Supporting Information

Graphene-Polyglycerol-Curcumin Hybrid as a Near-Infrared (NIR) Laser Stimuli-

Responsive System for Chemo-Photothermal Cancer Therapy

Farhad Bani,^a Mohsen Adeli,^{*b,c} Soodabeh Movahedi,^c and Majid Sadeghizadeh^{*a,d}

Result

The UV-VIS spectra of the nrGO-PG-Cur complexe showed Curcumin absorbance peak at 430 nm superimposing with the absorption curve of nrGO-PG (Figure S1).

Appeared bands at about 1728 cm⁻¹ (C=O stretching vibrations from carbonyl and carboxyl groups), 1627 cm⁻¹ (C=C stretching vibrations), 3420 cm⁻¹ (O-H stretching vibrations),1388 cm⁻¹ (O-H bending vibrations from hydroxyl groups), 1218 cm⁻¹ (the epoxy C–O stretching vibration), and 1056 cm⁻¹ (attributed to the alkoxy C–O stretching vibration) indicating existence of many kinds of oxygen-containing functional groups on the nGO were clearly removed or deceased after reduction by hydrazine (Figure S2). As already described¹, after hydrazine tratment, epoxide and hydroxyle groups located at the edge of aromatic domain remain.

The ratio of D/G bands (at 1358 and 1597cm-1, respectively) at raman spectra of nGO increased after reduction with hydrazine providing evidence of nGO reduction by hydrazine (Figure S3).

For investigate of thermodynamic parameter of interaction between nrGO and PG by ITC, we estimated molecular weight of nrGO. According to AFM and DLS results (Fig. S5) we assumed that nG was a circle with mean diameter of 50 nm. The area of this circle will be 1962 nm². The area of one aromatic ring as a hexagonal with 0.139 nm for each face will be 0.0502 nm². So the number of aromatic rings on nG plane will be 39093. We got a linear relation, y= 0.3527x-1.501, between number of aromatic ring, y, and number of carbon atom,

x, on graphene plane by drawing aromatic rings up to 79 number as a graphene plane . So the total number of carbon atom in our nG will be 110843 and the MW will be 1330 kDa.



Fig. S1 UV-vis spectra of nGO, nG, nG-PG, nG-PG-Cur and nG-PG-Cur hybrids in aqueous solutions and free Curcumin in ethanol. Insets are nG-PG (leaft) and nG-PG-Cur (right) dispersions.

Figure S2 show IR spectra of all synthesized nanomaterials. According to these spectra nGO is containing many functional groups such as carboxyl and hydroxyl. However, after reduction, those functional groups are disappeared to some extent. Functionalization by PG result in new peaks which are characteristic for polyglycerol.



Fig. S2 FT-IR spectra of a) nGO, b)nG, c) PG, d) nG-PG and e) nG-PG-Cur.



Fig. S3 Raman spectra of nGO before and after reducing by hydrazine.



Fig. S4 The fluorescence quenching of PG (8 μ g ml⁻¹) in PBS buffer in the presence of 4, 12, 16, 20 and 28 μ g ml⁻¹ nGO at 25 °C. The excitation wavelength was 215 nm (a). The Sterne-Volmer plot for quenching of the fluorescence of PG caused by nGO and nG at 25°C (b). The emission wavelength was 356 nm.



Fig. S5 DLS result for size distribution of nG (a), nG-PG (b) and nG-PG-Cur (c). The mean diameter of nG, nG-PG and nG-PG-Cur were 50, 65 and 73 nm respectively.



Fig S6 UV-vis absorbance spectra (a) and fluorescence spectra (b) of the nG-PG (1,2) and nGO-PG (3,4) dispersions before (1,3) and after (2,4) five laser on/off cycles laser irradiation (1W cm⁻², 5min). The excitation wavelength was 215 nm.



Fig. S7 Fluorescence spectra of ethanolic curcumin solution and curcumin loaded nG-PG dispersion with the same curcumin concentration. The excitation wavelength was 430 nm.



Fig. S8 The linear absorbance calibration curve of Curcumin in ethanol at 430 nm with $R^2 > 0.99$.



Fig. S9 Relative cell viability of MCF7 cells for 48 h after treatment with different concentrations of nG-PG. The data represented the means of triplicate measurements± SD.

References

1. X. Gao, J. Jang and S. Nagase, *The Journal of Physical Chemistry C*, 2009, **114**, 832-842.