Distribution of debris cloud caused by hypervelocity impact on an Al-foam shield

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Metallic foam, due to their relatively high yield strength, low density, and large compressive strain, are potential for use in applications which require superior impact energy absorption and significant weight reductions. The protection of spacecraft against hypervelocity impact of space debris and meteoroid particles causing fatal damages to spacecraft structures is an important problem. Constraints for the additional weight of protection are strong in all applications, so it is necessary to achieve a higher protection efficiency and weight savings. So, metallic foams may play a key role in the structural design of manned spacecraft and satellite in the future.

SPH is a technique for problem solving in Computational Continuum Dynamics. Recently, SPH has become widely recognized for numerical simulation of hypervelocity impact. But the existing commercial computing software canąŕt simulate foams against hypervelocity impact, for they have no appropriate foam model. And the existing Equation of State and Strength Model, which regard foams as homogeneous medium, canąŕt exactly describe the characterizations of metallic foams, because the pore size is big enough not to be ignored compared with projectile diameter or bumper width. A 3-dimansional SPH program with the foam model was developed. Metallic foams were created in the metal to model the real geometry in the program. Then the equation of state and strength model of the base metal of metallic foam can be used. The simulations were carried out by the program with the model, and compared with experiments. Good agreement was obtained.

To determine the distribution of debris cloud behind an Al-foam shield, numerical simulations of structure with one Al-foam plate were carried out in the velocity range of 3-9km/s. The distribution of velocity and mass of debris cloud were obtained at different angles at the same velocity. Then, the distribution at different velocities was compared.