Contribution ID: **50** Type: **Contributed Oral Presentation**

Hypervelocity impacts into laminates: experiments and multiphase SPH computations

Orbiting satellites or manned spacecraft experience hypervelocity impacts from micrometeoroids and space debris. Thin shields are used for their protection, and are typically made of monolithic metals. For better weight-to-strength ratio, the use of metal/epoxy laminates offers an alternative and is investigated in this study.

The Smoothed Particle Hydrodynamics (SPH) numerical method has proven to be a reliable tool for the study of hypervelocity impacts. Nevertheless, traditional SPH schemes produce large errors when inhomogeneous materials are treated. For this purpose an SPH multiphase compressible scheme has been developed and tested against numerical benchmarks.

A set of hypervelocity impact experiments was performed in order to validate the computational methodology and also to serve as a guide for the design of new shielding structures. These experiments refer to hypervelocity impacts at 4-5 km/s of mm-sized Aluminum projectiles onto glue bonded Aluminum 2024 laminate. In particular, the bonding layer consists of Stycast 2850FT glue, which is known for its good performance under cryogenic conditions as encountered in space.

The present study, examines the experimental results vis-à-vis the results obtained by means of the developed SPH algorithm. Furthermore, it discusses the observed material opening and breakup patterns, while it finally gives directions for further improvement of the algorithm.

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Track Classification: CEC-10 - Aerospace