Surface engineering by laser induced color center annihilation and generation

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Laser usually interacts with the surface of the materials against ionizing radiation that interacts with material bulks. This powerful tool has been found many applications for materials surface modification. So far, laser induced point defect and color center generation has been reported extensively for many materials at high energy irradiation regime. This effect has been observed soon after the laser invention on the surface of optical elements in high power laser setup as a destructive effect. Now, we know that the laser induced color center generation with increase in the material absorption has positive feedback in some applications such as for using as solar cells and scintillators. In addition, we have introduced recently a new capability of laser irradiation in interaction with materials. Laser induced point defects and color centers annihilation is a new effect that we introduced and reported at low energy irradiation regime. In this case, laser energy can help removing of some point defects of the material surface such as vacancies and color centers. In this report, we have performed nanosecond (ArF and XeCl) excimer laser interaction experiments with the surface of Nd:YAG crystal. Our experiments have performed with different pulse number and fluence and point defects annihilation and generation have observed for low and high energy irradiation regime, respectively. Annihilation and generation of point defects or color centers of a material are associated with a decrease and increase in UV-Vis absorption, respectively. Transmission increase due to color center annihilation is very important in optical and solid state engineering. This effect results in improved optical quality for materials as a laser active media and amplifier or as an optical element in optics and laser setups. At the end, with different parameters of laser irradiation we can control point defects and color centers of a material surface to achieve the desired properties for the intended application. This capability is very important in surface science and can apply in many interesting applications.