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PROCEEDINGS

The Coupled Thermo-Chemo-Mechanical Peridynamics for ZrB_2 Ceramics Ablation Behavior

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ABSTRACT

The ablation of ultra-high-temperature ceramics (UTHCs) is a complex physicochemical process including mechanical behavior, temperature effect, and chemical reactions. In order to realize the structural optimization and functional design of ultra-high temperature ceramics, a coupled thermo-chemo-mechanical bond-based peridynamics (PD) model is proposed based on the ZrB_2 ceramics oxidation kinetics model and coupled thermomechanical bond-based peridynamics. Compared with the traditional coupled thermo-mechanical model, the proposed model considers the influence of chemical reaction process on the ablation resistance of ceramic materials. In order to verify the reliability of the proposed model, the thermo-mechanical coupling model, damage model and oxidation kinetic model are established respectively to investigate the applicability of the proposed model in dealing with thermo-mechanical coupling, crack propagation, and chemical reaction, and the results show that the model is reliable. Finally, the coupled thermo-mechanical model and coupled thermo-chemo-mechanical model are used to simulate the crack propagation process of the plate under the thermal shock load, and the results show that the oxide layer plays a good role in preventing heat transfer and protecting the internal materials. Based on the PD fully coupled thermo-mechanical model, this paper innovatively introduces the oxidation kinetic model to analyze the influence of parameter changes caused by oxide layer growth and chemical growth strain on the thermal protection ability of ceramics. The proposed model provides an effective simulation technology for the structural design of UTHCs.

KEYWORDS

ZrB_2 ceramics; ablation; coupled thermo-chemo-mechanic; peridynamics model; oxide layer

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