

### **Multiplexed recording of dynamic gratings in bismuth silicate crystal by laser pulses**

*I.G. Dadenkov, A.L. Tolstik, A.V. Pestova, Yu.I. Miksuk, K.A. Saechnikov*

*Belarusian State University, Minsk, Belarus*

Multiplex recording of holograms is a good method of storage and processing of optical information. The property of holograms, which makes it possible to record in a small volume a large amount of information about incident optical beams, makes it possible to obtain a high density of data on a small volume and to recover a particular hologram independently of the others. In this work, a photorefractive crystal of bismuth silicate was used as a material for recording holograms. It belongs to the sillenite group and is a wide-gap dielectric with a large number of impurities and structural defects. The presence of the latter leads to the emergence of trap levels in the forbidden zone, recombination of electrons on which leads to the formation of holograms. The obtained holograms are dynamic, i.e. disappear with time and, due to the levels in the forbidden zone, can be obtained using radiation in the visible region of the spectrum.

Multiplexed holograms in bismuth silicate were recorded using the second harmonic of a pulsed Nd:YAG laser, and recovery was performed using a continuous 660 nm semiconductor laser. Laser pulses in the crystal formed holographic gratings with periods of 500 nm and 5  $\mu\text{m}$ , respectively, and an additional delay was created between the beams recording the gratings in order to exclude the formation of additional cross gratings.

### **Determination of the topological charge of a phase singular beam using a nematic liquid-crystal Fresnel lens**

*Y.P. Pantsialeveva, E.A. Melnikova*

*Belarusian State University, Minsk, Belarus*

Currently, many scientific groups are engaged in the study of phase singular beams carrying orbital angular momentum due to the active use of topological charge for the implementation of qudits (multilevel quantum states) in cryptography, quantum information and communication. A simple interference method for analyzing the phase topology of optical vortices based on the preliminary diffraction of singular light beam on an achromatic electrically controlled nematic liquid crystal cell, which is a Fresnel zone plate, is proposed and implemented here. The efficiency of the method has been tested experimentally and theoretically in the visible and near-infrared range. The use of an electrically controlled achromatic Fresnel lens based on a nematic liquid crystal in singular optics offers a promising method for determining the topological charge of a phase singular light beam due to the possibility of analyzing signals coming from free space in real time without changing the circuit based on the possibility of switching on/off the proposed element. The developed method will help expand the scope of application of phase singular beams and significantly simplify existing technologies.

### **Numerical simulation of metal melting within the framework of a two-temperature model**

*S. Lipski, O. Romanov*

*Belarusian State University, Minsk, Belarus*

Physical, mathematical and 3D numerical models of laser-induced heating and melting process of metals have been developed. Simulations have been performed in the framework of a two-temperature model (for electron gas and ion lattice) and can be used to describe the melting process of metals under action of ultrashort (femto- and picoseconds) laser pulses with various spatial structures. The nonlinear dependence of the thermophysical parameters of the electron gas and ion lattice on temperature is also taken into account in the numerical calculations.

### **Simulation of a-Si-Au composite modification by a nanosecond laser pulse**

*J.V. Shafarevich, A.S. Fedotov*

*Belarusian State University, Minsk, Belarus*

This study considers the numerical modeling of laser heating of composites and is conducted to analyze the temperature dynamics in thin films of amorphous silicon with a 130 nm thickness, with and without a 30 nm gold layer. Using finite difference methods to solve the heat conduction

equation, the study examines how laser radiation parameters, with a wavelength of 1064 nm and a pulse duration of 10 ns, affect the heating process. For a  $0.5 \text{ mm}^2$  area and the specified laser parameters, the threshold intensity at which material modification begins aligns with experimental data. Results highlight the gold layer's important role in enhancing heat distribution and improving crystallization. This study will aid in optimizing laser parameters for the experimental synthesis of nanocrystalline silicon via metal-assisted crystallization.

### **Electromagnetic properties of AgNi/MWCNT-PMMA composites in THz range**

*P. Y. Misiyuk<sup>1,2</sup>, G. V. Gorokhov<sup>1</sup>, G.V. Golubtsov<sup>3</sup>, M.A. Kazakova<sup>3</sup>*

<sup>1</sup>*Institute for Nuclear Problems of Belarusian State University*

<sup>2</sup>*Belarusian State University, Minsk, Belarus;*

<sup>3</sup>*Boreskov Institute of Catalysis SB RAS, Novosibirsk, Russia*

In this work the electromagnetic properties of AgNi/MWCNT-PMMA composites, obtained by coagulation precipitation of polymethyl methacrylate and multi-walled carbon nanotubes modified with AgNi nanoparticles, were observed in terahertz frequency range (0.1–1 THz). That composites are perfect candidates as EMI shielding materials in microwave range, so their investigation in THz range is promising for various shielding applications in this range.

It was shown, that modification of MWCNTs with AgNi nanoparticles led to a decrease in percolation threshold and an increase in conductivity and shielding effectiveness in broadband frequency range. At the same time, the real part of permittivity is decreasing from 8 to 5 while the conductivity is increasing from 35 to 135 Sm/m with increasing frequency from 0.2 to 1 THz. The most effective filler is 100 % Ag, due to its higher conductivity compared to Ni nanoparticles. Thus, AgNi/MWCNT-PMMA are promising for THz applications, in particular, as EMI shielding materials.

### **Superradiance in ultrashort pulse reflection signals taking into account the Bloch-Siegert shift**

*R. Rusetsky, K. Pistsova, A. Kolesenko, V. Kolesenko*

*Scientific- Practical Material Research Centre, Minsk, Belarus*

The effect of sample thickness and Bloch-Siegert shift on the reflection signal of resonant ultrashort pulses is investigated. In particular, the superradiance that is formed in this signal is studied. To take into account the effect of the Bloch-Siegert shift, numerical methods for solving the Maxwell-Bloch equations without the rotating wave approximation were used. It is demonstrated that in thinner samples, superradiance is formed at shorter times. It is found that one of the factors that affects the moment of formation of the superradiance maximum is the Bloch-Siegert shift, since it prevents a complete inversion of the two-level system when exposed to a  $\pi$  pulse.

### **Tenth order correction to the lepton anomaly from some bubble-type diagram**

*O.P. Solovtsova, V.I. Lashkevich, L.P. Kaptari*

*Joint Institute for Nuclear Research, Dubna, Russia*

Analytical expressions for the tenth-order electromagnetic correction to the lepton ( $L = e, \mu, \tau$ ) anomaly,  $a_L$ , are derived explicitly for the Feynman diagram involves the vacuum polarization insertion of four closed lepton, three of which are formed by a lepton  $L$  of the same kind as the external one. A method based on consistent application of the dispersion relations for the polarisation operator and the Mellin--Barnes transform for propagators of massive particles, was presented in our previous papers. The result is expressed in terms of the mass ratio  $r = m_\ell / m_L$ . From the exact analytic expressions we find the asymptotic expansions at  $r \rightarrow 0$  and  $r \rightarrow \infty$  and compare them with the corresponding expansions known in the literature. We estimate the interval for the mass relation in which the approximate expansions practically coincide with the exact formulas.