Nanomaterials synthesized in a microfactory and enhanced performances of optoelectrical devices

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Recently, it has been widely recognized, from various experimental and theoretical researches,[1] that pulsed laser irradiation in a liquid generates high temperature and pressure at around a target surface, which we treat a microfactory for nanomaterial synthesis. Since 2005, we have conducted pulsed laser ablation (PLA) of metal or semiconductor materials in a fluid at temperature and pressure beyond a vapor-liquid critical point, i.e. supercritical state.[2-7] In this talk, the author will introduce recent research progresses for nanomaterial synthesis by PLA in the microfactory, exposed at high temperature and pressure during synthesis. In particular, how a thermodynamic state in the microfactory affects properties of nanoparticles will be described, e.g. luminescence properties, disordered structure, field enhancement due to nanomaterials. As another topic, the author will introduce colloidal quantum dots (QDs) or colloidal nanoparticles (NPs) synthesized by PLA,[8-12] whose nanomaterials can be integrated to develop an optoelectrical device via a solution process.[9,10,12] Especially, a silicon (Si) QD light-emitting diode (QD-LED) demonstrated the first electroluminescence of Si QD-LED in a blue wavelength region.[9] Colloidal Si NPs can be also used as material for a solar cell[10]. By adding the Si-NPs into a conducting polymer (P3HT), 50- and 12-fold enhancements of hole mobility and hole density, respectively, were achieved in a Si-NP/polymer hybrid film.[12] According to our results, surface structures of nanomaterials prepared by PLA play important roles in better devices as well as properties of nanomaterials.

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