Graphene Quantum Dots Embedded in a Polymer Film

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Graphene quantum dots (GQDs) are a few nanometer sized pieces of graphene sheet that exhibit photoluminescence (PL) in the visible region, as well as unique electron transport and superior mechanical properties. The PL originates from large edge effects and exhibits strong quantum confinement effects. The intrinsic characteristics of GQD can be applied to various devices, e.g., light emitters, optoelectronic devices and photovoltaics. The technique to embed GQDs in a solid material is indispensable for realizing GQD-based devices. Here we report a simple method that produces a GQD-polymer composite film by drying a mixture solution of GQD and poly-vinyl alcohol (PVA). GQDs were homogeneously dispersed in the film, which was measured by absorption and Raman spectroscopy. The PL of GQDs in the film was also investigated. The simple technique enables the development of GQD-based composites for numerous applications of GQDs.
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**Introduction: Graphene Quantum Dots**

Graphene Quantum Dots (GQDs) are a few nanometer sized pieces of graphene sheet that exhibit photoluminescence (PL) in the visible region due to size effects and quantum confinements, as well as unique electron transport and superior mechanical properties.

**Absorption and Photoluminescence of GQDs in water**

The absorbance peak at 310 nm is a feature of GQDs due to quantum confinement effects and edge effects. GQDs exhibit PL in the visible region, which depends on the excitation wavelength. The dependence of PL could be attributed to the size effect of GQDs.

**Density Gradient Ultracentrifugation (DGU) for the size-separation**

PL peaks were significantly blue-shifted by 10 nm after DGU. DGU could remove large-diameter GQDs and/or aggregated GQDs.

**Purpose: To develop a GQD/Polymer composite**

We aim to develop a simple method that produces a GQD-polymer composite. Here we demonstrate the composite film by drying a mixture solution of GQD and poly-vinyl alcohol (PVA). The PL of GQD/PVA composite film and the temperature-dependence of PL intensity are investigated.

**Fabrication Procedure: GQD/PVA composite film**

1. Chemical Synthesis of GQDs
   - Graphite
   - Cut down
   - Neutralization
   - GQDs

2. Water-dissolved PVA
   - PVA 1.5 g
   - PVA: poly vinyl alcohol
   - Stir

3. GQD/PVA composite film
   - GQD/PVA film
   - Cast
   - Dry & Peel

**PL characterization of GQD/PVA composite film**

PL spectra at 514.5 nm excitation

The overall PL intensity increased with decrease temperature. The enhancement originated from the suppression of thermal quenching.

**Summary**

GQD/Polymer composites were developed by the simple method. The PL from GQD/PVA composite film was suppressed, but enhanced with decrease of temperature.

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