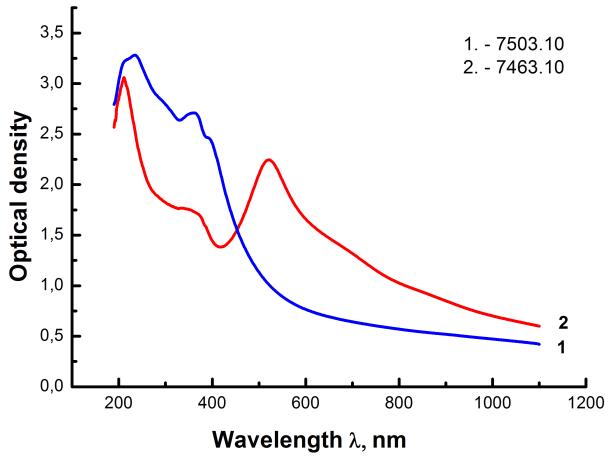
Resonance Enhancement of Optical Absorption in Nanocrystalline SiC (nc-SiC) films

A.V. Semenov, A.V. Lopin, S.N. Skorik

Institute for Single Crystals NAS of Ukraine, Lenin ave. 60, Kharkov, 61001, Ukraine.
E-mail: semenov@isc.kharkov.ua

One of effective methods for enhancement of optical and non-linear optical (NLO) properties of nanocrystalline SiC is application of local electrical fields in the nanocrystals. This is the base of different approaches described in the literature. The formation of strong electrical fields in SiC nanocrystals by means of hyperpolarization of the contact of their surface with organic compounds results in enhancement of the absorption and luminescence bands and rises the intensity of GSH [1]. The introduction of metal particles into nanocrystalline SiC medium is used for induction of electromagnetic field in the nanocrystals owing to resonance plasmon oscillations of electron density in metal particles [2].



Optical density spectrum for nc-SiC film without ordering (1) and with partial ordering (2).

In the present work we investigated the possibilities of enhancement of resonance optical absorption in the nanocrystalline SiC films obtained by direct ion deposition [3]. As established earlier, nc-SiC films show anomalously high values of the third-order non-linear susceptibility [4]. Thereat, the main factors which define the high NLO values are the structure and size of the nanocrystals, the state of the boundary regions. The optical absorption spectra (Curve 1) of the studied nc-SiC films were found to have the standard exponential fundamental absorption edge and an exponential tail testifying to a high concentration of surface and defect localized states in SiC nanocrystals. In the present work the study was performed on partially ordered films of nc-SiC nanocrystals of the rhombohedral polytypes 24R, 27R. The thickness of nc-SiC films were 400-900 nm, the size of SiC nanocrystals run into 20-50 nm. For the first time we observed a basically new behaviour of the absorption spectra (Curve 2) characterized by an intense absorption maximum in the region close to the forbidden energy band of the dominating polytype.

Depending on the width of the forbidden band of the polytype, the location of the maximum varied between 550 and 630 nm. The intensity of the maximum essentially depended on the film thickness which optimum value was found to be within the 200-500 nm region. The mechanism of resonance absorption in nc-SiC films may be based on exciton-polarized excitation in the nanocrystalline layer observed in nanoporous SiC layer at $r_B < d < \lambda_{exc}$, where d is the nanocrystal size, r_B, the Bohr radius of exciton, λ_{exc}, the excitation wavelength [5].

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