In_2O_3 Overcoating on InP/ZnS Quantum Dots toward Improved Fluorescent Stability

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Fluorescent stability of quantum dots (QDs) against environment and operation is a prerequite from a perspective of their ultimate commercialization. Regardless of QD composition, most of QDs do not retain their originally high quantum yield (QY) when continually exposed to excitation photons. The elaborate shelling engineering such as the formation of multiple or thick shell, by which the wave function of core QD becomes distant from QD surface, proved effective in mitigating the photodegradation-induced QY deterioration. Meanwhile, the photodegradation of QDs may be retarded by encasing them typically with oxides, by which the QD surface becomes physically isolated from their environments. For this, overcoating QDs with silica phase through an *ex-situ* sol-gel process is the most common strategy and has been successfully applied to CdSe [1] and InP [2], but usually accompanies a significant QY drop of silica-coated QDs *versus* pristine ones. Recently, Song *et al*. demonstrated another oxide overcoating with $ZnGa_2O_4$ onto CIS/ZnS core/shell QDs through an *in-situ* synthetic approach to minimize a QY reduction concomitant with overcoating [3].

For an effort to render QDs highly stable against photo-excitation, in this work, a novel oxide of *n*-type wide semiconductor In_2O_3 is for the first time chosen as a QD encapsulating phase. Red-emitting InP/ZnS QDs are first synthesized and consecutively placed in a simple In_2O_3 overcoating process. To confirm the presence of In_2O_3 overlayer, InP/ZnS and InP/ZnS@In_2O_3 QDs are compared through structural, surface-compositional, and microscopic analyses. Both QDs are identically subjected to a continuous UV irradiation for a long period of time up to 100 h and their temporal PL variations are monitored. As shown in Figure 1a and b, a markedly enhanced photostability of InP/ZnS@In_2O_3 *versus* InP/ZnS QDs is indeed observed as a result of the effective suppression of photooxidation at InP/ZnS QD surface by In_2O_3 overlayer. Furthermore, the beneficial effect of In_2O_3 overcoat is confirmed by packaging InP/ZnS and InP/ZnS@In_2O_3 QDs with a blue LED and evaluating the device stability of the fabricated QD-LEDs for a continual operational duration of 48 h, showing a much higher QD emission stability from InP/ZnS@In_2O_3 *versus* InP/ZnS QDs (Figure 1c).

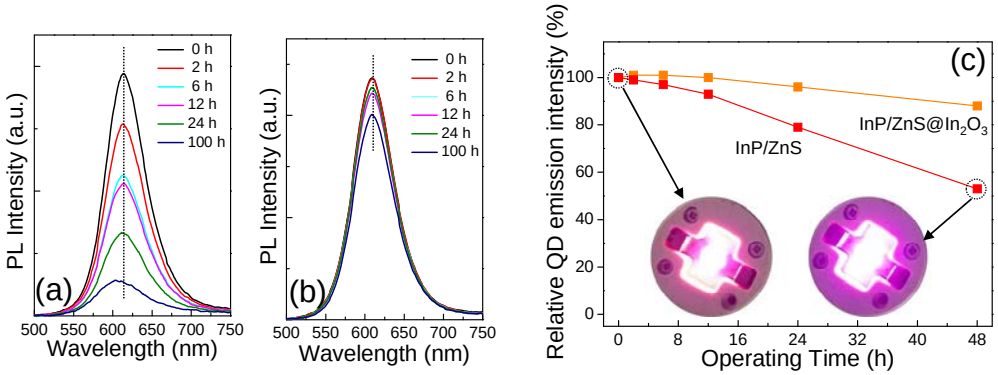

Fig. 1. PL variations of (a) InP/ZnS and (b) InP/ZnS@In_2O_3 QDs as a function of UV irradiation time. (c) Changes of relative QD emission intensity of packaged QD-LEDs with prolonged operation.

Acknowledgment

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIP) (No. 2013R1A2A2A01068158) and LG Electronics Co., Republic of Korea.

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