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1 *Trimming of CFRP with diamond tool*
2 *Trimming of 3D-shaped composite part using abrasive water jet*

END MACHINING OF COMPOSITE MATERIALS

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The future demand for high-performance composite structures will increase significantly throughout all knowledge-based European industrial sectors like aerospace, automotive, energy, construction, consumer, and medicine. Aiming for the achievement of market forecasts, the currently applied manufacturing methods need to be substantially improved in order to increase cost-effectiveness of composite materials. This also applies for the final machining of those materials.

Our offer

In the lightweight sector the Fraunhofer IPT deals with the systematical process design of the conventional end machining technology (milling and drilling) as well as abrasive water jet cutting for a wide range of composite material variants.

Considered materials

- Fiber reinforced thermo-set and thermo-plastic polymers (FRP) with any kind of reinforcement type and matrix composition
- Multi-materials like FRP metal stacks (CFRP-Aluminum, CFRP-Titanium, …)
- Sandwich materials (FRP honeycomb or foam structures)
- Metal matrix composites (MMC)
- Ceramic matrix composites (CMC)

High pressure water jet machining

- Flexibility by a 5-axis water jet machining with pressures up to 600 MPa
- Variable jet diameters available for a high detail resolution and high efficiency
- Use of alternative abrasive materials
- Application oriented process development and optimization
- Technology integration by customized process chain adaption and integration
- Feasibility studies
- Technology consultation

Conventional milling/drilling

- Individual and systematic process and cutting tool design and optimization for finishing processes
- Vibration assisted machining with low and high vibration frequencies
- Use of alternative cooling/lubrication solutions like cryogenic cooling with liquid CO_2
- Grinding of custom made cutting tool geometries
- Fixture solutions for labile (thin-walled) components
- Prototypical manufacturing
- Feasibility studies

Hybrid machining as an intelligent combination of conventional and water jet machining

Potential analysis for hybrid processing of various workpiece materials and geometrical shapes (e.g. roughing by water jet cutting, finishing by conventional machining technology).

Water jet Technology

High-pressure water jet machining as an unconventional manufacturing technology fills a gap for the machining of high performance materials as well as composites and covers a comprehensive range of applications. Main advantages of this technology are the cold cutting process without any heat affected zone at the material and its high efficiency. Highest material ablation rates can be achieved, irrespective of the physical material properties or composition. Therefore, abrasive material is added to the water jet for increasing performance of the water jet. Typical abrasive water jet diameters are in between 0.5 mm and 0.8 mm, with the possibility of further reduction up to 0.2 mm by the use of the micro water jet technology. High accurate 5-axis machine systems with a pressure range up to 600 MPa are now turning to industrial standard. Water jet can be regarded as a multi-purpose tool for cutting, drilling, layer removal as well as surface treatment. This flexible tool can be changed on the fly by the simultaneous adaption of the parameters. With this process adaption the sharp and thin shaped water jet enables the processing of thin walled 3-dimensional work pieces with a great economic value for production.

Milling/Drilling Technology

Conventional milling/drilling is characterized by highest geometrical flexibility in connection with low machining times. There is no need for special and cost-intensive machine technology. By adapting the cutting tool geometry for each composite material, optimal part quality and high precision drilling holes as well as functional surfaces and connection faces can be realized. The adequate use of abrasion resistant cutting materials and optimized CVD-diamond coatings makes it possible to increase tool life significantly. Through the application of innovative process cooling strategies in combination with vibration-assisted machining the productivity of conventional machining technologies can be further maximized.

1 *Drilling tools for FRP's*

2 *Abrasive water jet machining of glass-fibre polyamide laminate*