Self Amplified Spontaneous Emission in carbon nanotubes and graphene

K. Batrakov, P. Kuzhir, S. Voronovich
Research Institute for Nuclear Problems BSU, Belarus

Electromagnetic wave slowing down is one of the remarkable properties of carbon nanotubes [1]. This effect leads to possibility of Cherenkov synchronism between electron beams and electromagnetic wave [2]. Collective radiation generation based on this mechanism in nanotubes and graphene is analyzed. The initiation of generation from quantum fluctuation that leads to the random microbunching of electron beam is considered and compared with input seed generation mechanism.

1. G. Ya. Slepyan, S. A. Maksimenko, A. Lakhtakia, O. Yevtushenko, A. V. Gusakov, Phys. Rev. B 60, 17136 (1999).
2. K. G. Batrakov, P.P. Kuzhir, S. A. Maksimenko and C. Tomsen, Phys. Rev. B 79, 125408 (2009).

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Electron band structure of carbon nanotubes intercalated cupper

I. Bochkov, P. D'yachkov
Ryazan State Radio Engineering University, Russia

Preparation of the carbon nanotubes offers strong possibilities of manufacturing the nanowires with intriguing mechanical, electronic, and magnetic properties. The inner cavity of these tubules can be filled with a variety of substances including the transition metals. We are now being confronted with a problem of predicting properties of nanotubes intercalated with transition metals. Here, we present a linear augmented cylindrical wave (LACW) method and its application to band structure of the tubes doped with copper. The band structures and densities of states are calculated. It is shown that in the vicinity of Fermi level, the branches of the carbon and metal subsystems are intersected, which point to their considerable interaction and joint participation in conductivity. In the pure carbon armchair tube, the Fermi level is known to be located in dip of electron density of states. Intercalation of the transition metal fills this dip, which results in a growth of electron density of states in the Fermi level and consequently in a considerable increase in conductivity of the armchair carbon nanotubes. A metallization of the zigzag tubules due to the cupper intercalation is demonstrated too.

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Functionalized SNOM-probes with nanodiamond crystals hosting nitrogen-vacancy color-centers

D. Filimonenko, D. Pustakhod, V.Yasinskii
B. I. Stepanov Institute of Physics, National Academy of Sciences of Belarus, Belarus

The optical resolution of existing scanning near-field optical microscopes (SNOM), based on the use of aperture SNOM-probes, made of sharpened metallized fiber with a hole at the apex of the cone, is essentially limited by the size of the aperture. In order to improve the optical resolution of SNOM and, therefore, to overcome this restriction it was proposed to use point-like light sources. Additional practical requirements for such light sources are simplicity of their creation, the ability of stable operation at room temperature, possibility of single-photon emission. Color-centers in diamond, in particular nitrogen-vacancy (NV) centers, appear to match all of the above mentioned requirements. We performed the attachment of nanodiamond nanocrystal with nitrogen-vacancy color-centers at the vertex of an optical probe. Spectrophotometric measurements and normalized second order time-intensity correlation functions of the functionalized optical probe measured with Hanbury Brown and Twiss scheme giving evidence for NV-center presence. The work can be of great importance in various fields of nanotechnology, where a high optical resolution is required: in medical biophysics, plasmonics, quantum cryptography.

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