Terahertz Time-Domain Spectroscopy of Graphene Nanoplatelets

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In this study, commercially available graphene nanoplatelets (GNPs) in the form of pressed pellets were investigated, together with materials produced via the liquid phase exfoliation method, as well as natural graphite and shungite representing carbon materials containing naturally occurring fullerenes. The aim of the work was to examine how differences in internal structure, origin, and fabrication method influence the terahertz (THz) optical and electronic properties of these carbon-based systems. Terahertz time-domain spectroscopy (THz-TDS) was employed to determine key optical parameters, including the refractive index (n), absorption coefficient (α), and frequency-dependent conductivity (σ'). Significant variations in the THz response were observed among the studied materials, reflecting differences in structure and charge transport pathways. The terahertz-range conductivity was modeled using the Drude–Smith formalism, providing insight into electron localization and backscattering effects. To establish structure–property relationships, Raman spectroscopy and scanning electron microscopy (SEM) were performed, enabling a comprehensive correlation between microstructural features and the observed optical and electronic behavior.

References

[1] Ojrzyńska, M.; Jamroz, J.; Maciałowicz, M.; Wilczyński, K.; Daniszewska, A.; Antonowicz, J.; Zdrojek, M. Quality and Thickness Control of Graphene Nanoplatelets during Large-Scale Production Using Liquid Phase Exfoliation. *Mater. Today Commun.* **2025**, *42*, 111543.

[2] Skalsky, S.; Molloy, J.; Naftaly, M.; Sainsbury, T.; Paton, K. R. Terahertz Time-Domain Spectroscopy as a Novel Metrology Tool for Liquid-Phase Exfoliated Few-Layer Graphene. *Nanotechnology* **2018**, *30* (2).

Figures

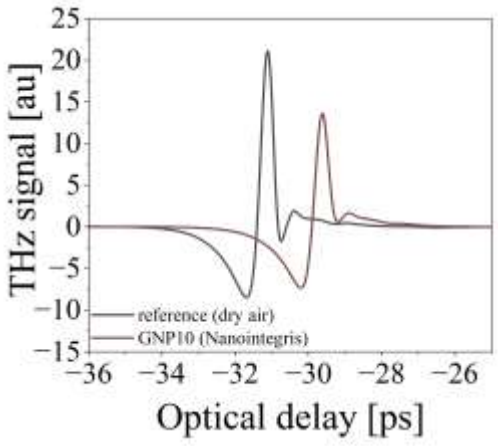

Figure 1: Measured terahertz signal of reference and graphene nanoplatelets presented as a function of optical delay.