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Advanced functional nanomaterials by laser technologies

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Surface nanotexturing is a crucial technological procedure allowing to improve basic characteristics of the practically important materials and interfaces or even endow them with new functionalities appearing when the feature sizes shrinks down to nanometer scales. Bright examples of such material improvement can be readily found in almost all aspects of modern engineering and device fabrication, where appropriate patterning allows to control electrical, optical, biological, tribological and wetting properties of the processed surfaces. Material processing using short and ultrashort laser provides a set of non-lithographic techniques showing continuously growing popularity for both scientific and industrial communities. Such interest is largely boosted by the development of the laser market offering cheaper, high-speed and stable pulsed sources, more precise beam shaping and scanning systems as well as the growth of fundamental understanding of laser-matter interaction via development of computer-aided simulation tools and analysis techniques based on machine learning.

In this report, we summarize our recent results on fabrication of advanced nanomaterials in the form of nanoparticle suspensions and nano-textured interfaces via several straightforward laser-assisted fabrication strategies: direct laser patterning, laser-induced period surface structuring (LIPSS) and laser ablation in liquids (LAL). In particular, we focus on advanced opportunities of the mentioned laser technologies for achieving deep-subwavelength feature sizes and hybrid multi-elemental compositions such as metal-semiconductor ones. Diverse applications areas of the produced nanomaterials for resonant light manipulation, light-to-heat conversion, security labeling and sensing are also discussed.

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