

## Synthesis of Single-layer Graphene-nanocomposite directly from graphene oxide

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Assembly of semiconductor nanoparticles, such as quantum dots (QDs), on matrices has been extensively studied for their promising optoelectronic applications [1-7]. To enhance the photocurrent generated by these semiconductor-matrices systems, it is essential to retard the recombination of electron-hole species in the semiconductors by molecular electron-relay semiconductor structures or efficient electron-transport matrices, such as the conductive polymer films or carbon nanotubes (CNT) [3-7]. The superior electrical conductivity and flexible atom-thin two-dimensional feature of graphene would make it an excellent electron-transport matrix. Herein, we report the synthesis of graphene-quantum dots (G-QD) nanocomposite directly from graphene oxide by a facile one-step reaction. Comparing with CNT, the large 2D flexible atom-thin layer of graphene makes it easier to control the distribution of CdS on graphene sheet and to fabricate future optoelectronic devices.

Currently, the yield of single-layer graphene sheets from various mass production methods is quite low, and the major product is usually multiple-layer graphene sheets. An even more serious problem is that single-layer sheets of graphene are not stable in solution and tend to aggregate back to graphite gradually. We developed a one-step method to synthesize G-QD directly from graphene oxide (GO) in dimethyl sulfoxide (DMSO), as illustrated in Figure 1. This approach overcomes the above two problems by synthesizing G-CdS directly from GO in a facile one-pot reaction, where the reduction of GO and the deposition of CdS on graphene occur simultaneously, as evidenced by XPS, FTIR, and Raman measurements.[8] The reduction of GO mainly due to thermal reduction at high reaction temperature (180°C). In addition to the advantage of simplicity and low cost, the high stability of the single-layer GO in solution guarantees the formation of single-layer graphene sheets in the final nanocomposite, hence they possess better structural and optoelectronic properties. Once the reaction was complete, CdS-decoration helps to prevent not only the aggregation of the single-layer graphene sheets, but also the aggregation of CdS QDs. In fact, our G-CdS composite can be stored in the solid state, and the solid product can be re-suspended in different solvents by sonication. The stability of the G-CdS composite against sonication demonstrates the strong binding between the CdS QDs and the graphene sheets. It is also worth mentioning that the CdS QDs are directly decorated on the graphene sheets, and no molecular linkers are needed to bridge the QDs and the graphene matrices. A picoseconds ultrafast electron transfer process from the excited CdS to the graphene sheet has been detected by time-resolved fluorescence spectroscopy, which demonstrates the potential optoelectronic application of this new type of graphene-based semiconductor hybrid system.[8]

Using similar approach, single-layer G-ZnS nanocomposite material has also been prepared from GO. Since the reaction temperature for GO-ZnS nanocomposite is too low to reduce GO to G, an additional reduction step is necessary. This two-step approach might be more popular for the production of graphene-based nanocomposites with varies reaction conditions. The key to this approach is that the deposition step is prior to the reduction step to guarantee single-layer of graphene sheets in the final products.

## References

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## Figures

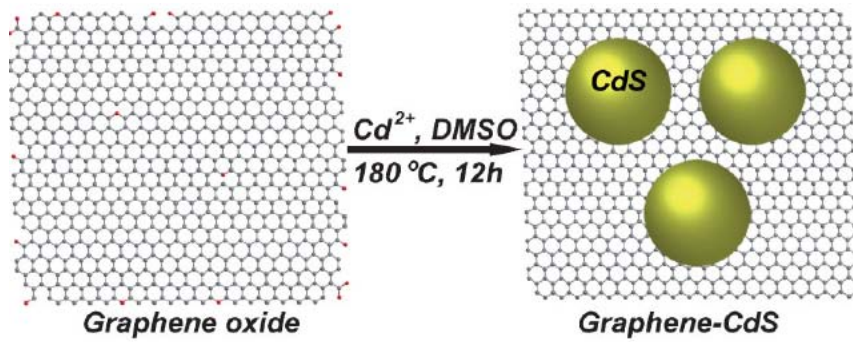


Fig.1 Scheme of the one-step synthesis of G-CdS nanocomposite.

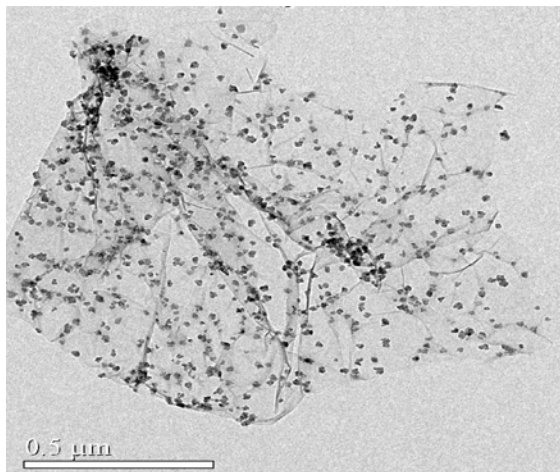


Fig.2 TEM images of Graphene-CdS nanocomposite.

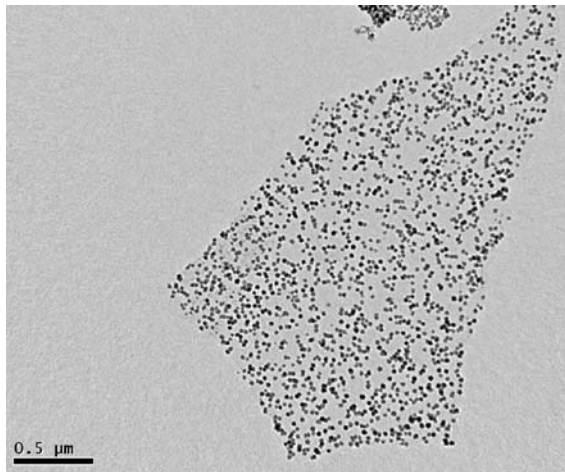


Fig.2 TEM images of Graphene-ZnS nanocomposite.