Revisiting Carbon's Optics: From Graphite's Past to Graphene's Future

Adilet Toksumakov
Georgy Ermolaev, Dmitriy Grudinin, Aleksandr Slavich, Andrey Vyshnevyy, Anton Minnekhanov, Gleb Tselikov, Aleksey Arsenin, Valentyn Volkov
XPANCEO RESEARCH ON NATURAL SCIENCE L.L.C S.O.C, Arjumand Building, 17th Street, Green Community Village, Dubai Investment Park First, UAE
adilet.toksumakov@xpanceo.com

The optical properties of carbon allotropes, from bulk graphite to monolayer graphene, are crucial for their widespread applications. However, the fundamental optical constants of graphite remain surprisingly unrefined, with various research collectives reporting inconsistent values obtained through diverse methodologies over time [1-3]. Similarly, while graphene exhibits unique optical absorption (e.g., 2.3% on SiO2) [4-5], its superior electronic performance on hexagonal boron nitride (hBN) substrates contrasts with its optical properties in this configuration, which remain largely unexplored. This investigation addresses these critical gaps. We employed spectroscopic ellipsometry and measurements via transmission and reflection to precisely determine graphene's optical properties on hexagonal boron nitride substrate and graphite's anisotropic optical constants, providing a refined and validated dataset. This novel work offers unprecedented nanoscale insights into graphite's localized optical phenomena, bridging the gap between macroscopic properties and their nanoscale origins. Our findings are vital for advancing the fundamental understanding and application of van der Waals materials in next-generation optoelectronic and nanophotonic devices.

References

[1] E. D. Palik. Handbook of Optical Constants of Solids (Academic Press, 1998)
[2] B. Song et al. Broadband optical properties of graphene and HOPG investigated by spectroscopic Mueller matrix ellipsometry. Appl. Surf. Sci 439, 1079-1087 (2018)
[3] A. B. Djurišić and E. H. Li. Optical properties of graphite. J. Appl. Phys. 85, 7404-7410 (1999)
[4] R. R. Nair et al Fine Structure Constant Defines Visual Transparency of Graphene. Science 320,1308-1308 (2008)
[5] M. A. El-Sayed et al. Optical Constants of Chemical Vapor Deposited Graphene for Photonic Applications. Nanomaterials 11, 1230 (2021).

Figures

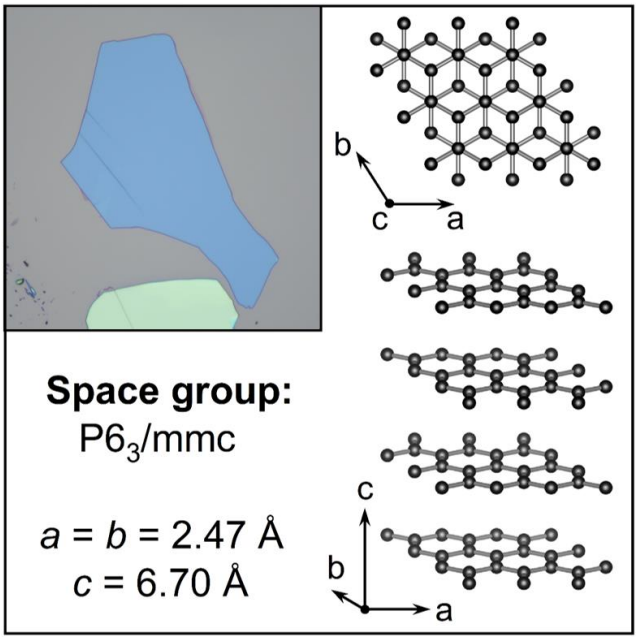

Figure 1: Crystal structure of graphite. The inset: optical micrograph of graphite flake.