Numerical simulation of aerodynamic heating and stresses of chemical vapor deposition ZnS for hypersonic vehicles

高速飞行器CVD ZnS窗口材料气动热和应力数值模拟研究

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Main goal

Provided a theoretical guidance to evaluate the influence of aerodynamic heating and forces on infrared window materials.

Main method in the numerical simulation

Flowfield analysis: A finite volume is used to simulate the aerodynamic heat flux from Mach 3 to Mach 6 flight at an altitude of 15 km in a standard atmosphere.

Structural analysis: A finite element analysis is used to present the thermal and stress responses under constant heat transfer coefficient boundary conditions for different Mach numbers.

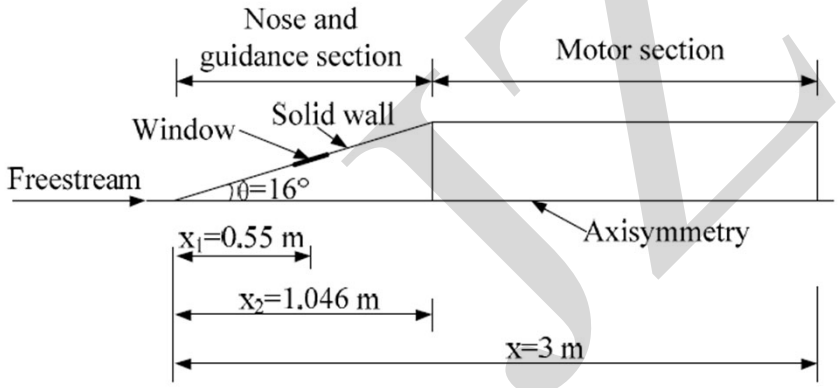


Fig. 1 Hypersonic vehicle configuration

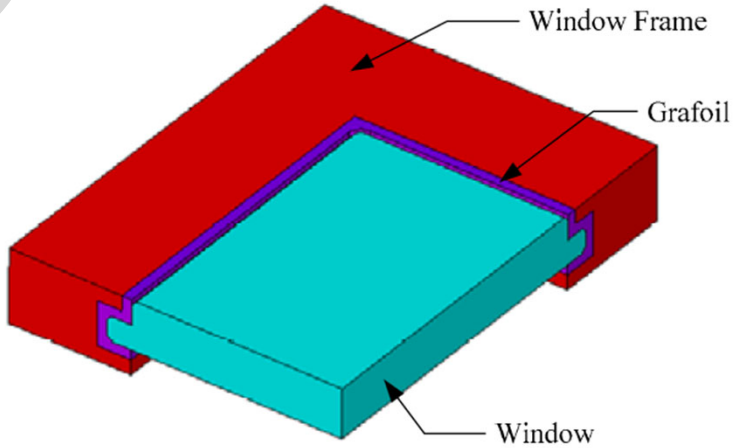


Fig. 2 Physical model of the window structure

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Main results & conclusions

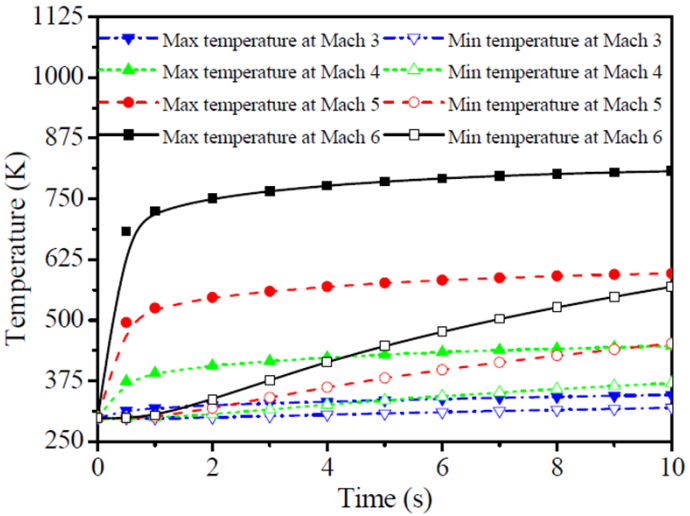


Fig. 3 Temperature variation with time

The maximum temperatures over the range of Mach 3 to 6 are all very far from the melting point 2103 K of CVD ZnS, so the material meets the requirements of the thermal response of the window.

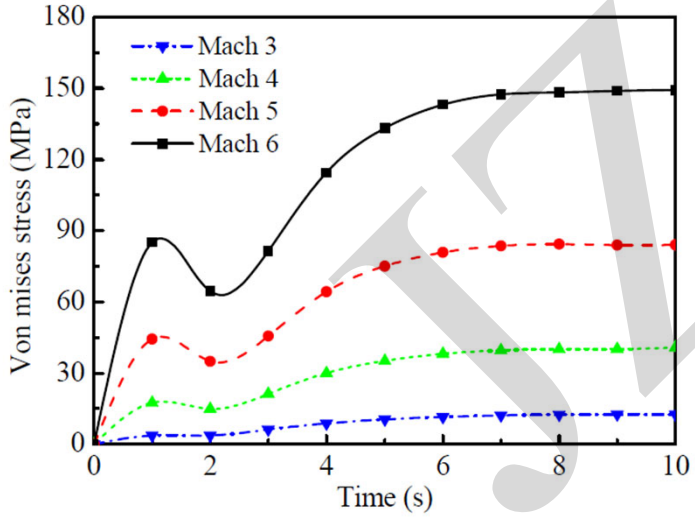


Fig. 4 Von Mises stress variation with time

The maximum stresses at Mach 3, Mach 4 and Mach 5 are less than the mean strength of the material, so the material is safe in these cases. However, the maximum stress at Mach 6 is far beyond the mean strength of the material, so it does not meet the working requirements in this case.

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