Bulk and surface micro- and nanostructures in chalcogenide glassy semiconductors induced by femtosecond laser pulses

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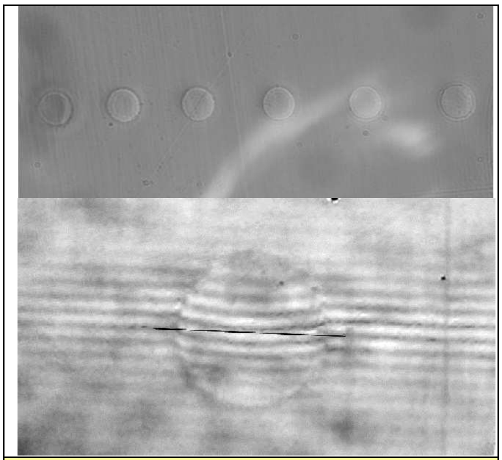
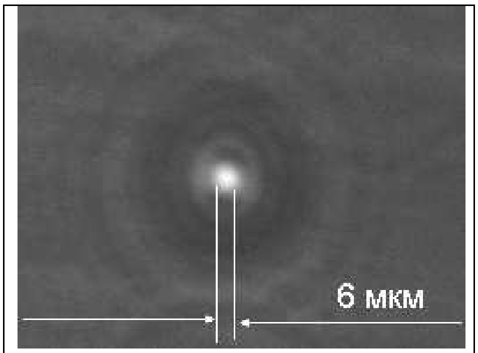
It is shown that femtosecond laser radiation induces the process of Kerr filamentation in chalcogenide semiconductor glass (ChSG) of $As_4Ge_{30}S_{66}$ composition, which is featured by the presence of structural mesh elements of nanometer scale. Formation of high-intensity filament core which hosts a variety of different nonlinear processes, including two-photon absorption, is closely related to this phenomenon. As a result, free charge carriers, photoinduced transformations and local change of refractive index occur in the plasma channel of the filament. Basing on this phenomenon, we proposed and tested a method filament-induced self-writing of micro-waveguides in bulk ChSG. Refractive index profile of the waveguide is calculated based on defocused microscopic images of the excited area, using one-dimensional Transport of Intensity Equation and inverse Abel transform. We found that a zone of increased refractive index (up to 0.5×10^{-3}), appears along the waveguide axis, which is surrounded by a zone of negative refractive index changes of ~ 7 mm diameter.



The surface of the 65GeS2-25Ga2S3-10CsCl ChSG the exposure by a number of single fs laser pulses, illustrating the produced microlenses, and micro-interferense pattern of a single microlens of 23 μm diameter.

We tested the possibility of production of microlenses using a single pulse of femtosecond laser radiation and proposed a method of microlens production, which can serve as a basis for the technology of rapid production of regular arrays of microlenses for telecom applications. The advantage of this method is its high performance that is limited only by the repetition rate of the laser pulses (1000 microlenses per second).



Imaginary focus of the microlens. The object plane is in the sample at a depth of 150 microns from the surface.