Nanographene production scale-up and its biomedical applications with focus on cancer phototherapy

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Abstract

Cancer, the second leading cause of death worldwide, requires more effective treatment strategies. Photothermal therapy (PTT) is a non-invasive alternative based on the use of near infrared (NIR) light energy. It results in hyperthermia (39-47 °C), leading to increased membrane permeability, which, in turn, induces higher nanoparticle/drug uptake and consequent tumor cell apoptosis. Graphene-based materials (GBM), owing to their large surface area and strong radiation absorption, can act as platforms for chemo-photothermal therapy.

Through a simple and facile method functionalized rGOn was obtained as a promising photoabsorbing agent for PTT applications in non-melanoma skin cancer treatment. The combination of this functionalized nanomaterial with NIR irradiation using a safer LED-based NIR light source opens new possibilities toward exploring lower power and cheaper systems for mild hyperthermia cancer therapy, enabling better control over nanomaterial heating.

GBM have been studied regarding their biocompatibility; their lateral size, surface oxidation degree, and surface modification with polymers revealed to impact on biointeractions.

Recently, a system has been developed by our team, which allows the scale-up of water stable monolayer nanographene (<200nm) production. Smaller materials usually present better biocompatibility, penetration through skin and cell internalization.

GBM have been shown to provide mechanical reinforcement of polymers used for 3D printing of biomedical implants, preventing mechanical properties decay during hydrolytic degradation at body temperature.

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REFERENCES

[1] Costa-Almeida, R.; Bogas, D.; Fernandes, J.R.; Timochenco, L.; Silva, F.A.L.S.; Meneses, J.; Gonçalves, I.C.; Magalhães, F.D.; Pinto, A.M. Near-Infrared Radiation-Based Mild Photohyperthermia Therapy of Non-Melanoma Skin Cancer with PEGylated Reduced Nanographene Oxide. Polymers, 12 (2020) 1840.

[2] Pinto AM, Gonçalves IC, Magalhães FD. Graphene-based materials biocompatibility: A review. Colloids and Surfaces B: Biointerfaces, 111 (2013) 188.

[3] Pinto AM, Gonçalves C, Sousa D, Ferreira AR, Moreira JA, Gonçalves IC, Magalhães FD. Smaller particle size and higher oxidation improves biocompatibility of graphene-based materials. Carbon, 99 (2016) 318.

[4] Pinto AM, Moreira JA, Gonçalves IC, Magalhães FD. Polymer surface adsorption as a strategy to improve biocompatibility of graphene nanoplatelets. Colloids and Surfaces B: Biointerfaces 146 (2016) 818.

[5] Gonçalves C, Gonçalves IC, Magalhães FD, Pinto AM. Poly(lactic acid) composites reinforced with carbon-based nanomaterials: a review. Polymers, 9 (2017) 269.

[6] Pinto AM, Gonçalves C, Gonçalves IC, Magalhães FD. Effect of biodegradation on thermo-mechanical properties and biocompatibility of poly (lactic acid)/graphene nanoplatelets composites. European Polymer Journal 85 (2016) 431.