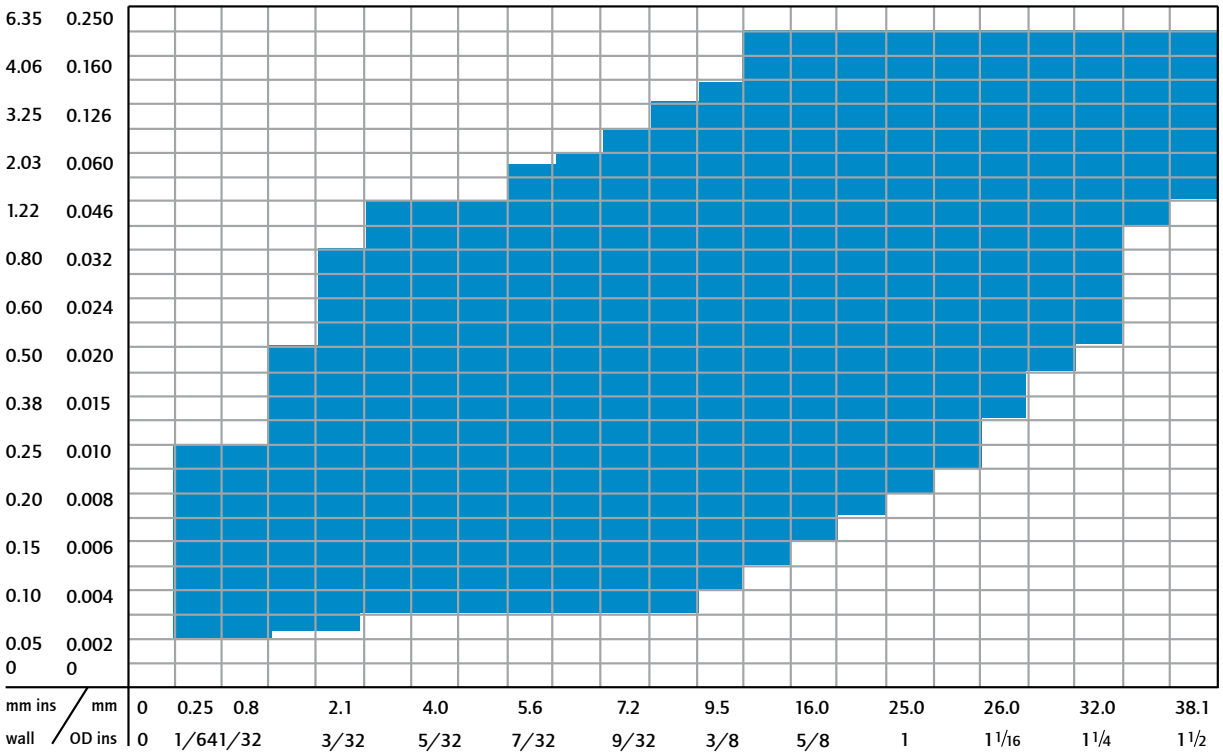
Fine Tubes and Superior Tube produce a wide range of custom-sized tubing in an ever expanding range of alloys – available in three different forms, i.e. seamless, welded or welded & redrawn (Weldrawn®) finish.

	FORM	
	SEAMLESS	WELDED & REDRAWN
STAINLESS STEEL		
304	•	•
316	•	•
321	•	•
347	•	•
15-5PH®	•	
17-4PH®		•
17-7PH®		•
21-6-9	•	•
F607	•	

We also manufacture tubing in many other grades. Please contact us for more details.

	FORM	
	SEAMLESS	WELDED & REDRAWN
NICKEL ALLOYS		
Waspaloy®		•
X-750	•	
Nimonic Alloy® 75	•	
Invar® 36		•
C263	•	
200	•	
201	•	
211	•	
600	•	
625	•	•
718	•	
TITANIUM		
Ti 3Al-2.5V (Grade 9)	•	
Ti 6Al-4V (Grade 5)	•	
Ti CP (Grade 1 and 2)	•	
Ti 4Al-2.5V	•	
Ti 6Al-4V ELI (Grade 23)	•	
Ti A-40	•	

SIZE RANGE



Our tubing sizes typical for aerospace applications range from 0.25 mm (0.010 in) to 38.10 mm (1.5 in) OD in seamless, welded and welded & redrawn.

QUALITY

QUALITY CERTIFICATIONS

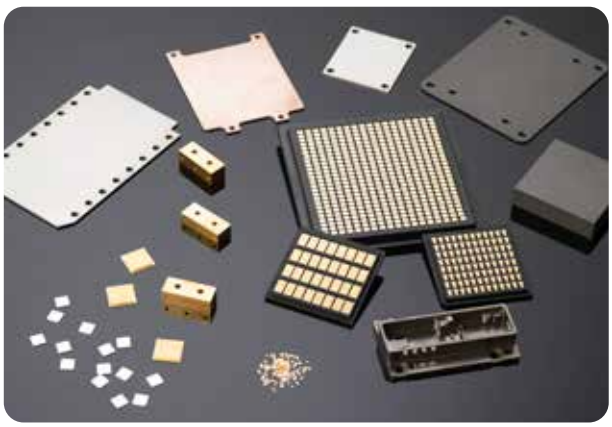
- Nadcap (Chemical Processing)
- Nadcap (Fluid Distribution Systems)
- Nadcap (Heat Treatment)
- Nadcap (NDT)
- Nadcap (Welding)
- TUV AD-2000 Merkblatt W0-TRD 100
- 97-23-EC (PED) - TüV
- ISO 9001
- AS EN 9100
- ISO 10012

Visit our website to explore our full list of Quality Certifications

EXPANDING HORIZONS BEYOND TUBING

Beyond precision tubes, we offer a range of cutting-edge materials engineered in superalloys for space applications. Trusted by Space OEMs, our innovative materials ensure unrivalled performance over decades, remaining uncompromised even in the most extreme temperatures, pressures, and radiation.

Visit our website to explore our full range of space materials.



Thermal Management Materials for Electronic Packages

Effective heat dissipation in space electronics is critical to ensure optimal performance. Our conductive materials deliver highly controlled thermal expansion to prevent overheating.

Nickel Strip for Battery Connectors

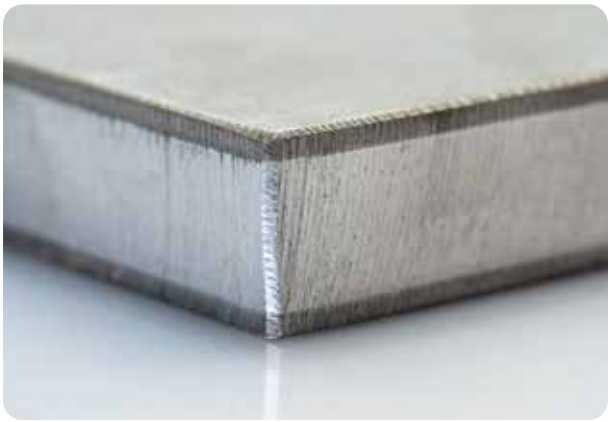
Advanced battery systems in spacecraft demand highly conductive and lightweight materials. Our pure nickel strip materials deliver a 20% increase in conductivity compared to traditional products.

Metal Power for Additive Components

Additive manufactured parts are used in diverse space applications, such as magnetic shields, heat pipes, and thrusters. Our powders enable the production of custom components through Laser Powder Bed, Binder Jet, and Cold Spray processes.

Precision Foil for Flexible Heaters

Flexible foil heaters provide precise, dependable, and immediate heat transfer for satellites. Our precision foils are custom-made to exacting sizes and thickness for consistent performance.

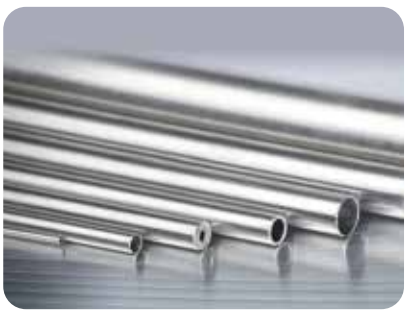


Clad Plate for Heat Shields

Heat shields are critical components in spacecraft design, protecting the vehicle from the intense heat generated during atmospheric re-entry. Our rollbonded clad plate is engineered to withstand the highest mechanical stress and temperature.

Molybdenum Double Clad Nickel Bond Pads for Satellite Applications

Molybdenum Bond Pads are essential for ensuring reliable electrical connections in satellite systems. Designed for top-side wire attachment via soldering, these pads form a robust metal bond that supports long-term durability.



World Leading Manufacturers of **Advanced Metallurgical Products** for Critical Space Applications.

ABOUT AMETEK SPECIALTY METAL PRODUCTS

AMETEK Specialty Metal Products (SMP) consists of six world-class manufacturers in the United States and the United Kingdom.

The range of manufactured products includes precision metal tube, strip and ultra-thin foil as well as custom metal powders, and microelectronic components for cutting-edge space and satellite programs.

Specialty metal tube businesses, Fine Tubes and Superior Tube, manufacture precision-engineered tubes for satellite propulsion systems, heat exchangers, and fuel and hydraulic tubes for space rocket engines.

AMETEK SMP Eighty Four develops metal additive powders for space application components as well as custom powders for thermal barrier and surface coatings.

AMETEK SMP Wallingford engineers pure nickel strip for battery connectors in weight-sensitive space applications. The business also produces thermal management materials for electronic packages in spacecraft.

AMETEK COINING engineers Cover Assemblies (CCA), molybdenum double clad nickel bond pads, and gold bonding wire for satellites.

AMETEK Specialty Metal Products (SMP) is a business unit of AMETEK, Inc. a leading global provider of industrial technology solutions serving a diverse set of attractive niche markets.

finetubes / AMETEK SPECIALTY METAL PRODUCTS

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