

INCONEL AEROSPACE

CASE STUDY
ELECTROCHEMICAL POLISHING

THE CHALLENGE

In the aerospace sector, strict regulatory requirements, environmental and safety standards combine with high performance needs to product exceptionally rigorous criteria for manufactured components.

Existing manufacturing and post-processing techniques are often insufficient for the levels of surface finish demanded for the type of complex high-performance alloy components deployed in the demanding aeronautical environment.

With this in mind, Holdson was approached by an industry-leading blue-chip aerospace manufacturer to enhance the surface quality of Inconel components used in their critical applications.

In this case, efficient airflow across the Inconel component's surface was essential for optimising both performance and fuel efficiency. The initial surface roughness of approximately $6\mu\text{m Ra}$ created friction, which was hampering airflow and decreasing the overall aerodynamic efficiency of the part. Achieving a smoother surface finish was critical, as even minor irregularities could negatively impact stability, fuel consumption, and the component's longevity. Traditional post-processing techniques had been explored, however, they proved to be either too time-consuming and costly, or unable to achieve the necessary smoothness for this demanding application.

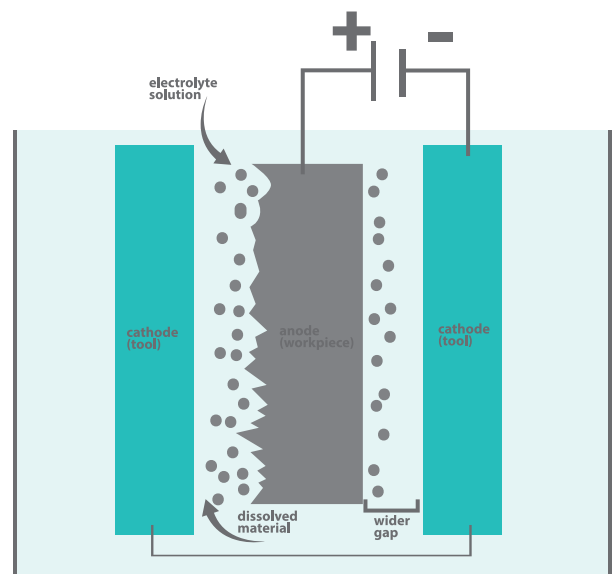
Input surface finish	6 $\mu\text{m Ra}$
Manufacture method	SLM printed
Material	Inconel
Weight	CONFIDENTIAL
Dimensions	CONFIDENTIAL
Required output surface finish	<2 μm
Required processing cycle time	<30 minutes

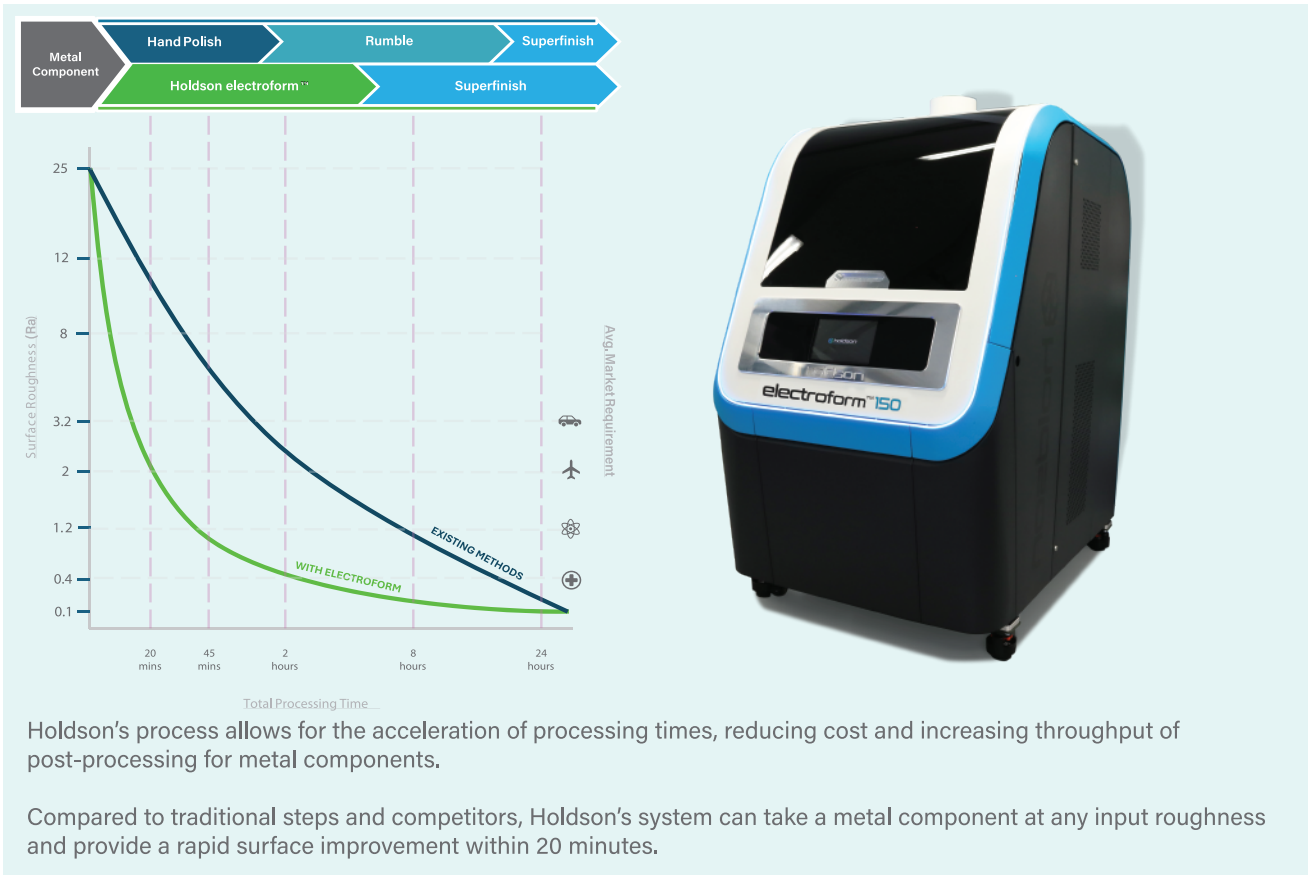
THE SOLUTION

Holdson's electrochemical polishing technology, supported by advanced computational fluid dynamics (CFD), optimises electrolyte flow to ensure a smooth and uniform finish across all surfaces, even on complex geometries and internal channels. This process allows for repeatable results on each cycle, ensuring the critical aerospace components meet stringent surface requirements while reducing cycle times.

During Holdson's customer engagement process, the specific finishing requirements of the component were identified, documented and agreed with the customer. The samples were then polished in Holdson's ef-150 machine using non-toxic ef-Ni electrolyte fluid. As with all Holdson's proprietary electrolytes, this is custom-formulated for enhanced material removal on the surface to be treated, in this case high performance nickel alloy parts.

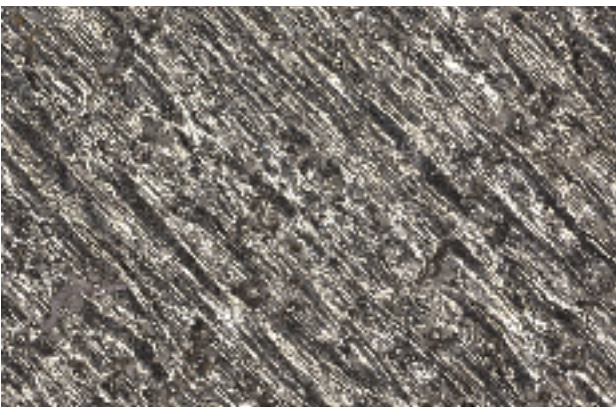
After uploading the CAD model to the ef-150's Nitere control system, the electrolyte solution is agitated by the machine's advanced Computational Fluid Dynamics (CFD) technology, which optimises the key parameters including fluid direction, pressure, density and velocity. This combination provided the level of control to result in uniform material removal from the component.



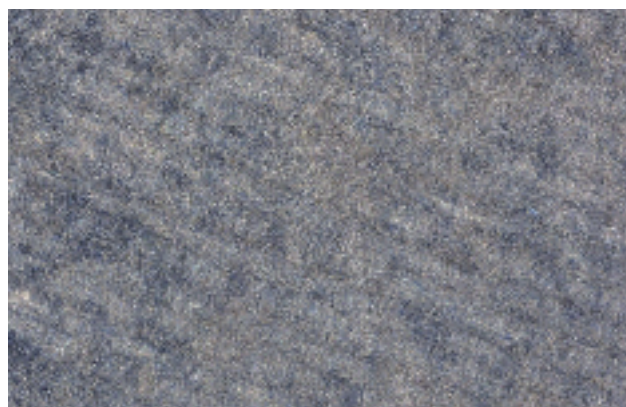


THE RESULT

PRE POLISH MICROSCOPE



POST POLISH MICROSCOPE



Holdson successfully reduced the surface roughness of the customer's component from an initial 6µm Ra to a polished finish of 1-2µm Ra, meeting the specified quality requirements with a 55% reduction in process cycle time compared to the customer's current method.

Input surface Roughness	Output surface Roughness	Required cycle Time	Actual cycle Time
6 µm Ra	1-2µm Ra	<30 minutes	15 minutes

Reducing the component's surface roughness resulted in smoother internal channels which are essential for optimising airflow and thermal management and as a result eliminating pre-existing points of thermal and mechanical stress in the part. As such, electroform™ proved to be an ideal solution to the customer's post-processing challenges based on their identified requirements for rapid processing, precise repeatability, and consistent, uniform results. The net effect on the finished component is that friction was minimised and fuel economy, heat dissipation, durability and aerodynamic efficiency were improved such that the part became viable for deployment into the extreme operational environment of aerospace applications.

To experience the results of electroform™ for yourself, contact us today at: sales@holdson.co.uk.