Nanooptics and nanophotonics

Optical constants of graphene layers versus graphite

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The single atomic layer of graphite, graphene, has gained most interesting between different reported two-dimensional crystals due to its remarkable electronic properties. Graphite optical properties, refraction index and absorption coefficient spectral dependencies are known during many years [1]. From the beginning of our century renewed interest appears to the optical properties of thin layers of different graphite-like materials [2, 3] and their thickness dependencies.

It is known, that one graphene layer absorbs 2.3% of incident radiation in the region of 350-800 nm and linear thickness dependence of absorbance is observed up to 4 layers. However, a variety of thin and thick films of carbon nanomaterials are prepared by different methods and studied now, so knowledge of optical constants for explanation of the observed effects is important.

We have studied and compared optical properties of carbon-based samples: thin (5-30 nm) films of pyrolytic carbon deposited by CVD method, graphene layers, bulk HOPG, as well as graphene nanoparticles and carbon nanotubes prepared in different solutions. Optical measurements were performed in 200 – 1000 nm spectral range in transmittance mode and 380-1100 nm in the reflectance mode.

Analysis of data allows supposing that differences in determined optical properties of thin carbon-based films of identical materials are caused by, in the first place, by structural film imperfectness, disordering, porosity etc. Structural changes and defects in ideal crystal structure of graphene nanostructures have effect as well.

We found experimentally that dependencies of *n* and *k* reveal weak peculiarities in the region of 600-1100 nm, namely, some small peaks (about 1% in absorbance relative units) are appeared in majority of the investigated samples. They might be connected with structural peculiarities of carbon nanostructure (intraband transition in carbon nanotubes, in ribbons of graphene, etc.) that cause resonance optical properties of graphene nanostructures and can be used as graphene enhanced substrates in SERS, CARS, etc. spectroscopies.

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