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Irreversible luminescence from graphene quantum dots prepared by the chain of oxidation and reduction process

Min-Ho Jang[1], Hyun Dong Ha[2], Eui-Sup Lee[3], Yong-Hyun Kim[3], Tae Seok Seo[2*], and Yong-Hoon Cho[1*]

[1]Department of Physics and Graphene Research Center of KI for the NanoCentury; KAIST
[2]Department of Chemical and Biomolecular Engineering and Institute for the BioCentury, KAIST
[3]Graduate School of Nanoscience and Technology, KAIST

Recently, graphene quantum dots (GQDs) have attracted great attention due to various properties including cost-effectiveness of synthesis, low toxicity, and high photostability. Nevertheless, the origins of photoluminescence (PL) from GQDs are unclear because of extrinsic states of the impurities, disorder structures, and oxygen-functional groups. Therefore, to utilize GQDs in various applications, their optical properties generated from the extrinsic states should be understood. In this work, we have focused on the effect of oxygen-functional groups in PL of the GQDs. The GQDs with nanoscale and single layer are synthesized by employing graphite nanoparticles (GNPs) with 4 nm. The series of GQDs with different amount of oxygen-functional groups were prepared by the chain of chemical oxidation and reduction process. The fabrication of a series of graphene oxide QDs (GOQDs) with different amounts of oxygen-contents is first reported by a direct oxidation route of GNPs. In addition, for preparing a series of reduced GOQDs (rGOQDs), we employed the conventional chemical reduction to GOQDs solution and controlled the amount of reduction agents. The GOQDs and rGOQDs showed irreversible PL properties even though both routes have similar amount of oxyen-functional groups. In the case of a series of GOQDs, the PL spectrum was clearly redshifted into blue and green-yellowish color. On the other hand, the PL spectrum of rGOQDs did not change significantly. By various optical measurement such as the PL excitation, UV-vis absorbance, and time-resolved PL, we could verify that their PL mechanisms of GOQDs and rGOQDs are closely associated with different atomic structures formed by chemical oxidation and reduction. Our study provides an important insights for understanding the optical properties of GQDs affected by oxygen-functional groups. [1]

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Synthesis and Analysis of $Ge_2Sb_2Te_5$ Nanowire Phase Change Memory Devices

이준영[1,2], 김정현[1,2], 전덕진[1,2], 한재현[1,2], 여종석[1,2]

[1]연세대학교 글로벌융합공학부, [2]연세대학교 글로벌융합기술원

A $Ge_2Sb_2Te_5$ nanowire (GST NW) phase change memory device is investigated with Joule heating electrodes. GST is the most promising phase change materials, thus has been studied for decades but atomic structure transition in the phase-change area of single crystalline phase-change material has not been clearly investigated. We fabricated a phase change memory (PCM) device consisting of GST NWs connected with WN electrodes. The GST NW has switching performance with the reset/set resistance ratio above 10^3. We directly observed the changes in atomic structure between the ordered hexagonal close packed (HCP) structure and disordered amorphous phase of a reset-stop GST NW with cross-sectional STEM analysis. Amorphous areas are detected at the center of NW and side areas adjacent to heating electrodes. Direct imaging of phase change area verified the atomic structure transition from the migration and disordering of Ge and Sb atoms. Even with the repeated phase transitions, periodic arrangement of Te atoms is not significantly changed, thus acting as a template for recrystallization. This result provides a novel understanding on the phase-change mechanism in single crystalline phase-change materials. This research was supported by the National Research Project for Next Generation MLC PRAM Development by the Ministry of Knowledge Economy (MKE) of Korea. And this research was also supported by the MSIP(Ministry of Science, ICT and Future Planning), Korea, under the “IT Consilience Creative Program” (IITP-2015-R0346-15-1008) supervised by the IITP(Institute for Information & Communications Technology Promotion)

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