OTT-P2-17

Formation of zinc oxide nanoobject arrays for electrically switchable diffraction gratings

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The aim of this study is to determine the specific characteristics and regularities of the formation of nanostructured arrays of ZnO nanowires with changing morphology from the center to the periphery on a conductive copper-zinc alloy base for their further application in electrically switchable diffraction gratings.

Topicality:
Diffraction gratings are used in applications where it is difficult to achieve the required separation of the incident beam using refractive or reflective optics. These are widely used in optical devices, for example, to produce angular and linear displacement sensors, as well as strain gauges, etc.

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Electrically switchable diffraction gratings are used in many applications and have broad prospects for telecommunications optics. When creating such devices, a crucial step is to manufacture either a gradient matrix of electrodes or a periodic matrix of electrodes where the period is comparable to the wavelength of the incident beam.

Such matrices generate a locally controlled electric field. Structures of ZnO nanorods or nanowires allow to create a periodic localized electric field under the action of direct current. In turn, the electric field provides an opportunity to modulate the optical properties of the liquid crystal medium.

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Vertically aligned ZnO nanostructures were synthesized by hydrothermal growth on a two-dimensional layer. It was also stated in that arrays of vertically oriented ZnO nanorods or nanowires can be produced by the electrochemical method applying direct current. But it was noted that the morphology of ZnO nanoobjects was extremely sensitive to the synthesis conditions.

In reference books and monographs dedicated to Computer Design of Diffractive Optics it was shown that to create two-dimensional (2D) diffraction gratings it is effective to shape zones that are different from periodic slit- and ring-shaped ones, thus allowing new functional possibilities for diffractive optical elements.

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Results:

The specific characteristics and regularities of the formation of nanostructured arrays of ZnO nanowires on a conductive copper-zinc alloy base were determined. Pulsed-periodic CO_2 laser irradiation led to the vibration of the treated samples, which was only a condition for the intensification of nanowires growth during laser heating.

The laser irradiation resulted in an increase in temperature in the central region and the arrays of ZnO nanobjects were formed with greater intensity in the central part of the sample. Surface dezincification and a selective oxidation process may represent a new approach in the production of nanomaterials with customizable and controllable electrical and optical properties.

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In this case, a layer of copper oxide (I) is formed on the surface of the material from which zinc oxide nanowires are emerging. High air humidity, in which an additional hydratogenic layer is formed on the surface of the brass, also contributes to a change in the mechanism of oxide structures formation.

Measurements of electrical resistance of the created samples was established that the specific electrical resistance was by 30–40 % greater in the central area of the sample than at the periphery, and it reached 700 Ω × cm. The oxygen adsorbed in the sample increased the electrical resistivity by 70 % up to the value of 1200 Ω × cm.

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Such arrays can be used to create a periodic localized electric field when a direct current is applied. In turn, this provides the opportunity to produce electrically switchable diffraction gratings with a varying character of zones.

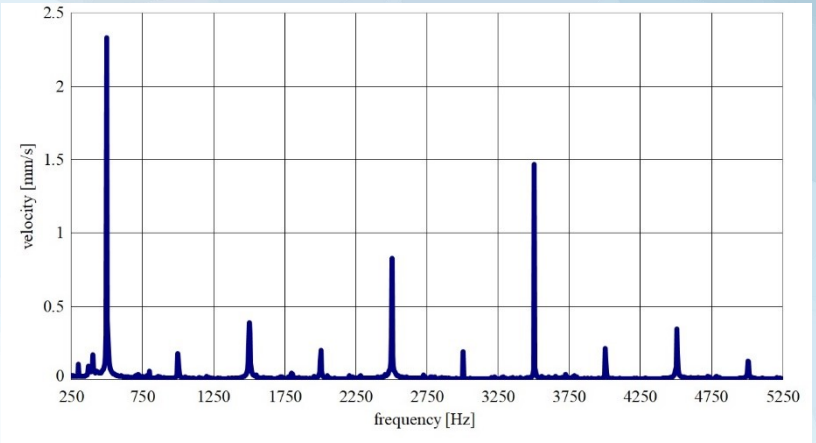

Figure 1. Graphical representations of the spectrum of vibration rate averaged over the samples surface subjected to laser irradiation with a pulse frequency of 500 Hz.

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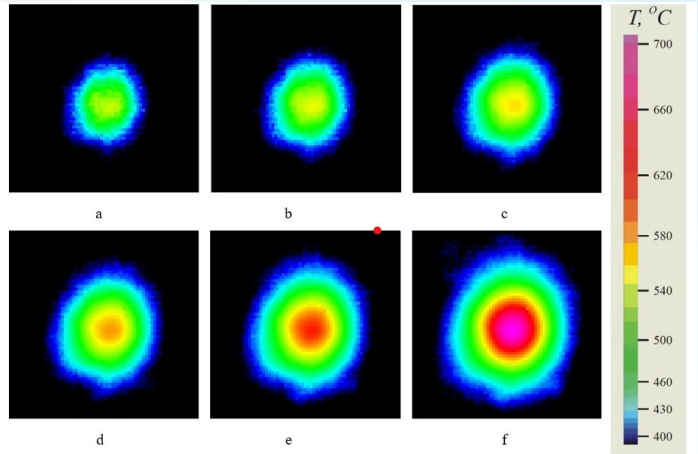

Figure 2. Temperature field of the sample in the heat affected zone during pulse-periodic laser treatment, exposure time: 11 s (a), 12 s (b), 13 s (c), 14 s (d), 15 s (e), 16 s (f).

Conlusion: ZnO nanoobjects arrays were formed by laser irradiation, which allowed the creation of electrically switchable diffraction gratings.

Контакты

e-mail для вопросов и обсуждения

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