SPH simulation on high velocity impact of C/SiC composite

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Impact resistance of Thermal Protective Stucture is an important factor for the safe service of spacecraft on orbit. As a typical high temperature resisitance composite, ceramic-matrix material has been widely used in the thermal protection structure. Based on the hypervelocity impact experiments under the velocity of 3400 m/s ~ 9300 m/s, the structure of debris cloud of plain-woven C/SiC composite under impact load was found with a special axial columnar high energy zone. In this study, an orthotropic composite model of the plain-woven C/SiC with its material parameters were derived firstly. Then the model were verified by the comparison between SPH simulation and the experimental results. The dynamic responses and faiulure machanisms of composite plate with the comparison of standard Al plate are discussed. We find that the residual velocity of projectile, the axial average velocity and the distributed angle of the debris cloud are characteristic parameters to describe the dynamic response of C/SiC composite. Various cases of impact simulation were performed. Several conclusions are obtained: (1) C/SiC plate with thickness of 6mm can reduce more than 90 percent of the average initial kinetic energy of the punch body; (2) the distributed angle of the debris cloud would remain unchanged when the impact velocity is higher than 6000m/s.

Keywords: SPH method; impact resistance; C/SiC composite; hypervelocity impact; debris cloud