Graphene Nanoparticle-Polymer Composite by Pulsed Laser Ablation in Liquid

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Graphene quantum dots (GQDs) are graphene nanoparticles with dimension less than 100 nm[1] and have great potential for a wide application in photovoltaics, water treatment, gas and bio-sensor, MEMS packaging, fluorescence probe in bioimaging and semiconductor materials[2]. The increasing interest towards these functional materials is associated with their unique optical, electrical and mechanical properties[3]. There are many different ways for their synthesize such as cutting graphene sheet into small pieces[4], chemical treatment[5]and pulsed laser ablation in liquids(PLAL)[1,6]. Laser ablation is a novel and clean techniques that can be produced high quality graphene nanoparticle in one and two dimensions using different ablation parameters like laser wavelength, pulse energy, reputation rate, pulse duration and ablation time[1]. The laser ablation of carbon in different liquid environment is a useful method for production of carbon chains with sp^2 hybridization bonds. In this work, the graphite sheet was ablated in different liquids using pulsed energy from a nanosecond laser at wavelength of 532 nm, reputation rate of 1KHz, pulse duration of 150 ns and pulse energy in the range of 500 µJ to 4.8 mJ. Figure 1, shows the UV-VIS spectrum of graphene nanoparticles in water, ethanol and toluene for different pulsed laser energies. As can be seen from Fig.1a, there is not any absorption at wavelength 293-305 nm which is due to–C=O molecular bonds. This confirm that there is not any graphene oxide nanoparticels (NPs) in the solutions. Furthermore, the graphene NP (GNP) absorption peaks were observed at wavelength of 265 nm and as a shoulder in the range of 200 nm to 209 nm. The absorption peak at 265 nm could be attributed to the π-π* transition of –C=C- which is shifted by 30 nm due to size effects and quantum confinement of GNPs[5]. From Fig.1b, it can be seen that the theπ-π* transition of –C=C- absorption was recorded at wavelength of 269 nm in GNPs-ethanol environment.The effects of adding different polymer with different concentrations of 0.2%, 0.4% and 0.6% into the ablation liquid medium are compared in Fig. 1c-1d. In Figs.1c-d, the graphite sheet was ablated in the Water-PVA and the Ethanol-PMMA for 30 min using pulsed energy of 800µJ. Fig.2 shows the AFM images of fabricated GNP in Ethanol (Fig.2a) and Ethanol-PMMA (Fig.2b-2c).It was found that the GNPs/ GQDs with dimensions in the range of 9.4 nm to 34.8 nm were fabricated using technique of PLAL particle roughness (RMS) and vertical dimension were reduced from 12.4 nm to 3.59 nm and 34.8 nm to 9.44nm,respectively.More morphological analyses such as SEM and TEM and optical analysis like photoluminescence were undertaken.

References

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Figures

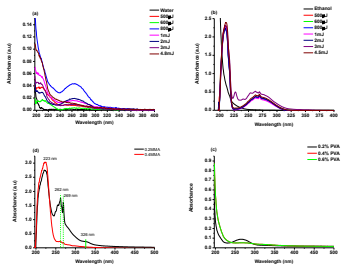

Fig.1: (a) and (b) absorbance vs wavelength of GNP-Water and GNP-ethanol suspensions, respectively.(c)-(d) absorbance vs wavelength of GNP-water-PVA and GNP-ethanol-PMMA suspensions, respectively.

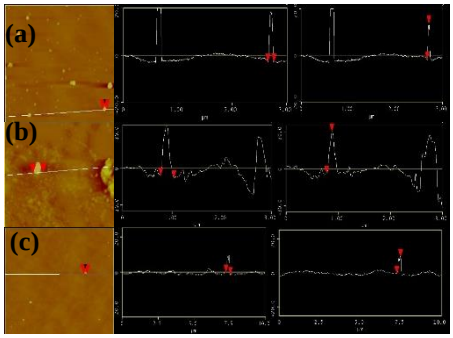

Fig.2: AFM images of GQDs fabricated in (a) ethanol, (b) ethanol-0.2%PMMA and (c) ethanol-0.4%PMMA**.**The vertical and horizontal distance were measured as (a) 15.4 nm, 111 nm, (b) 34.8 nm, 269.5 nm and (c) 9.44 nm , 312 nm respectively.