Johnson noise and optical characteristics of polymer nanocomposites based on colloidal quantum dots and in-situ nanoparticles formation

ABSTRACT

Electrical and optical properties of polymer nanocomposite thin films have been analyzed to study their reliability and competency as a component for optoelectronic devices such as LED and solar cells. Polymer nanocomposite encounters various challenges, such as the dispersion of nanoparticles in the matrix that hinders their efficiency for potential devices. In this paper, two types of polymer nanocomposites have been fabricated, and their Johnson noise, current density-voltage, and optical have been measured. The first type of nanocomposite produced through an in-situ method, that is by impregnating CdS or CdSe nanoparticles in conjugated polymer, P3HT (NP-CdX:P3HT). The nucleation of the nanoparticles was done using gas exposure. The second type is by directly adding CdS or CdSe quantum dots into P3HT (QD-CdX:P3HT). Both kinds of polymer nanocomposite thin films were fabricated using modified Langmuir-Blodgett technique. Results showed that for frequency above 10 Hz, the Johnson noise was less than 1× 10-27 A2/Hz, regardless of the quantity of quantum dots or nanoparticles. The J-V results show (NP-CdX:P3HT) electrical performance compared with QD-CdX:P3HT. High polymer crystallization of NP-CdX:P3HT thin films is revealed by UV-Vis absorbance spectra. The quantum confinement effect is evidence through peak shifting and depreciation of absorption. The photoluminescence intensity of thin films decreased when they were exposed to the gas. It can be concluded that the NP-CdX:P3HT nanocomposites can be further studied as they have greater potential to be exploited in optoelectronic devices.

Keyword: Johnson noise; Polymer nanocomposite; Cadmium sulfide