Study on the degradation of high reflection film performance induced by stray light irradiation of CFRP in high-power continuous laser facilities

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Carbon fiber reinforced polymer (CFRP) is widely used in aerial platform confinement of high-power continuous laser facilities due to its lightweight and high stiffness. In the high-power laser system, abundant random stray light is inevitably generated due to the surface scattering and the residual reflection, which may cause damage to the high-reflection film optical components. Thus, to realize the clean environment control in a high-power continuous laser system from the root, the degradation of high reflection film performance induced by contaminants induced by stray light irradiation of CFRP materials was studied. The damage threshold of a typical resin-based carbon fiber composite was investigated under continuous laser irradiation (λ=1064 nm). The results showed that the surface temperature rise effect of CFRP increased significantly with the increase of laser spot size at the same power, and the laser-induced damage threshold of CFRP decreased significantly. When the laser spot diameter is 8.4 mm, the damage threshold of CFRP after 30 s continuous laser irradiation is 14.07 W/cm^2. The stray light energy in high energy continuous laser system is generally less than one thousandth of the main laser energy (kilowatt level). The stray light energy (1.44 W/cm^2) far below the damage threshold of CFRP was adopted for irradiation experiment. After the highly reflective film optical components and CFRP were placed in the same sealed chamber for a week, the surface temperature rise effect was significantly increased under 3 kW laser irradiation. About 2°C can increase the maximum temperature, and the film layer ablative defects were accompanied, which was unacceptable for continuous laser systems with tens of millions of energies or higher. Thus, it is necessary to seriously consider the influence of stray light irradiation CFRP on the high reflection film optical component contamination damage in high-power continuous laser facilities.

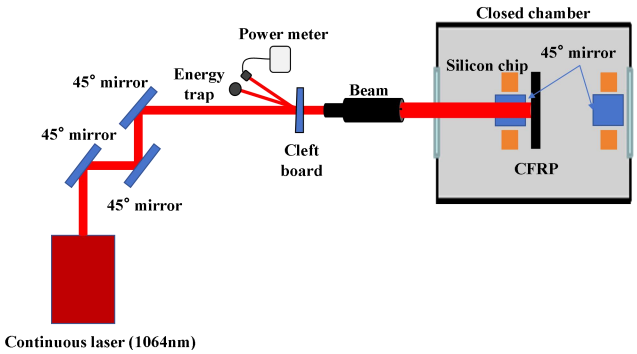

Fig. 1 Simulated stray light dust production experiment light path

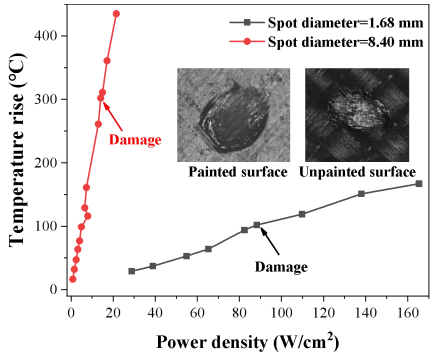

Fig. 2 Surface temperature rise and damage of CFRP at different power densities

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