Photoluminescence of plasma produced graphene quantum dots

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Free-standing graphene sheets were synthesized using surface wave driven microwave plasmas, operating at 2.45 GHz stimulating frequency and at atmospheric pressure. A chemical treatment has been applied to cut the sheets and obtain small size, less than 10 nm particles, i.e. graphene quantum dots (GQDs) in an aqueous solution. The obtained suspension was then irradiated with soft UV light emitted by a commercial blue LED (λ = 410 nm). The photoluminescence of GQDs was evidenced by the rise of a broad peak at 510 nm, following the main one radiated by the LED. SEM and Raman analysis further confirmed the presence of GQDs in the suspension.

1. Introduction

Graphene quantum dots are nanometer sized fragments (< 10 nm) of graphene that demonstrate unique properties and show significant potential for many applications, ranging from energy storage and conversion, to optoelectronics and nano-medicine [1]. Their photoluminescence is one of their most promising properties for applications. However, the mechanism behind this phenomenon is not yet fully understood [2]. In the present work, free-standing graphene sheets were synthesized using microwave plasmas driven by surface waves at 2.45 GHz stimulating frequency and at atmospheric pressure as described in detail in [3, 4]. A chemical route has been applied to cut and reduce the size of the graphene sheets, so as to obtain GQDs in an aqueous solution.

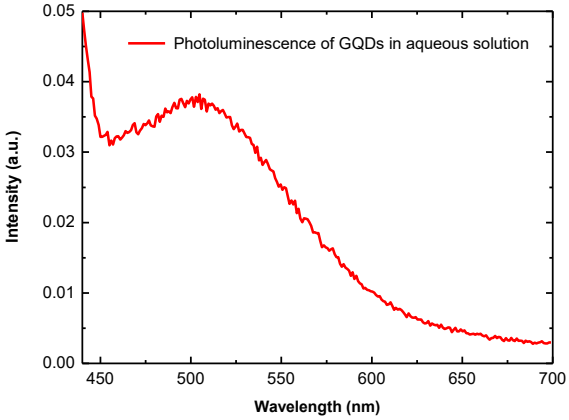

Figure 1. Photoluminescence of GQDs in aqueous solution, upon irradiation with a LED (λ = 410 nm).

2. Photoluminescence of GQDs

The GQDs were obtained in a suspension after the chemical treatment of the graphene sheets in acid environment under mild sonication for 15 – 20 h, followed by neutralization. The solution was then irradiated with UV light from a commercial blue LED. Optical emission spectroscopy measurements were performed with a Czerny-Turner spectrometer coupled to a photomultiplier for wavelengths between 300 – 700 nm. The photoluminescence of GQDs, although weak compared to the main peak of the LED at 410 nm, is evidenced by the rise of a broad peak centered at 510 nm (figure 1). Posterior SEM and Raman analysis confirmed the presence of GQDs in the obtained suspension. The observed photoluminescence is clearly originated by the GQDs in the solution, since no similar effect was observed upon irradiation of the LED on reference solutions containing graphene sheets as synthesized, i.e. without chemical treatment.

3. Final remarks

GQDs in an aqueous solution, obtained after the chemical treatment of plasma produced free standing graphene sheets, exhibited clear photoluminescence upon irradiation with a LED (λ = 410 nm). The effect is evidenced by the rise of a broad peak centered at 510 nm.

4. References

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