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Manifestation of electron bands structure of one- and two-layer graphenes, bulk graphite and single-walled carbon nanotubes by means of double-resonant Raman spectra

Yu.Yu. Stubrov[1], A.S. Nikolenko[1], V.V. Strelchuk[1], A.E. Belyaev[1],

V.O. Gubanov[2], M.M. Biliy[2], L.A. Bulavin[2]

[1] *V. Lashkaryov Institute of Semiconductor Physics, Natl. Acad. of Sci. of Ukraine. Prospect Nauki, 45, Kiev-03028, Ukraine.*
E-mail: chig-ua@rambler.ru

[2] *Kyiv National Taras Shevchenko University, Department of Physics. Volodymyrs'ka str., 64, Kiev-01601, Ukraine.*

In the present work micro-Raman spectra of one-layer and two-layer graphene, graphite bulk crystals and single-walled carbon nanotubes in the range of two-phonon 2D-bands were investigated in details. Micro-Raman spectra were carried out in backscattering geometry at room and liquid nitrogen (77K) temperatures using triple Raman spectrometer T-64000 Horiba Jobin-Yvon. Lines of Ar-Kr ion laser with wavelengths of 454.5, 457.9, 476.5, 488.0, 496.5, 514.5, 520.8, 530.9, 568.2 and 647 nm were used for exitation.

From the analyses of frequency position of observed radial breathing modes (RBM) at used excitation energies we analized the diameters distribution of SWCNTs, which are excited in the resonant Raman process.

The fine structure of two phonon 2D-bands in the Raman spectra of two-layer graphene, graphite bulk crystals and mixture and individual single-walled carbon nanotubes is considered as the reflection of structure of their π-electron zones.

The dispersion behavior of 2D-band fine structure components in the resonant Raman spectra of single-walled carbon nanotubes mixture is studied depending on the energy of excitating phonons. The role of incoming and outgoing electron-phonon resonances in formation of D and 2D-bands fine structure in Raman spectra of single-walled carbon nanotubes is analized. The similarity of dispersion behavior of 2D phonon bands in single-walled carbon nanotubes, one-layer graphene and bulk graphite is discussed.