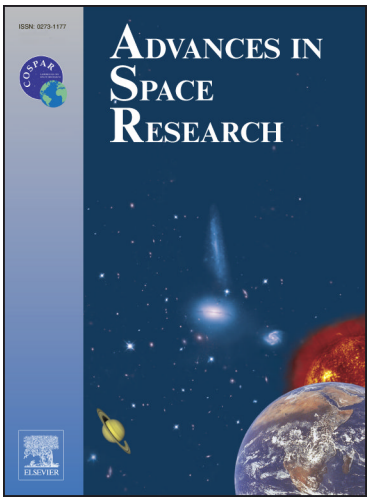

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Reentry Trajectory and Survivability Estimation of Small Space Debris with Catalytic Recombination

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Abstract

A code has been developed to analyze reentry trajectories and survivability of space debris. In particular, an attention was given to small sizes. Based on simple shapes such as a sphere, a cylinder, and a box with sizes of 12.5 to 50 centimeters, reentry trajectories were calculated. Materials considered were graphite epoxy, aluminum, and titanium. In total, 120 different cases were examined. The results were compared and validated with various existing codes. Good agreement was found. In the heat transfer calculation, all of the existing codes used the well known Lees' and Fay and Riddell's formulae which assume an equilibrium boundary layer flow with a super-catalytic wall where the surface recombination efficiency is regarded infinity. In the case of small space debris having sizes of 2.5 to 10 centimeters, however, the flow residence time behind a shock wave is far too short, so that the super-catalytic assumption leads to over-estimation of surface heat transfer rates. Assuming a frozen boundary layer, a finite catalytic recombination can be considered and the results were compared with that of the super-catalytic cases. Both hollow and solid spheres were considered with different sizes and materials. In total, 24 different cases were examined. The results showed that, 16 out of 24 cases survived, while only 8 cases for the super-catalytic and 19 cases for the non-catalytic walls survived, implying the importance of catalytic wall effects for the study of small space debris.

Keywords: Space debris; Catalytic recombination; Survivability

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