Synthesis of graphene oxide with different degrees of oxidation for applications in gene silencing

Ngoc Do Quyen Chau [1],
Giacomo Reina [1], Jésus Raya [2], Cécilia Ménard-Moyon [1], Yuta Nishina [3], Alberto Bianco [1]

[1] *University of Strasbourg, CNRS, Immunopathology and therapeutic chemistry, UPR 3572, 67000 Strasbourg, France*
[2] *Membrane Biophysics and NMR, Institute of Chemistry, UMR 7177, University of Strasbourg, 67000 Strasbourg, France*
[3] *Research Core for Interdisciplinary Science, Okayama University, Tsushimanaka, Kita-ku, Okayama 700-8530, Japan*

ndq.chau@ibmc-cnrs.unistra.fr

Graphene oxide (GO), the oxidized form of graphene, has attracted a lot of interest in the biomedical field, especially in drug and gene delivery. Thanks to its vast specific surface area GO offers an opportunity for loading a large amount of various targeting molecules [1]. Indeed, the polar oxygen-containing functional groups of GO, such as epoxide rings, carboxyl and hydroxyl groups, make its highly hydrophilic, leading to a good dispersibility in water and many other solvents [2]. The main goal of this project is to covalently functionalize GO with amines groups via epoxide ring opening reaction (Figure 1). This approach will allow to develop a novel platform complexing biologically active molecules for gene delivery study, especially for silencing specific genes using small interference RNA (siRNA).

With the aim of reducing the amount of negative charges on GO surface while keeping some epoxide rings, we focused first on the design, synthesis and investigation of GO with different degrees of oxidation to eliminate a fraction of the oxygenated groups. For this purpose, we used different green methods such as hydrothermal treatment, microwave assisted reduction or vitamin C. To increase the amount of ammonium groups which leads to better complexation with siRNA, we performed the reepoxidization of reduced GO under different conditions.

The different functionalized GOs (f-GO) were characterized by complementary analytical techniques such as X-ray photoelectron spectroscopy, thermogravimetric analysis, and solid state NMR spectroscopy. Finally, important part is the achievement of the complexation of f-GO with siRNA at the very low mass ratio, as assessed by UV-Vis spectrophotometry and gel electrophoresis.

References

[1] Krishna KV, Ménard-Moyon C, Verma S, Bianco A., Nanomedicine, 8 (2013)1669.
[2] Dreyer, D. R., Park, S., Bielawski, C. W. & Ruoff, R. S., Chem. Soc. Rev., 39 (2010) 228.

Figures

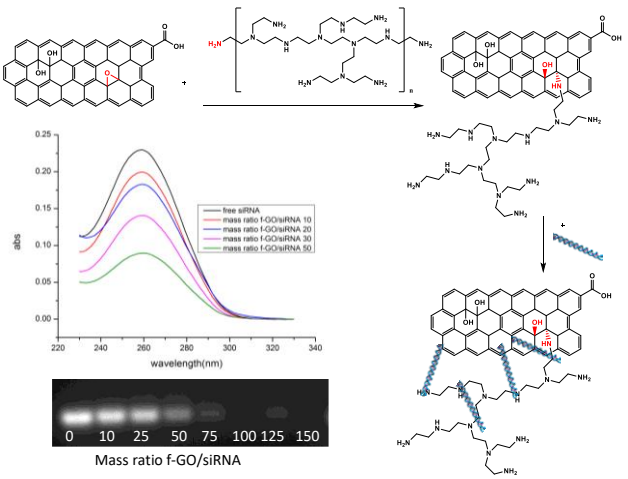

Figure 1: GO epoxide ring opening reaction with polyethylenimine. Left inset: UV curve (top) and agarose gel electrophoresis (bottom) of the complexation of f-GO with siRNA