To increase the storage density in NVM devices, multiple states can be recorded in a single PCM memory cell. There are several approaches to achieve this goal. One is to store multiple states in a single film of phase change material by controlling the crystalline to amorphous ratio in the thin film. Another approach is to stack different films of chalcogenide materials. In this case, each state corresponds to a different value of the cell resistance and to a different combination of the layer structure.

We show here our recent results in developing selector devices [1] and PCM cells [2-5].

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The photoinduced displacement of amorphous chalcogenide and photochromic organic compounds.

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The direct surface patterning of chalcogenide and photochromic organic compound amorphous films via photoinduced displacement of matter was studied. The influence of the amorphous film thickness, grating period, intensity and polarization direction state of recording beams for the holographic recording efficiency of surface relief gratings (SRG) with laser wavelengths in the spectral range of (375 nm – 671 nm) was studied. The amorphous chalcogenide films (As-S, As-S-Se, As-Se and Ge-Se systems) were studied and obtained results were compared with the measurements on photochromatic organic compound (azo-benzene containing low molecular organic glasses, epoxy and gelatin systems) thin films [1, 2].

The phase relationship between the recording light field and the resulting surface deformation was studied. It was observed that the peak of the SRG on chalcogenide films was formed at the position of p-polarization state (polarization direction of recording light is paralel to grating vector) in the polarization modulated interference pattern of $+45^0/-45^0$ recording beam configuration. The experiments performed on azobenzene containing organic compounds showed that in this case the direction of the photoinduced matter transport is opposite to that obtained with As2S3 films.It was shown that the efficiency and direction of mass displacement is determined by a value and sign of photoinduced birefringence in amorphous films. This fact is crucial to clarify the direction of the forces in SRG formation processes.

Holographic as well as the one beam method for the grating recording enables a fabrication of the gratings with a period from 100 nm up to 50 μm. A practical application of organic and inorganic optical recording photoresists for surface *direct* patterning will be discussed.

The mechanism of the direct recording of surface-relief on amorphous films based on the photoinduced softening of the matrix, formation of defects with enhanced polarizability, and their drift under the optical field gradient forces is discussed [2].

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Surface relief recording-erasing in amorphous chalcogenide layers and nanocomposites

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New materials and technologies are under intensive research and development last time for fabrication of separate or integrated photonic elements, matrices, photonic crystals, and metasurfaces in our laboratories [1,2] and worldwide. Among the wide number of inorganic and organic materials and proper fabrication methods by optical or e-beam lithoghraphy, imprint technology the holographic recording is one of the most known, although the selective etching, development of optical reliefs in standard resists causes essential shortcomings. The spectral range of applicability, stability or reversibility of the recorded reliefs are also important.

The goal of the present work was the development, selection of efficient light sensitive chalcogenide layers made of As(Ge)-S(Se) glass compositions and their application for optical, holographic recording in one step, direct process of 1- or 2D-photonic structures formation. Functional acrylate nanocomposites, which contain chalcogenide nanoparticles and which are sensitized to blue and green laser illumination were also developed and applied for one step optical recording of amplitude-phase reliefs.