New insights into laser damage mechanisms of optics by exploring the evolution of intrinsic defects before and after intense laser irradiations

Wenyu Ding, Suet To#

State Key Laboratory of Ultra-precision Machining Technology, Department of Industrial and Systems Engineering, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong SAR, People's Republic of China
Corresponding Author / Email: Sandy.To@polyu.edu.hk (S. To)

KEYWORDS: Laser damage mechanism, Photoluminescence, Radiation-induced intrinsic defects

The large number of cross-scale defects (i.e. micro/nanoscale structural defects and atomic-scale intrinsic defects) that are easily introduced on the surface during diamond fly-cutting greatly reduce the laser damage resistance of components. Due to the differences in these defects scales, the damage mechanism is exceptionally complex. Herein, the fluorescence characteristics and energy spectrum distribution of crystal with structural defects before and after damage under 355nm nanosecond laser irradiation were characterized and compared. The intrinsic defect concentration before and after laser damage was also quantified. The results indicated that the intrinsic defects are the main causations for exacerbating laser damage of crystals. Under laser irradiation, the collapse of intrinsic defect structures and the occurrence of phase transition lead to the initiation of crystal surface damage. Moreover, more radiation-induced intrinsic defects associated with hydrogen/oxygen atoms introduced by cross-scale defects make the damage more severe. This work provides new insights into laser-induced damage mechanism of KDP crystals, which has theoretical guidance for the subsequent repair of damaged optics.