Case study: Precision gold plating of a Venturi throat for cryogenic rocket engines

When standard coating reaches its geometric limits

Customer

Manufacturer of components for cryogenic rocket engines.

The challenge

In modern rocket engines, Venturi nozzles perform a safety-critical function. They regulate the propellant flow and ensure a defined supply into the combustion chamber. The so-called Venturi throat, the narrowest point of the nozzle, is particularly critical. This is where the highest flow velocities and the lowest pressures occur.

The use of cryogenic propellants results in low temperatures. Combined with ambient humidity, this can lead to ice formation in the area of the Venturi throat. Icing can impair the propellant flow and, in the worst case, endanger the operational safety of the system.

To minimise this risk, the critical inner area of the Venturi throat was to be gold plated. The real challenge, however, was not the precious metal itself, but the exceptionally complex geometry of the component.

The problem

The surface to be coated was located deep inside a highly constricted Venturi geometry.

With components like these, conventional electroplating processes often reach their limits:

- Shadowing effects caused by the geometry
- Uneven layer distribution
- Insufficient metal deposition in the inner area
- Lack of reproducibility of the coating
- Risk of functional impairment in the critical flow area

For the customer, the gold plating itself was therefore not the actual problem.

The decisive question was:

How can a uniform and reproducible gold layer be produced exactly where the function of the component determines whether the overall system works reliably?

The SURPRO solution

SURPRO developed a specially adapted coating concept for the complex internal geometry.

To this end:

- the current-carrying areas of the plating rack were redesigned,

- the current distribution was specifically optimised,
- the electrolyte flow was tailored specifically to the Venturi geometry.

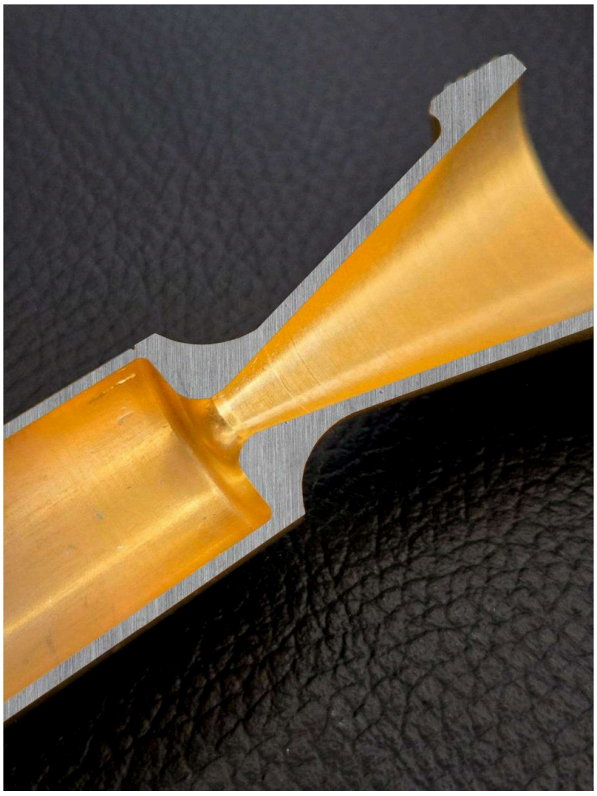
This made it possible to apply the gold coating precisely into the highly critical area of the Venturi throat.

The solution enabled significantly improved throwing power of the coating into areas that are difficult or impossible to reach with standard processes.

The result

For verification, a reference component was sectioned and analysed.

The analysis showed uniform gold deposition all the way into the relevant area of the Venturi throat. This proved that the developed process control enables the required coating even in the geometrically most demanding zone of the component.



Customer benefits

With the developed coating solution, the customer gained:

- ☑ Gold plating of complex internal geometries
- ☑ Reproducible coating quality
- ☑ Reliable access to critical functional areas
- ☑ A validated process for demanding aerospace applications
- ☑ A development partner for components that cannot be reliably coated with standard processes

---

Why this project is special

Many coating companies can apply gold to surfaces.

It is considerably more difficult to achieve controlled and uniform precious-metal deposition inside highly complex flow geometries.

This is exactly where SURPRO's core competence lay.

The challenge did not lie in gold as a material, but in developing an electroplating process that makes it possible to coat a safety-critical inner area in the first place.

Conclusion

SURPRO achieved the precise gold plating of a geometrically demanding Venturi throat for a cryogenic rocket engine. By combining special rack technology, optimised current control and targeted electrolyte flow, a uniform coating of the critical inner area was demonstrated. This created a solution where conventional coating processes reach their geometric limits.

When complex geometries prevent precise coating, SURPRO develops the process that makes it possible.