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Editors
Suzana Petrović, Goran Gligorić and Milutin Stepić

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Microstructures and oxides formation on structural steel by nanosecond laser irradiation

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Creation of various surface structures on the laser-irradiated materials and formation of metal oxides play an important role to improve the mechanical, physical and chemical properties of materials used in different fields of industry [1-4]. Therefore, the establishment of main mechanisms and optimal regimes of laser micro and nanostructuring of materials and regularities of oxides formation is an important task.

In the present study the multipulse laser irradiation ($\lambda = 1064$ nm, $\tau = 1$ ns, $f = 100 \div 500$ Hz, $q = 4.4 \cdot 10^9$ W/cm^2) was used to create micro and nanostructures on the surface of high quality structural carbon steel at different conditions. Steel samples were moving along a computer given trajectory with a velocity of $v = 0.2$ cm/s. Steel samples were irradiated in ambient air, 3% hydrogen peroxide (H_2O_2) and ethanol (C_2H_5OH). Surface structures and composition analysis were examined by methods of optical and scanning electron microscopy. X-ray diffraction (*XRD*) was used to analyze a phase composition of irradiated steel samples. XRD spectra for various conditions of laser action have had different intensity profiles (peaks value, its position and width). Energy-dispersive X-ray spectroscopy (EDS) was used for elemental analyses.

Surface structures were examined by scanning electron microscope (SEM). The detected surface structures are strongly depends on environment conditions and parameters of laser irradiation. In particular, on the surface of steel samples irradiated in the ambient air, wave structures with a period of 1 μm, irregular structures with a size of 20÷200 nm, grains with the size of 50÷200 nm, pores and irregular threadlike structures were observed. Quasiregular structures with a size of 100÷200 nm and plurality of pores with a size of 40÷600 nm were discovered on the surface of steel samples irradiated in the ethanol. On the surface of the samples irradiated in the environment of hydrogen peroxide numerous cracks and grain structures with the size of 30÷70 nm were observed. The reasons of these differences are discussed.

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Assessment of structural and optical properties of self-assembled photonic structures

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The great potential of self-assembled colloidal structures in several technological areas of modern photonics derives from the low cost and relative simplicity with which they are fabricated. The optical properties of this kind of medium are not only determined by the response of its isolated constituents but also by their spatial arrangement. When polystyrene spheres self-assemble in a periodic fashion, the spatially ordered variation of the dielectric function gives rise to photonic bands and thus the colloidal structure becomes a photonic crystal [1,2].

In this study, colloidal thin films were prepared by the spin-coating [3] and vertical deposition method [4]. By varying the spinning velocity, acceleration and duration of rotation, we obtained different number of colloidal crystal layers. Also, we have prepared opals (multilayer films) with the vertical deposition technique and compared the obtained structures with those obtained by the spin-coating method. In both cases, the thin films were fabricated by depositing colloidal dispersions of 300 nm polystyrene spheres onto microscope glass slide substrates.

The morphology of samples was studied by atomic force microscopy, while their optical properties were investigated by spectroscopic ellipsometry and UV-VIS-IR spectrophotometry. An appropriate model has been developed for the determination of the optical properties of the colloidal films by ellipsometry. In order to validate the model applied, the parameters obtained have been compared with those determined by means of transmittance measurements. From transmittance measurements, in the case of monolayer films, diffraction peak in the visible range was observed. On the other side, in the case of opal has been verified the presence of a photonic band gap which should be attributed to Bragg diffraction [5].