NANOTECHNOLOGIES

Graphene-based materials for photothermal therapy of skin cancer

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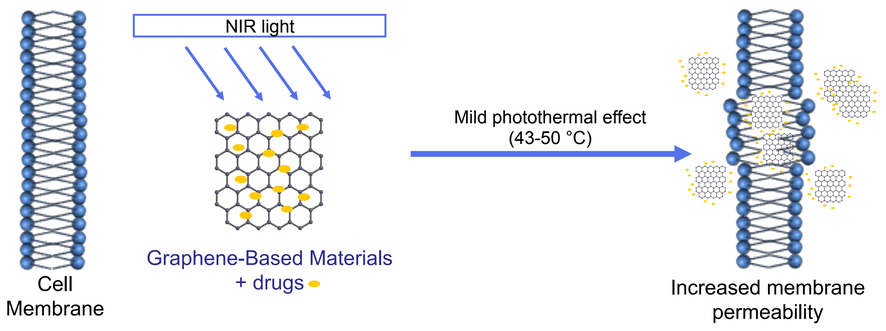
Background

Basal Cell Carcinoma (BCC), the most common form of cancer, requires surgical treatment. Alternatively, photothermal therapy may be an effective non-invasive treatment [1].

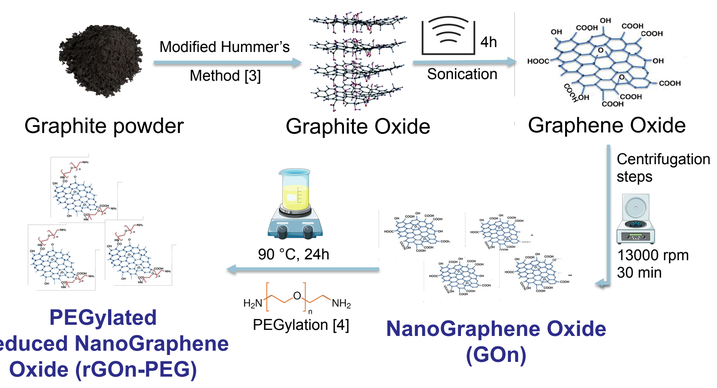
In this study, graphene-based materials (GBMs), which can absorb radiation, are investigated as platforms to induce mild photothermal effects and further loaded with an anti-cancer drug envisioning a combined therapy to treat BCC, improving current clinical outcomes.



Near-infrared (NIR) light energy can induce mild temperature increases (43-50 °C), leading to the activation of apoptotic pathways on tumor cell, including enhanced membrane permeability and consequent increased cell uptake [2].

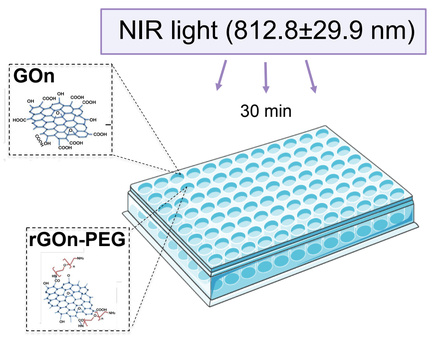
Methodology

1) Synthesis of GOn and rGOn-PEG



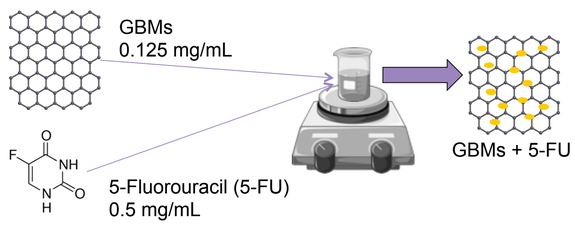
GBMs were characterized in terms of particle size, surface charge, oxidation degree and thermal stability.

2) NIR absorption



The capacity of GBMs to absorb NIR radiation was evaluated through temperature changes during 30 min.

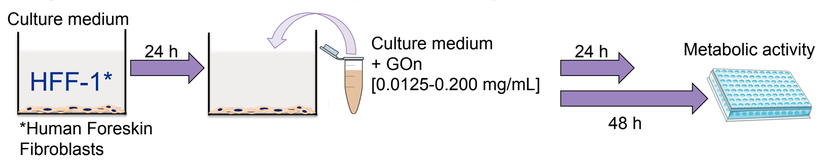
3) Drug loading on GOn and rGOn-PEG



Free (non-adsorbed) 5- FU was determined by UV-vis absorbance peak at 265 nm.

Drug Loading (mg/mg) = m drug in GBMs/m GBMs

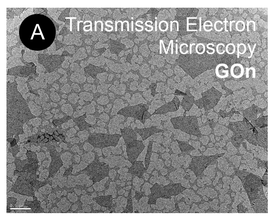
4) *In vitro* biocompatibility of GOn



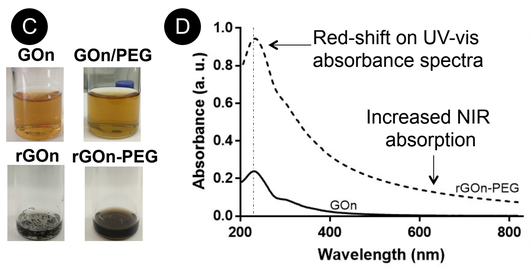
Resazurin assay was used to evaluate the effect of synthesized nano-sized GO (GOn) on the viability and metabolic activity of non-cancer skin cells. HFF-1 in culture medium were used as control.

Results

Characterization of GOn and rGOn-PEG

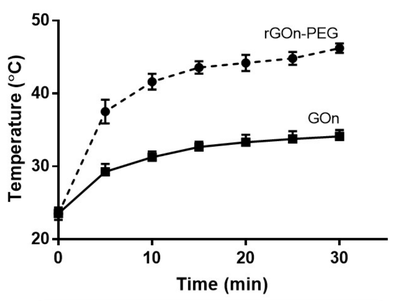


B	GOn
Particle size	
TEM (average; range)	287 nm; 99 – 840 nm
DLS (average; range)	141 nm; 96 – 230 nm
Zeta potential	- 50 mV



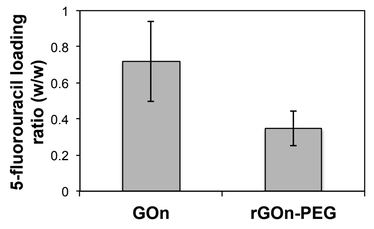
Nano-sized GO was synthesized (A, B), successfully reduced and functionalized with PEG to obtain stable aqueous dispersions (C, D, rGOn-PEG).

Temperature change



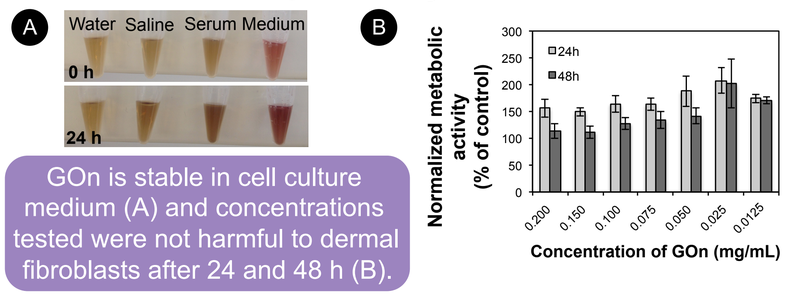
NIR irradiation increased the temperature of selected GBMs, GOn and rGOn-PEG, over time, with a maximum value of 47 °C for rGOn-PEG.

5-FU loading on GOn and rGOn-PEG



5-Fluorouracil was successfully loaded at the surface of both GOn (0.72±0.22 mg/mg) and rGOn-PEG (0.35±0.09 mg/mg).

In vitro biocompatibility of GOn



GOn is stable in cell culture medium (A) and concentrations tested were not harmful to dermal fibroblasts after 24 and 48 h (B).

Conclusions

- NIR radiation can induce temperature changes on rGOn-PEG that are on the range of hyperthermia-effective temperatures.
- The combination of mild photothermal effects with the delivery of 5-FU, an anti-cancer drug, will be further explored using *in vitro* and *in vivo* basal cell carcinoma models.

References: [1] Peris et *al.*, Eur J Cancer, 2019, 118:10; [2] Zhang B *et al.*, Curr Med Chem, 2017, 24:268; [3] Pinto AM *et al.*, Carbon, 2015, 99:318; [4] Chen J *et al.*, Biomaterials, 2014, 35: 4986.

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