Novel carbon materials and structures for photonics

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Abstract

Advanced carbon materials, such as CVD diamond, single-wall carbon nanotubes and graphene, as well as micro and nanostructures based on them, will be presented. It will be shown that such materials demonstrate unique optical properties which can be used in application to photonic elements and devices. The following photonic applications will be considered.

1. **CVD diamond plates as windows, mirrors, microresonators and transmissive diffractive optical elements for IR laser radiation**. Optical and other properties (thermal conductivity, thermoelastic stability, etc.) of polycrystalline CVD diamond will be outlined. The techniques for such optical elements fabrication (laser ablation, laser and plasma reactive etching, "replica" method) will be considered. Applications to high power 1 and 10 μm wavelength rare-earth crystal and CO_2-lasers and coupling elements for fiber optics delivery systems will be demonstrated. Possibility of creation of single-photon emitters based on N-V and Si-V centers in CVD diamond will be discussed.

2. **Diamond photonic crystals**. They can be produced by CVD deposition of diamond material into the substrate of opal or reverse opal structure. Another approach is based on femtosecond laser produced phase transformation (diamond-graphite) in the bulk of diamond sample.

3. **Stimulated Raman scattering in CVD diamond and Raman laser converters**. Major features of such lasers will be presented. The output intensity limitation determined by diamond nanoablation by means of material oxidation during short laser pulse action will be discussed.

4. **Ultrafast non-linear optical elements as water suspensions and polymer films doped with single-wall carbon nanotubes (SWNT).** Optical properties of semiconductor and metallic SWNT for low and high intensity radiation will be presented. The techniques for purification of SWNT containing materials, production of individual and selected by properties SWNT will be considered. Mode-locking of 1-2 μm wavelength crystal and fiber lasers and emission of ultra-short laser pulses (duration as low as 200 fs) by means of SWNT elements will be demonstrated.

5. **Graphene as a presize and conductive optical filter and non-linear optical element**. The specific optical properties of single and multi-layered graphene sheets will be discussed. Application of graphene as non-liners optical switch for mid-IR lasers will be demonstrated. Creation of graphene nanostructures by ablation technique will be also considered.