

GRAPHENE QUANTUM DOT CHARACTERIZATION USING BLACK SILICON BASED SERS SUBSTRATE

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Fluorescent graphene quantum dots (GQDs) are promising nano-agents for optically guided targeted drug delivery. Accurate control of physical properties of the manufactured nanomaterials as well as determination of their surface chemistry is a paramount issue, as GQDs structure determines the efficiency of their application as imaging and diagnostic agent and surface chemistry governs the interaction of GQDs with living cells and tissues. Raman spectroscopy as well as surface-enhanced Raman spectroscopy (SERS) are highly specific methods of investigation and characterization of QGs. Black silicon-based substrate (bSi/Au) [1] has outstanding SERS properties and was applied for GQD analysis.

GQDs dispersed in water (1 mg/mL) were analyzed via Raman spectroscopy, however, the spectra obtained did not allow to perform GQD quality characterization (see Fig. 1, line 1 and inset). Investigation of GQD water suspension using bSi/Au SERS-active substrate made it possible to reveal the presence of additional surfactant used by the supplier to solubilize GQDs and identify PEG 1500 (or PEG of higher MW) as this surfactant (see Fig. 1, line 4 for GQD-PEG, line 2 for PEG). Using bSi/Au as SERS-substrates also allowed to demonstrate, that GQD-PEG treatment with oxygen plasma and additional washing effectively remove GQD functionalization with PEG leaving only GQDs (see Fig. 1, line 3).

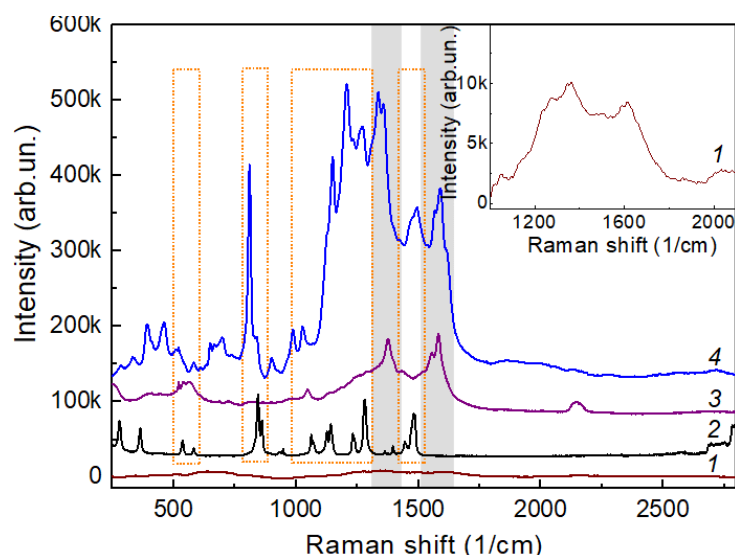


Fig. 1. Raman spectrum of GQDs dispersed in water (line 1), Raman spectrum of PEG-2000 (line 2), SERS spectrum of GQDs (1 mg/mL) on the bSi/Au substrate (line 4) and GQDs (1 mg/mL) after additional treatment for organics removal on bSi/Au (line 3). Inset: enlarged range 1000-2100 cm^{-1} of GQDs Raman spectrum (line1). Excitation wavelength $\lambda_{\text{ex}} = 785 \text{ nm}$, working power 50 mW, accumulation time 30 cycles per 10 s

Thus, GQD structure quality control and surface chemistry analysis could be successfully performed using bSi/Au SERS substrate.

References

1. L. Golubewa, et al. ACS Appl. Mat. Interfaces. **12** (2020) 50971.