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Terahertz Spectroscopic Characterizations for Graphite Nanofibers and Graphite

Terahertz (THz) time-domain spectroscopy (THz-TDS) is a powerful technique to study materials properties such as complex dielectric response and conductivity in the far-infrared spectral region, with the advantages of high signal-to-noise ratio (SNR), noncontact optical probe, and measuring the amplitude and phase of electric field simultaneously thus not requiring Kramers-Kronig (K-K) transformation. Graphite is an allotrope of carbon, classified as a semimetal, which is characterized by a high anisotropic three-dimensional (3D) band structure [1]. The research for electrical, magnetic and optical properties of graphite have been triggered by the single layer Graphene [2], and other two-dimensional materials (e.g. Hexagonal Boron Nitride-hBN, MoS2 and Black phosphorus) [3]. The generation of THz pulses from highly oriented pyrolytic graphite (HOPG) samples illuminated with femtosecond laser pulses has also been reported [4]. Graphite nanofiber is produced by the metal catalyzed decomposition of certain hydrocarbons at temperatures from 400-800℃ [5]. One of the outstanding features of these structures is the presence of a large number of edges, which in turn constitute sites readily available for chemical or physical interaction, particularly adsorption. These properties are likely to be derived from the intermolecular bonds in graphite nanofiber, which may have different characteristics than for standard graphite [6]. THz spectroscopy is a technique of choice for studying these characteristics, as the energy of THz radiation corresponds to the weak intermolecular bonds between graphite sheets and in the same time intra-molecular vibrations of the graphite rings can be excited. We concentrate on the seldom used frequency range of 0.1-7 THz, which cannot be accessed by standard far-infrared spectrometers. THz spectra of graphite nanofibers are compared to other forms of graphite, such as pencil lead (B, HB, and 2H) drawing on paper, absorption modes identified and conclusions have drawn on specific characteristics of graphite nanofiber.

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