NONLINEARITY OF LIQUEFYING GALLIUM: A BREAKTHROUGH OPPORTUNITY FOR CONTROLLING LIGHT WITH LIGHT AT MILLIWATT POWER LEVELS

S. Dhanjal, V.I. Emel'yanov**, P. Petropoulos*, D.J. Richardson* and N.I. Zholudev+

*Department of Physics and Astronomy, and +Optoelectronics Research Centre University of Southampton Highfield, Southampton SO17 1BJ, UK

email: N.I.Zholudev@boston.ac.uk **Department of Physics & International Laser Centre Moscow State University Moscow 119899, Russia

We have found that an interface between glass and metallic gallium held just below the melting point shows an astonishingly large broadband cubic nonlinearity reaching (chi)(3) ~ 1 esu. This constitutes a new type of nonlinear optical response. This large nonlinearity is available in a very versatile material geometry, it works at room temperature and has major device potential in optoelectronics. The physical mechanism behind the nonlinearity is related to a new type of optically induced phase transition between two phases of gallium and shows critical behavior of the material susceptibilities and relaxation times appropriate to a second-order phase transition. The nonlinearity is much faster than in liquid crystals and has the advantage of being very broadband in comparison with the near band-gap and excitonic nonlinearities in semiconductors. It spans from visible to near infrared covering important telecom spectral windows. The nonlinearity is fully reversible and the effect is stable as long as the sample temperature is maintained to within 1°C just below the melting point of gallium which is about 29°C. We have demonstrated that the nonlinearity is fully compatible with waveguide technology as the gallium mirror may be formed at the tip of a single-mode fiber. A high-contrast optical switch has already been demonstrated operating at milliwatt light power levels, with a roll-off frequency in excess of 100 kHz. The switch is also capable of routing sub-microsecond optical pulses. In another application, a liquefying gallium mirror was used to achieve q-switching of an erbium fiber laser.


Pulse Compression in Photonic Crystals

M. Karstei, S.A. Magnitskii, A.V. Terashinsh, and A.M. Zheltikov

International Laser Center, Physics Department, M.V. Lomonosov Moscow State University, Vorob'evy gory, Moscow, 119899 Russia

Photonic band gap (PBG) structures [1] have been widely investigated in recent years in connection with a broad variety of applications, including the control of spontaneous emission [1], vertical-cavity surface-emitting semiconductor lasers [2], Bragg-reflecting structures [3], low-threshold optical switching [4], etc. At the same time, as highlighted in [5], PBG structures also provide an opportunity to control the group and phase velocity of light pulses whose frequencies lie near the edge of the relevant band gap. In this paper, we consider the possibilities of pulse compression in photonic crystals. Based on the estimates for one-dimensional PBG structures and numerical simulations for photonic crystals whose parameters are close to those implemented experimentally, we will demonstrate that photonic crystals allow chirp compensation and pulse compression on a submillimetre spatial scale (Fig. 1), which permits us to propose a concept of compact pulse compressors based on Photonic Band Gaps (ComPGs), providing new opportunities for the miniaturization of femtosecond solid-state laser systems.