Cyclodextrin Functionalized Graphene Nanosheets for Targeted Delivery of Doxorubicin

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Abstract

A multifunctional nanocarrier based on cystamine (Cys) and β-cyclodextrin (β-CD) modified graphene oxide (GO) was designed for targeted delivery of Doxorubicin (DOX). The obtained CD-Cys-GO nanosheet was characterized by thermogravimetric analysis, Fourier transform infrared spectroscopy, Raman spectroscopy, Atomic force microscopy and Field emission scanning electron microscopy, which confirmed that Cys and CD had been effectively functionalized on the surface of GO. DOX loading and delivery were also examined and the results suggested that multi-functionalized GO is an efficient nanocarrier for targeted delivery and controlled release of anticancer drug for biomedical applications.

Introduction: Graphene oxide (GO) based drug carriers have been introduced as an important topic of research at the interface of nanotechnology and biomedicine due to their high specific surface area, enriched oxygen-containing groups, low cost and scalable production, excellent biocompatibility, and physiological stability. Cyclodextrin (CD) is a cyclic oligomer which its biological nature makes it attractive in pharmaceutical field. Moreover, the hydrophobic cavity of CD can selectively bind various organic, inorganic and biological molecules to form supramolecular complexes without structural changes.

Methods and Results: In this research, GO nanosheet was synthesized according to Hummer's method and then was functionalized by Cys in order to design a targeted and controlled drug delivery system. In the next step, β-CD was attached to free amine groups of attached Cys moieties on GO surface. DOX was used as a model drug to assess the drug-loading and releasing properties and the effect of pH was examined. The synthesized graphene-based nanomaterials were structurally and morphologically characterized with FT-IR, CHN, Raman, TGA, XRD and FE-SEM techniques. In addition, the CD-Cys-GO exhibited remarkably higher loading capacity for DOX than Cys-GO and GO. The release of drug was pH-sensitive which would control the release in acidic cytoplasm of cancer cells and can be due to the existence of disulfide bonds in the structure of this nanocarrier.

Conclusions:

In summary, a unique CD-Cys-GO system has been developed. The versatile system combines the advantages of graphene, Cys and CD that provides multifunctional and inter-reversible anchor sites. The hybrid is found to possess a high drug-loading capacity and strong targeting effect.

Key words: Graphene, Nanocarrier, Targeted Drug Delivery, Cyclodextrin.

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