Ongoing European Developments on Entry Heatshields and TPS Materials

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The paper will provide an overview on some elements of current European developments for heatshields of atmospheric entry probes and TPS materials. In particular, it will talk about the ongoing heatshield development for the European ExoMars EDL demonstrator and the ongoing development of a European low-density ablative material for extreme heat flux applications.

The joint ESA-NASA ExoMars program now includes two launches. While in 2018 a NASA spacecraft is planned to deliver a rover module to the surface of Mars, in 2016 a European composite spacecraft is planned to be launched consisting of an orbiter module and an EDL demonstrator (EDM). The EDM will have an entry mass of 600kg with a heatshield diameter of 2.4m. The heatshield will be based on a cork-based ablator. It will be designed in order to withstand not only the aerothermodynamic entry loads with peak heat fluxes up to 2 MW/m^2, but also to survive the possibility of a severe dust storm during entry allowing an arrival during a global dust storm season. Further, a set of entry system sensors will be integrated in the heatshield allowing to reconstruct part of the entry environment and the TPS response.

Various sample return missions have been studied in recent years. Most recently the ESA Cosmic Vision program has selected a revised version of MarcoPolo as one of four candidates for a medium-class mission that is planned to launch in the period 2020-22. MarcoPolo-R is a mission to return a sample of material from a primitive near-Earth asteroid (NEA) for detailed analysis in ground-based laboratories.

The Earth return from extraterrestrial bodies involves a hyperbolic trajectory resulting in atmospheric entry velocities of typically around or above 12 km/s and resulting peak heat fluxes in the order of 10-20 MW/m^2 with dynamic pressure loads up to around 1000 mbar. In addition, since the Earth return capsule is subject to a “double” delta-V (to the object and back to Earth), the return capsule and its heatshield have to conform to a very stringent mass budget.

This requires the availability of a highly efficient light-weight ablator material. ESA has therefore initiated a dedicated activity aiming at the development of a European lightweight ablative material for extreme heat flux applications. Initial development has been completed following two different material concepts and first plasma tests showed promising results. Refined development is currently ongoing. However, further test results will not yet be available at the workshop.