Sand and rain erosion testing of structured and modified Titanium surfaces

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Effective boundary layer control of the air streaming around external aircraft surfaces like wings or control elements like rudder or ailerons is paramount for reducing fuel burn and emissions. To implement new hybrid laminar flow control (HLFC) systems on aircraft that are based on the suction of the boundary layer, the operability, performance, and durability of a microperforated titanium plate is investigated in laboratory scale in the frame of the "OptiHyL" project. Suction of the boundary layer through a microperforated surface element leads to a significant drag reduction and thereby to fuel saving and a reduction of CO2 and NOx emissions. For enabling the controlled suction of the boundary layer, the micro holes must remain open during all flight phases. To avoid the blockage of the micro holes by insects, dust, dirt, water, or ice the titanium surface was patterned with a hydrophobic/superhydrophobic nanostructure. Apart from being dirt repellent and showing low adhesion to ice, the surface pattern must withstand erosion during flight. Therefore, we tested sand and rain erosion on differently nanostructured titanium surfaces (without structure, with laser, with a galvanic process) with a hydrophobic coating on top of. Figure 1-a shows the velocity distribution of the sand particles during the sand erosion test and Figure 1-b the principle of the rain erosion test rig. Results will be discussed and possible design rules for resilient functional surface patterns will be proposed.

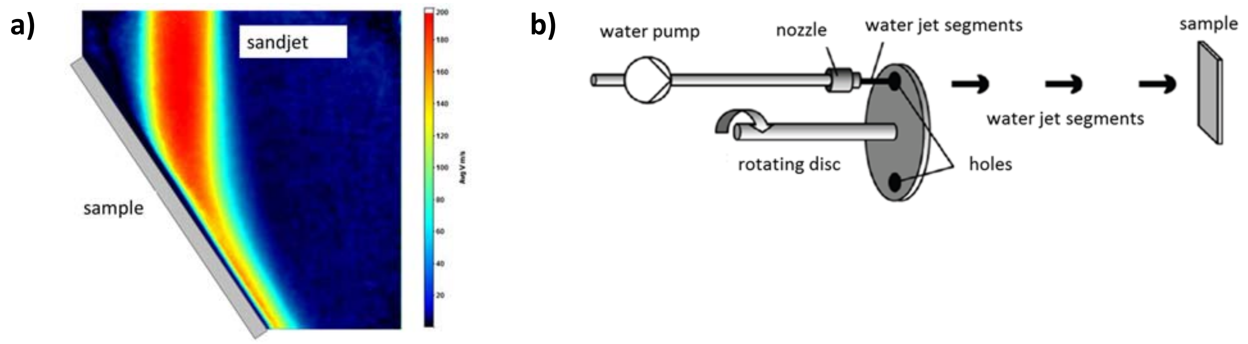

Figure 1. Sand and rain erosion test; (a): Velocity distribution of sand particles measured by particle image velocimetry (PIV); (b): principle of rain erosion testing with a segmented water jet.

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