

High Enthalpy Ablation Testing at DLR Cologne

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Testing thermal protection capabilities of ablative materials is one of the main working areas of DLR's arc heated facilities LBK in Cologne. Work on this particular topic has been intensified about five years ago with the following major focus points:

- Significant improvement of the facilities testing capabilities with respect to cold wall heat flux rates and stagnation pressure.
- Ablation testing in Martian atmosphere.
- Influence of dust particle erosion on ablation.

With a new nozzle the testing capabilities at LBK could significantly be improved. Cold wall heat flux rates up to 12 MW/m² can be reached at stagnation pressures up to 1500 hPa. These conditions have already been used intensively for the characterization of new ablative materials within ESA projects as well as in direct commission of European space industry. The corresponding flow field around a flat-faced cylinder model was characterized by single pulse broadband Coherent Anti-Stokes Raman Scattering (CARS). Vibrational and rotational temperatures were measured simultaneously with this technique identifying thermodynamic non-equilibrium for both, free stream and shock layer.

When planning interplanetary missions to Mars with a direct entry into the atmosphere the possibility of being exposed to a dust storm must be taken into consideration. Therefore, thermal protection systems have to be designed for sustaining higher loads caused by dust particle erosion. In the frame of three studies under the lead of ESA and CNES several test campaigns were performed to investigate the influence of particle erosion on the Norcoat Liege ablator, which will be used as heat shield for the EXOMARS missions. Tests were carried out at several flow conditions imposing different heat loads on the samples. Particle velocities up to 2 km/s could be achieved. Particle deceleration in the shock layer was measured using the Laser-2-Focus (L2F) technique. Based on the erosion results a new particle erosion correlation could be developed for Norcoat Liege.

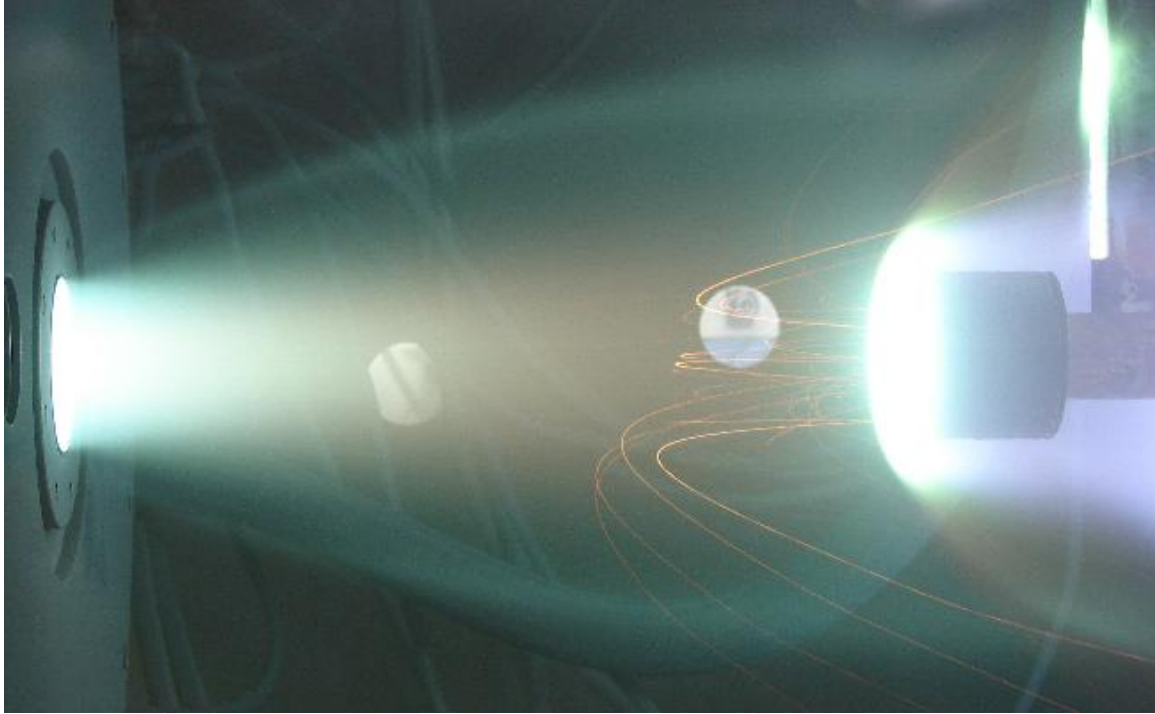


Figure: Ablator sample in dust loaded CO₂/N₂ flow