Guided wave-based damage imaging of quartz ceramic thermal protection structures ablation

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ABSTRACT

As a key protective component of a hypersonic vehicle in harsh service environment, the thermal protection structure (TPS) is prone to ablation damage in the extreme thermal environment during the reentry process of the vehicle, seriously affecting its safe service, and structural health monitoring (SHM) is urgently needed. In this paper, the delay-and-accumulation damage imaging method based on guided wave (GW) is used to study the damage imaging of the ablation damage of the quartz ceramic TPS structure. First, the ablation damage of the quartz ceramic TPS structure was produced by oxygen-acetylene high-temperature and high-speed gas flow ablation, and then a GW monitoring experiment method for the ablation of the quartz ceramic TPS was designed, and the results of the quartz ceramic TPS under different states and different damage degrees were obtained. Finally, by extracting the GW signal features in different states and different damage degrees, the delay-and-accumulation imaging method is used to image and locate the ablation damage of quartz ceramics. The results show that the delay-and-accumulation imaging algorithm based on GW can accurately image and locate ablation damage with different degrees of ablation, and the positioning error does not exceed 3cm, which verifies the feasibility of this method for TPS ablation damage monitoring. The research on TPS guided wave monitoring theory and method of hypersonic vehicle provides a reference and basis.

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