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Effect of Electron-beam Irradiation for π-Conjugated Polymer Nanomaterials

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We report on an effect of electron (E)-beam irradiation on the optical and electrical properties of π-conjugated polymer nanomaterials, such as light emitting poly (3-methylthiopnehe) (P3MT) nanotubes, conducting polypyrrole (PPy), and poly (3,4-ethylenedioxythiophene) (PEDOT) nanowires. E-beam generated from linear electron accelerator was irradiated onto the π-conjugated polymer nanomaterials with the various dosages (1.6×10^{13} ~ 8.0×10^{16} electrons/cm^2) and energies (300 keV, 1 MeV, and 2 MeV). To discern conformational modification due to the E-beam irradiation, Raman and ultraviolet-visible (UV/Vis) absorption spectra of the pristine and E-beam irradiated polymer nanomaterials were measured. From UV/Vis absorption spectra, we observed that the π-π* transition peak and the doping induced bipolaron peaks of the polymer nanomaterials varied with E-beam irradiating conditions. From the laser confocal microscope (LCM) photoluminescence (PL) images and spectra for the single strands of P3MT nanotubes, we observed the significant red-shift of LCM PL peaks and enhancements in the LCM PL intensity of P3MT nanotubes through E-beam irradiation. Comparing of the current-voltage characteristics between the pristine and E-beam irradiated PPy and PEDOT nanowires, the resistance of PPy and PEDOT nanowires gradually decreased as the energy and/or dosage of E-beam increased. We suggest that the variation of optical and electrical properties of π-conjugated polymer nanomaterials might have originated from conformational change and dedoping effect, produced by the E-beam irradiation.

Keywords: π-conjugated polymer, poly (3-methylthiopnehe), polypyrrole, poly (3,4-ethylenedioxythiophene), nanotubes, nanowires, electron-beam, dedoping