β-Cyclodextrin-modified graphene quantum dots: enhanced photoluminescence and use for fluorescent detection

Pei-Chun Chen , Dong-Hwang Chen

Department of Chemical Engineering, National Cheng Kung University, Tainan, Taiwan, Republic of China

E-mail: chendh@mail.ncku.edu.tw

Graphene and its derivatives have received a lot of attentions in the past decade due to their excellent properties and wide applications. When their size was reduced to several nanometers, the resulting graphene quantum dots could exhibit good fluorescence property which makes them useful in photocatalysis, fluorescent detection, bioimaging, drug delivery, and other related fields.[1] Their photoluminescence (PL) depended on not only the quantum confinement effect or conjugated π-domains of carbon core but also the surface state, which might be affected by the hybridization of the carbon backbone and the connected chemical groups.[2] In this study, graphene quantum dots (GQD) and β-cyclodextrin-modified graphene quantum dots (βCD-GQD) were synthesized for the fluorescent detection of toxic organic contaminants by the direct heating of citric acid in the absence and presence of βCD at 200^{o}C for 35 min. After neutralization by the addition of NaOH solution, GQD could be collected via centrifugation and washing with ethanol, while βCD-GQD was collected after further dialysis and freeze-drying. The formation of GQD and βCD-GQD has been demonstrated by the analyses of TEM and XRD. It was shown that the resulting GQD and βCD-GQD had the average sizes of 9.16 and 9.13 nm, respectively (Fig. 1a and 1b). The further study on the fluorescent property revealed that the modification of GQD with βCD could significantly enhance the fluorescence intensity, but excess βCD contrarily led to the decrease of fluorescence intensity (Fig. 1c). It was found that the βCD-GQD with 10% βCD in the reaction mixture exhibited the highest fluorescence intensity. In addition, for the fluorescent detection of *p*-nitrophenol by βCD-GQD, two linear concentration ranges of 0.1~7.5 μM and 7.5~100 μM with a LOD of 0.093 μM were obtained. Also, it was demonstrated that the performance was significantly better than the un-modified GQD. This revealed that the resulting βCD-GQD indeed have great potential in the fluorescent detection of toxic organic contaminants.

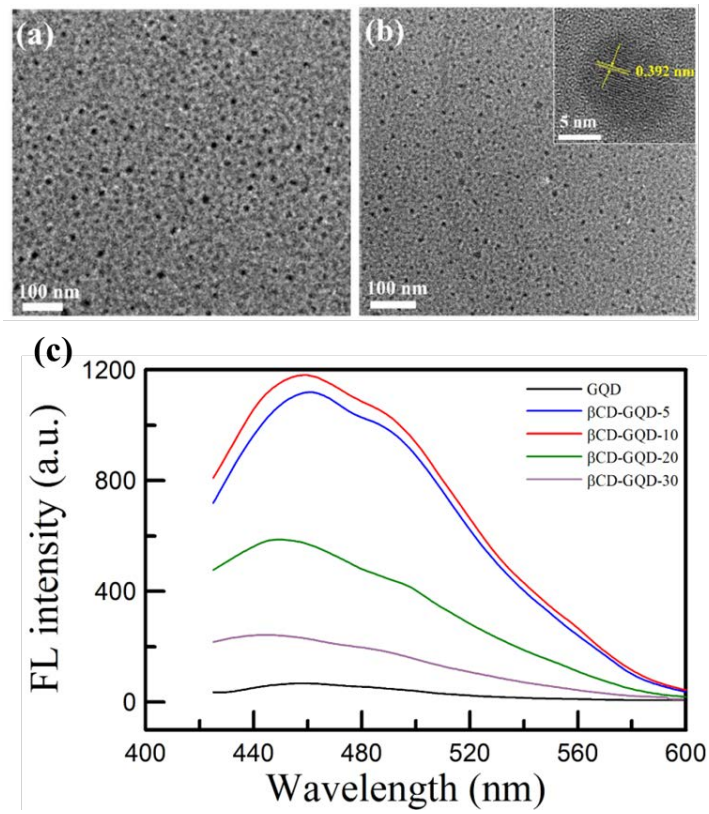

Figure 1. TEM images of GQD (a) and βCD-GQD (b) and their fluorescence spectra under an excitation wavelength of 365 nm (c).

Funding: Ministry of Science and Technology, R.O.C.（MOST 105-2221-E-006-234)

References:

[1] Y. Wang, A. Hu, *J. Mater. Chem. C*, **2014**, 2, 6921–6939

[2] S. Zhu, Y. Song, X. Zhao, J. Shao, J. Zhang, B. Yang, *Nano Res.*, **2015**, 8(2), 355–381