

Medical-grade, top-down Graphene Oxide Quantum Dots (GO-QDs) as a biocompatible theranostic platform

Gloria Garcia-Ortega, Vania Papantoniou, Clementine Quintana, Kostas Kostarelos
Nanomedicine Lab, Institut Català de Nanociència i Nanotecnologia (ICN2), Edifici ICN2, UAB,
Bellaterra, Barcelona
gloria.garcia@icn2.cat

Graphene oxide (GO) is a leading candidate for the clinical translation of 2D materials due to its biocompatibility, preferential uptake by certain cell types (e.g. macrophages) [1] and minimal acute toxicity in humans [2]. However, the sheet-like morphology and relatively large lateral size of GO nanosheets can limit their diffusion in complex biological environments. To overcome this limitation, we engineered top-down graphene oxide quantum dots (GO-QDs) designed to preserve GO chemical identity while enhancing diffusion and providing intrinsic photoluminescence. GO-QDs were synthesized from thin GO nanosheets via an optimized top-down hydrothermal method. Comprehensive physicochemical characterization confirmed the preservation of GO surface chemistry. The resulting GO-QDs showed sub-20 nm size and displayed robust photoluminescence. Biological characterization identified a biocompatible threshold and confirmed compliance with medical-grade requirements. Functional studies in a brain-mimicking extracellular matrix phantom demonstrated homogeneous diffusion of GO-QDs, superior to that of GO nanosheets. *In vivo* studies of GO-QDs stereotactic injections in the motor cortex of mice further indicated no behavioural or histological side-effects (up to 72hrs from injection), also tracking their brain localization using their inherent optical signal with an IVIS imaging system. This work reports the development of medical-grade GO-QDs, paving the way for a GO-based theranostic platform that can integrate biocompatibility, tissue penetration and real-time imaging.

References

- [1] Stylianou, M., Kisby, T., Despotopoulou, D., *et al.* Cell Reports Phys. Sci. 6, 2025, 102342
- [2] Andrews, J.P.M., Joshi, S.S., Tzolos, E. *et al.*, Nat. Nanotechnol. 19, 2024, 705–714

Figures

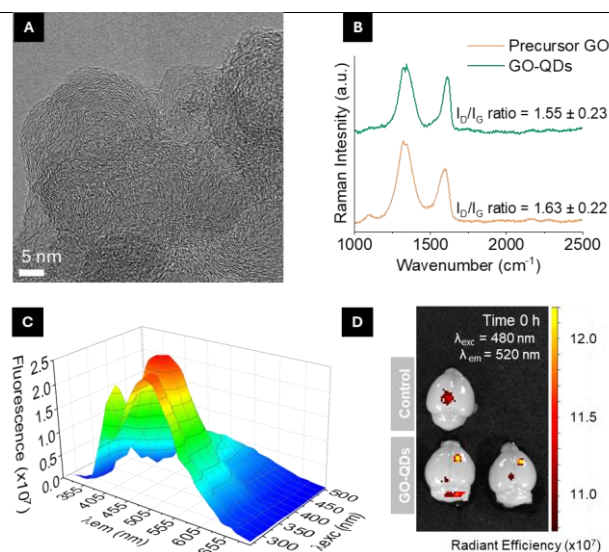


Figure 1: GO-QDs characterization showing morphological, chemical, optical, and biocompatibility features: (A) HR-TEM, (B) Raman, (C) fluorescence and (D) IVIS after 1 μ L cortical injection in mice.