PROGRESS ON KEY TECHNOLOGIES TO IMPROVE THE DAMAGE RESISTANCE CAPABILITY OF HIGH POWER SOLID-STATE LASER FACILITIES

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Improving the damage resistance capability is the only way to develop the high power solid-state laser facility used for Inertial Confinement Fusion. The damage resistance capability is usually determined by lots of factors due to the complexity of these high power laser facilities. In general, the damage capability is mainly decided by three factors. The first one is the beam properties of the laser facility, such as the beam profile, laser fluence, nonlinear effects, etc. The second one is the damage threshold of the optics, which is affected by varies defects in the surface or in the bulk of optics. And the third one is the operation environments of optics, such as the cleanness and vacuum. The essential factor is the damage threshold of optics because it is the foundation of the damage resistance capacity of a laser facility. And it will be remarkably degraded due to the different defects including cracks, pinpoints and contaminations, which are usually introduced during optics manufacture, integrated assembly and online operation.

In order to reduce the defects in the surface, we developed a series of methods to control the defects during whole process. The key problems of these methods are the damage mitigation of the optics and the cleanness close-loop control of the facility. The techniques of the damage mitigation by a CO_2 laser had been investigated in detail. The results show that the damage sites with the size less than 400 μm in the surface of fused silica optics can be mitigated and the success rate is more than 95%. The surface cleaning technologies have also been studied and the surface cleanness could reach the order of 50 and 100 for the optical and mechanical components, respectively. The high-sensitive measurement of the cleanness had also been developed with the accuracy of 0.5 μm for dusts and 0.1 μg/cm^2 for molecular contaminations. These technologies have been used to improve the optical damage during the laser facility operation at high fluence.

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