Fraunhofer IWS

Surface Functionalization with DLIP

Production of Different Surface Properties by Laser-based Process

Direct laser interference patterning (DLIP) has developed into a flexible and industry-oriented tool for producing targeted surface topographies. DLIP can be used to process all light-absorbing materials such as metals, ceramics and plastics as well as transparent polymers and glass.

DLIP technology proves its particular strength in the structuring of large surfaces in the micrometer and sub-micrometer range. It allows scalability while maintaining the same structure resolution. In addition to topography, the electrical, chemical and mechanical properties can also vary periodically. No filler material is required, the structures produced acquire the same mechanical properties as the base material, and the process step of layer adhesion during surface finishing is eliminated. The Fraunhofer IWS researchers develop technical solutions (DLIP modules), process parameters and specific functionalities that enable users to find exactly the solutions they need:

- Microstructured embossing and molding tools for the fabrication of functionalized surfaces
- Functionalized part and component surfaces for improved adhesion and biocompatibility
- Increased reaction surfaces, anti-icing effect, and antibacterial surfaces
- Reproduction of biomimetic structures such as hydrophobic, hydrophilic, and antibacterial surfaces
- Light management: Absorption or emission increase of the device (OPV and OLED) by topographic microstructuring through diffraction effect and light scattering

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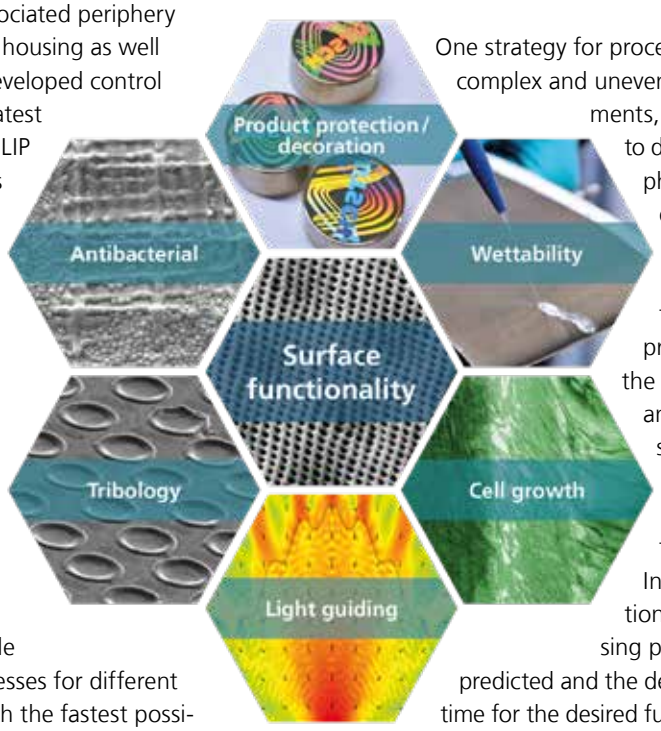
Compact DLIP Systems and Equipment

The current generation of DLIP processing heads allows the structure period and orientation to be varied during processing. This enables realizing a wide range of surface structures with one system and process step. On the one hand, the modules can be integrated as individual components, e. g. into existing and robot-assisted laser systems. On the other hand, Fraunhofer IWS offers compact DLIP systems with an already integrated processing head of the associated periphery such as laser or housing as well as a specially developed control software. The latest generation of DLIP systems permits the processing of 3D components by integrating the process into a 5-axis machine.

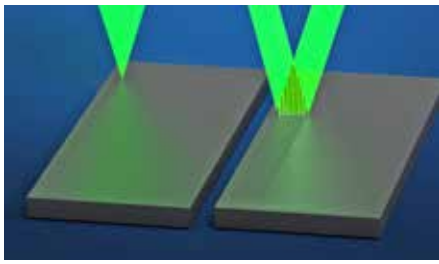
Roll-to-roll Principle

Fraunhofer IWS researches and develops suitable roll-to-roll processes for different applications with the fastest possible, precise and high-quality surface functionalization via DLIP. These advancements significantly enhance the laser processing rates, allowing for a remarkable achievement of up to 0.9 square meters per minute. Rather than employing laser technology for direct film structuring, a new approach involves utilizing a stamp to impart the desired structure onto a foil. With this innovative method, it becomes possible to achieve process rates of up to ten square meters per minute.

Increased Efficiency through Prediction Modeling of Surface Properties



One strategy for process monitoring of complex and uneven surface treatments, for example, is to detect and analyze photoacoustic emissions. The knowledge gained during the structuring process enables the development of an autofocusing system that uses only the acoustic emission signals for 3D processing. In this way, deviations in DLIP processing parameters can be predicted and the development time for the desired functionalities can be shortened.



Top:
Direct Laser Writing (DLW) vs. DLIP: 100 times faster due to interference processing.

Center:
DLIPµcube: Compact system with novel DLIP nano scan module.

Bottom:
AI Testbench: Predictive modeling for laser precision manufacturing. Combining micromaterial processing with artificial intelligence and machine learning.

Left:
World's first DLIP 5-axis machine for processing 3D components.