Laser control of TiO_2-based nanocomposites optical properties

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Laser processing of nanocomposite materials paves the way to local and precise control of their optical properties. However for concrete applications such as integrated optics, photonic devices, photocatalytic devices, and security labels it is critical to know the exact relationship between laser irradiation parameters and optical properties of the resulted material. This study is aimed at local control of spectral characteristics of TiO_2 based nanocomposite thin films with Ag nanoparticles (NPs) carried out by a 405 nm diode continuous wave laser. In order to manage over the optical properties of such films, we changed scan speed and laser intensity. According to our experimental observations and numerical calculations based on the effective medium model, the mean size of Ag NPs and their size distribution differ within the laser track. A decrease of the scan speed, as well as an increase of the intensity, lead to a red-shift of reflection maxima at the edges of the track as a result of the mean particles size reduction and decrease of dispersion width. On the other hand, in the center of the track, a change in the reflection spectra occurs only at a laser power below 330 mW, where an increase in power leads to a shift of maxima to the blue region, which indicates a decrease in the mean size of NPs and a narrowing of their distribution. At a power above 330 mW, there is no change in the size and dispersion of NPs in the center of the track. These spectral dependencies are caused by different temperature distribution for different laser processing modes. The reported study was funded by the Russian Science Foundation, project No. 19-79-10208.