Shockwave-based cleaning of insect residue using a CO_2 laser

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Aviation is one of the main emitters of greenhouse gases with a total proportion of 5 % [Lia22]. Simultaneously, it is also the sector that can make a particular contribution to saving such gases in the future. Hence, various technologies are being investigated and implemented to achieve this goal. One of these is laminar air flow technology on aircraft wings. This involves the use of special structures that increases the area of laminar flow on the upper side of the wings. In this way, drag on the wings is reduced, consequently lowering the fuel consumption [Kok15]. However, laminar air flow technology is negatively influenced by many factors, e.g. the accumulation of insect residues on leading edges of wings. At a certain residue height, the technology is no longer effective [Pet78]. Repeated cleaning of the wings is necessary. Laser-assisted cleaning processes like dry laser cleaning and liquid assisted laser cleaning have upfront downsides regarding feasibility which shockwave-based laser cleaning doesn't. Consequently, this process was investigated to remove artificially created insect residue off metallic surfaces like 1.4544.9 and titanium grade 5. The residue consisted off a single flesh fly that was anesthetized and shot onto the surface. A TEA-CO_2 laser at 10600 nm with a pulse duration of 100 ns, and a frequency of 10 Hz was used. The results show that the inhomogeneously distributed insect residue, based on the material peak volume Vmp, could be significantly reduced by 85 % for stainless steel and 73 % for titanium, without any discernible change in the microhardness and topography of the surface or even the grain structure of the underlying material. The present work thus provides the basis for a laser-based cleaning process that enables regularly repeated cleaning of contaminated metallic surfaces without any detectable surface changes.

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