LASER MICRO DRILLING OF AIRFOIL SURFACES FOR HYBRID LAMINAR FLOW CONTROL (HLCF)

Task

The goal of the HLFC technology is to delay the airflow boundary layer transition from laminar to turbulent during cruise of a long-range aircraft. This reduces aerodynamic drag which leads to up to 10 percent fuel saving. Therefore, future airfoil surfaces shall be partially perforated with micro holes that are connected with a dedicated pneumatic suction system to stabilize the airflow. This system can also be utilized to blow hot air out of the holes for de-icing purposes. A drilling process by using laser radiation shall be implemented for the selected aerodynamic surface in order to obtain:

- hole diameter: < 100 µm
- aspect ratio: ~ 20
- hole density: ~ 2 x 10^6 holes/m^2
- hole geometry: negative conical

Method

A single-pulse drilling process with µs-pulsed single mode fiber laser radiation has been developed in order to meet the criteria of high productivity. The hole geometry is achieved by a suitable combination of pulse peak power and pulse duration. To compensate deviations of the real part with respect to the CAD data, an optical coherence tomography based distance measurement system with an additional z-axis has been integrated into the drilling optic. Thus, the focal position of the laser radiation is maintained on the surface of the part within acceptable tolerances.

Results and Applications

By establishing an »on-the-fly« drilling process, a productivity of 200 holes per second could be achieved. The reproducibility of the drilling process is high with diameter tolerances within 10 µm. By means of a CAD/CAM program the drilling process has been transferred to 3D components with a footprint of about 2 m x 1 m under a 6-axis gantry system.

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1 Drilling process.