

## High Quality Machining

Innovation in the precision manufacturing of highly complex components from high-quality materials, and in the optimization of surface properties

Manufacturers must constantly improve their manufacturing processes and technologies to keep up with marketplace demands to improve product quality, speed up production and reduce costs. In sectors such as the energy industry, medical technology and aerospace, quality and safety aspects are of particular importance. In order to meet the need for adaptability and cost-effectiveness in this context, flexible manufacturing cells require autonomous processes.

### Objective

The Institute for Production Engineering and Photonic Technologies (IFT) at TU Wien strives for significant quality improvements as well as energy and cost savings through innovation. Our work focuses on industrial high-performance production, ranging from mass production all the way down to single items (batch size 1).

### Our Solutions

Successful approaches at the IFT include a majority of the following elements:

- feasibility studies
- selection and further development of appropriate production processes
- development of suitable measurement and test procedures as well as sensor and actuator systems
- sensor integration to record process data (for monitoring, quality assurance) as well as for data communication and the adaptive control of production processes (in-process control)
- targeted modification of the surface properties of complex components

### Additive manufacturing

Additive manufacturing enables near-net-shape production. This saves on material, is resource-efficient and is particularly important for high-strength materials

or materials that are difficult to machine.

The materials required are often nickel-based (e.g. Inconel) or contain especially costly elements (e.g. titanium). Through the targeted combination of additive and subtractive manufacturing processes, it is possible to significantly reduce both the volume of material to be machined and the machining time. In addition to state-of-the-art robot welding systems (WAAM, DAD), the IFT also has a 3D metal powder printer based on the SLM process (Selective Laser Melting). The component to be manufactured is built up layer-by-layer from metal powder by a laser, using micro-welding processes.



The IFT has experience and specialized know-how in additive manufacturing. This means users' projects benefit from:

- targeted selection and optimization of machining processes, process control, monitoring and regulation based on the desired level of component quality
- rapid development of measurement systems and databases, also data analysis— to enable automated detection of defects and geometric deviations, as well as largely autonomous and self-optimizing production

### Sensorised tool holder

For high-precision machining, the IFT developed a tool holder with an active control system which records process parameters parallel to machining and communicates them to the process control system. This allows process instabilities to be detected and compensated for at an early stage and avoids production downtimes. The machining values transmitted by the tool holder are processed in real time in the process control and, if necessary, an adjustment of the current machining parameters, such as feed rate and speed, is made.

This enables:

- autonomous optimization of process parameters, increase in productivity
- Avoidance of instabilities such as rattling and premature tool failure
- Monitoring to provide data for process documentation, post-processing and quality management



## Micromachining

Increasingly, tight tolerances, miniaturization of individual parts and micromachines, and particularly delicate materials (e.g. optical lenses) pose special challenges for manufacturing technology. At the IFT, an ECM milling machine with ultra-short voltage pulses and a unique mechanical milling machine that delivers surface qualities similar to grinding are available. They enable:

- Structures in the range of micro- to nanometers
- Select optimal processes and tools for the high-precision machining of high-strength and difficult-to-machine “delicate” materials
- Optimization of process parameters for manufacturing

## Surface micromachining with MHP

The functional performance of a component is to a great extent determined by the properties of its surface and the near-surface boundary layer. In order to manipulate these properties, mechanical surface hammering or machine hammer peening, MHP, is used. A tool, typically with a spherical carbide metal tip, is set into an oscillating motion of up to 500 Hz by an actuator system. Surface treatment is performed by strokes of the tool tip

arranged consecutively along a path.

The new actuator system developed at the IFT is the first one to allow for individual and precisely defined strokes as well as control and monitoring of the entire mechanical surface treatment process. Due to the highly dynamic short-stroke linear reluctance motor, each single movement of the hammer can be accurately set and controlled. This fine level of control enables:

- specific manipulation of roughness, smoothness, micro-geometry and hardness as well as the magnetic, thermal, electrical, and chemical properties of surfaces
- reduction of flow resistances
- substitution of thermal hardening processes
- replacement of manual polishing processes
- invisible 3-dimensional coding option for components



## Your Benefits

The IFT at the TU Wien has more than 40 years of experience innovating in the field of machining and machine tools. The findings from a large number of scientific projects and industrial co-operations enable highly effective co-operation, competent consulting, and the efficient implementation of innovation. TU Wien offers you:

- comprehensive improvement of individual manufacturing processes with multidimensional objectives
- product innovation
- optimization of the entire production chain – including machining, logistics, energy consumption, and operational efficiency
- access to a diverse network of experienced tool and machine manufacturers
- rapid implementation of innovation ideas for your products

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