

## Graphene oxide as a nanocarrier for a theranostics delivery system of protocatechuic acid and gadolinium/gold nanoparticles

### ABSTRACT

We have synthesized a graphene oxide (GO)-based theranostic nanodelivery system (GOTS) for magnetic resonance imaging (MRI) using naturally occurring protocatechuic acid (PA) as an anticancer agent and gadolinium (III) nitrate hexahydrate (Gd) as the starting material for a contrast agent. Gold nanoparticles (AuNPs) were subsequently used as second diagnostic agent. The GO nanosheets were first prepared from graphite via the improved Hummer's protocol. The conjugation of the GO and the PA was done via hydrogen bonding and  $\pi$ - $\pi$  stacking interactions, followed by surface adsorption of the AuNPs through electrostatic interactions. GAGPA is the name given to the nanocomposite obtained from Gd and PA conjugation. However, after coating with AuNPs, the name was modified to GAGPAu. The physicochemical properties of the GAGPA and GAGPAu nanohybrids were studied using various characterization techniques. The results from the analyses confirmed the formation of the GOTS. The powder X-ray diffraction (PXRD) results showed the diffractive patterns for pure GO nanolayers, which changed after subsequent conjugation of the Gd and PA. The AuNPs patterns were also recorded after surface adsorption. Cytotoxicity and magnetic resonance imaging (MRI) contrast tests were also carried out on the developed GOTS. The GAGPAu was significantly cytotoxic to the human liver hepatocellular carcinoma cell line (HepG2) but nontoxic to the standard fibroblast cell line (3T3). The GAGPAu also appeared to possess higher T1 contrast compared to the pure Gd and water reference. The GOTS has good prospects of serving as future theranostic platform for cancer chemotherapy and diagnosis.

**Keyword:** GO nanosheets; Gadolinium; Protocatechuic acid; Gold nanoparticles; Diagnostics; Anticancer; Theranostics

