Quantization of Energy Gap to the Tunable Photoluminescence of N-doped Graphene Quantum Dots

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Graphene had attracted numerous attentions in many applications due to its strong chemical stability, mechanical, thermal, optical and electronic properties. Graphene quantum dots (GQDs) are graphene in less than 20 nm in size. Zero-dimensional fluorescent graphene has been applied in low-cost optoelectronics devices and biological labelling sensor due to a few properties such as low cytotoxicity and long-term photobleaching resistance. The outstanding photoluminescence (PL) properties of graphene quantum dots (GQDs) had attracted great interest in optical applications such as fluorescent imaging. In this work, a facile one-step hydrothermal method was used to synthesize nitrogen doped GQDs (N-GQDs) with a Teflon-lined autoclave heated at 180 °C for 8 hours. High crystallinity was discovered in the purified N-GQDs with a lattice spacing of 0.21 nm corresponding to in-plane graphene (100 facet). Green luminescence of N-GQDs and highly soluble in aqueous solution, with an average size of 3.5 nm and 3 nm in height were obtained. Touc plot indicated the quantum dots have a direct band gap material with 3.12 eV optical energy gap derived from their UV-vis absorption spectrum. Due to the cheap material source, this synthesis provides a feasible route towards the commercial synthesis of N-GQDs. Thus provides an effective strategy studies of electron transfer and to engineer the optical properties of GQDs.

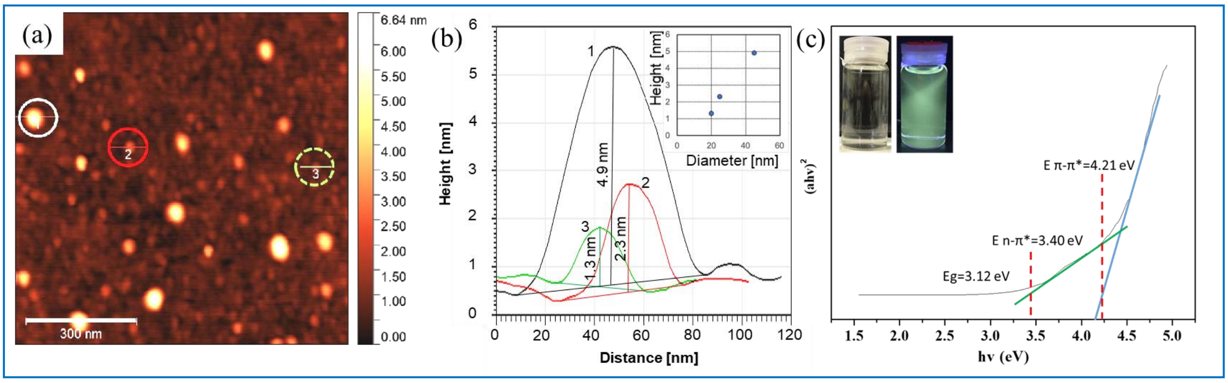

Figure 1. AFM images of (a) N-GQDs dispersed on silicon wafer, (b) line profile showing the thickness of N-GQDs along the line labelled 1, 2 and 3, and (c) $(\alpha h\nu)^2$ vs hv curve of N-GQDs (black curve).