Advances in High-Energy Laser Thermal Protection Materials: Postprint

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Abstract

With the increasing military applications of high-energy lasers, various equipment materials and structures are confronted with survivability issues under high-energy laser irradiation. For instance, the instantaneous concentration of high energy density generated by lasers induces a series of damage effects, including thermal ablation, thermal melting, and vaporization. Consequently, investigating the damage effects and protection mechanisms of materials under high-energy laser irradiation represents a hot and challenging topic for enhancing equipment survivability. First, the damage process and mechanisms of high-energy lasers are systematically reviewed. Second, the concept of laser thermal protection is introduced, and the performance of currently available thermal protection materials is summarized based on thermal conductivity and ablation rate, resulting in the construction of a material performance selection chart. Third, the thermal protection mechanisms of materials in different regions of this chart are elaborated in detail. Finally, with respect to laser energy homogenization technology and ablation-resistant technology, the key considerations for selecting and designing laser protection materials are discussed, specifically emphasizing the prioritization of three parameters: low density, high thermal conductivity, and low ablation rate, while also exploring the future development directions of laser protection materials to provide design references for subsequent research in the field of laser thermal protection materials.

Full Text

Preamble

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Note: Figure translations are in progress. See original paper for figures.