

Summary

With the application of appropriate surface structuring on aircrafts, up to 8% fuel may be saved in regular air traffic. This not only decreases costs, but especially reduces exhaust of greenhouse gases significantly.

Before these techniques can be introduced into productive environments, a controlling method for the quality of surface structuring had to be established to be used during fabrication and service, ensuring persistent quality of the structured coatings and a justified decision for surface renewal. In this project, these important requirements for achieving the improvements defined above are fulfilled. We have shown that fast sampling is possible using noncontacting laser probing, and we have presented a working preliminary configuration for the sensor.

In the theoretical part, a model for the interaction between a probing laser beam and the surface is developed and the resulting wavefront is derived. This is done using a combination of Huygens-Fresnel diffraction theory and geometrical optics. The model is then used to counsel the design of the experimental setup, to interpret the emerging data and to develop characteristic quantities for the sample, their derivation from the data and their signal-to-noise ratio.

In the experimental part, the interaction of laser light with the structured riblet surface is studied. For this purpose an optical setup was installed to perform measurements of undegraded and degraded surfaces depending on a variety of experimental parameter like probe wavelength or angle of incidence. The results of these measurements in the form of intensity distributions as a function of angles are constantly compared and checked with the theoretical calculations. A preliminary configuration of an optical setup with an optimized laser system is now available for further studies. It allows for very sensitive measurements of even slight degradations of the surfaces. Here, it is regardless if the damage to the riblets is symmetrical or asymmetrical due to mechanical loss of material or if it is deriving from changes of reflectivity due to chemical processes of the riblet material itself.

A fast implementation in commercial products should be possible on the basis of this report.