

Press Release

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Fraunhofer IST combines selective electrochemistry and robotics for a new generation of surface modification

Precision instead of immersion electroplating: New platform for selective surface modification

With a comprehensive expansion of its research infrastructure, the Fraunhofer Institute for Surface Engineering and Thin Films IST is establishing a new platform for localized electrochemical surface processing. The combination of proven electroplating processes with innovative technologies such as Electrochemical Jet Processing (EJP) and intelligent robotics enables precise, resource-efficient processing of complex workpieces. In doing so, the institute is creating new opportunities for industry in fields such as electronics, energy technology, medical engineering, and aerospace.

Electroplated coatings play a central role in numerous future-oriented industries. They impart specific functional properties to components, improve their durability and performance, and extend the service life of products, thereby contributing to resource conservation and the reduction of CO₂ emissions over the entire life cycle. In this context, Fraunhofer IST is specifically advancing electrochemical manufacturing technologies and combining established electroplating processes with selective approaches to surface treatment.

Expansion for the next generation of electrochemical manufacturing

At the heart of the facility expansion is the new Electrochemical Jet Processing (EJP) platform, which combines various selective electrochemical processes for the localized processing and functionalization of surfaces. These include Electrochemical Jet Machining (EJM) for non-contact, micrometer-precise material machining, as well as Electrochemical Jet Deposition (EJD) for the localized deposition of functional layers. This allows surfaces to be selectively structured, smoothed, repaired, or coated.

In contrast to conventional electroplating processes, in which entire components are treated in process baths, the EJP platform uses a movable electrochemical jet that acts only where material is actually to be processed, or layers are to be deposited. This makes it possible, in the future, to flexibly process even complex or large-scale components. Restrictions imposed by the dimensions of process baths or potential masking and demasking steps are eliminated. At the same time, the use of chemicals, energy, and raw materials – as well as the generation of waste – is minimized.

Intelligent process control for complex component geometries

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The platform is complemented by a modern robotics and automation infrastructure. In addition to high-precision industrial robots, autonomous mobile robots (AMRs) are used to flexibly support material and tool logistics and navigate their environment independently. This results in highly precise and reproducible processes that adapt to different component geometries and can be integrated into automated production lines.

“With our new system design, we combine selective electrochemical processes and robotics into a comprehensive system. Unlike with conventional systems, the process adapts to the component and its requirements – not the other way around,” explains Rowena Duckstein, a research scientist at Fraunhofer IST.

Diverse applications for high-tech industries

The new system technology is relevant wherever the highest precision, flexibility, and sustainability are required. For example, it enables the material-conserving production of microstructures with high deposition rates, as well as more targeted filling and thus better coating of, for instance, micro-holes. Localized deposition eliminates the need for stencils and masking.

A look to the future

In the future, the EJP platform is to be integrated even more closely with robotics, sensor technology, and data-driven control methods. The goal is an adaptive manufacturing system that continuously optimizes processes and reduces resource consumption and scrap. In this way, Fraunhofer IST is laying the foundation for adaptive manufacturing concepts that flexibly integrate local electrochemical processes into industrial production lines and open up new possibilities for micro-machining, repair processes, and functionalized surfaces.

“Our goal is to further develop a technology platform that not only meets current industrial requirements but also actively sets new standards – more precise, more sustainable, and more application-oriented than existing solutions,” Duckstein summarizes.

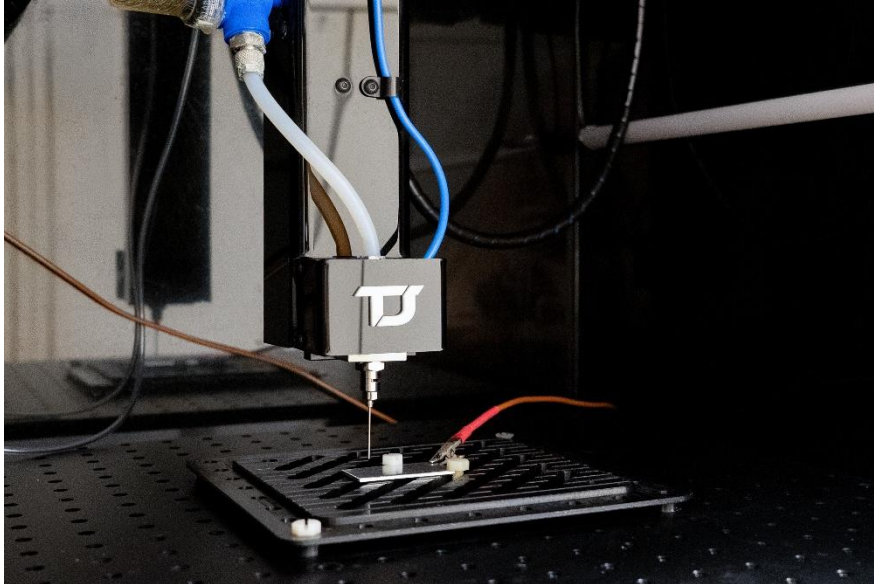


Fig. 1 The Desktop Jet from TextureJet for electrochemical jet machining (EJM) as part of the Fraunhofer IST electrochemical jet processing (EJP) platform. © Fraunhofer IST



Fig. 2 Local surface structure on a stainless steel substrate created by electrochemical jet machining (EJM). © Fraunhofer IST

The Fraunhofer Institute for Surface Engineering and Thin Films IST is an innovative partner for research and development in surface technology, with expertise in the associated product and production systems. The aim is to develop customized and sustainable solutions: from prototypes, through economic production scenarios, to upscaling to industrial magnitudes – and all this whilst maintaining closed material and substance cycles. The Fraunhofer IST is one of the seventy-five institutes of the Fraunhofer Society, one of the world's leading organizations for applied research.

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