Microscopic characterization of graphene derivates in life science

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Background incl. aims
Graphene derivatives are becoming increasingly important materials in the field of biomedicine, particularly in neurosciences. Their ability to interact with cells and their potential applications in neuroapplications present an intriguing and revolutionary potential1. This study focuses on the microscopic characterization of various graphene derivatives with the aim of identifying the most suitable ones for neuroapplications, taking into account cell uptake and their biocompatibility. The objective of this study is to conduct microscopic characterization of graphene derivatives and evaluate their interaction with cellular structures. Specifically, we focus on their distribution within cells, cellular uptake, and biocompatibility.

Methods
Microscopic characterization of graphene derivatives was performed using several techniques, including the combination of scanning electron microscopy (SEM) with atomic force microscopy (AFM), transmission electron microscopy (TEM), high-resolution TEM (HR-TEM), time-lapse confocal microscopy and Raman spectroscopy. These methods allowed us to examine the morphology, structure, and interaction of derivatives with cellular structures.

Results
Our microscopic characterization revealed that different graphene derivatives exhibit distinct morphology and structure. Using SEM/AFM, we observed differences in particle size and shape. TEM and HR-TEM enabled detailed examination of the internal structure of derivatives. Time-lapse confocal microscopy will be employed to track the dynamic interaction of graphene derivatives with cellular structures over time, providing insights into their uptake kinetics, intracellular trafficking, and potential effects on cellular dynamics. Raman spectroscopy provided information about the chemical structure of derivatives. An important finding was that certain derivatives demonstrated higher cellular uptake and better biocompatibility than others.

Conclusion
Based on our results, microscopic characterization is crucial for selecting optimal graphene derivatives for neuroapplications. Certain derivatives exhibited significantly enhanced ability to interact with cells and higher biocompatibility, indicating their potential for use in neurosciences2. Further studies focusing on long-term effects and applications of these derivatives are necessary to assess their full therapeutic potential.

Graphic:

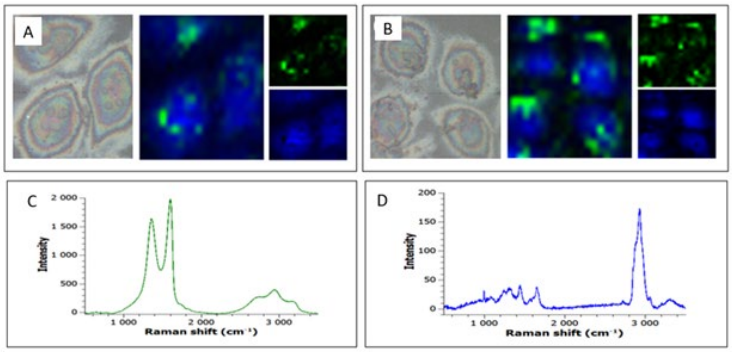

Figure 1: *Map of HeLa cells with GO incubation concentration of 18.75 μg ml^{-1}. The top left shows the microscope image with the mapping area marked, the top right shows the obtained RGB map (also for the individual components, i.e. GO and HeLa cell). Blue represents HeLa cells and green represents GO particles; B – HeLa cell map with GO concentration of 25 μg ml; C – Raman spectrum of GO, shown in green on the RGB map and D – Raman spectrum of HeLa cell, shown in blue on the RGB map. Note: the scale bars are 10 μm.*[3]

Keywords:

Graphene, cells, SEM/AFM, TEM, Raman

Reference:

1Nejabat M. et al. J Biomed Mater Res A. 105(8), 2355, 2017
2Su X. et al. Biosens Bioelectron. 92, 489, 2016
3Chaloupková et al., Analytical Methods, 15 (42), 5582-5588, 2023