Laser-induced self-organization of nanocomposite films

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Laser technology can be an effective tool for modifying materials at the nanoscale to achieve desired optical properties. When dealing with metal-dielectric nanocomposite thin films, lasers can trigger different mechanisms over large areas to control the statistical properties of these materials. Nanoparticles can be reshaped, resized, and ordered through self-organization mechanisms that extend over micrometer-wide areas. The crystal phase and thickness of the dielectric matrix can also be altered due to laser-induced temperature rises. These laser-induced changes affect the optical properties of the films and can lead to very specific visual effects. Here, we will describe the physico-chemical mechanisms triggered by lasers that result in self-organized nanostructures. We will also demonstrate the various nanostructured patterns that can be produced and how they can be exploited to create secure images. The structural changes are investigated upon exposure to continuous wave (cw), femtosecond (fs), and nanosecond (ns) pulse laser beams. The thermal behaviour upon exposure to cw and pulsed lasers shows opposite trends relative to the deposited energy. This surprising behaviour is explained by considering the competition between optically and thermally activated mechanisms. The diffractive and dichroic properties of the self-organized nanostructures are investigated. Full-color images drawn by pulsed lasers will demonstrate the potential of this technique for security printing.