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Size-dependent Optical and Electrical Properties of PbS Quantum Dots[1]

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This report investigates a new synthetic route and the size-dependent optical and electrical properties of PbS nanocrystal quantum dots (NQDs) in diameters ranging between 1.5 and 6 nm. Particularly we synthesize ultra-small sized PbS NQDs having extreme quantum confinement with 1.5～2.9 nm in diameter (2.58～1.5 eV in first exciton energy) for the first time by adjusting growth temperature and growth time. In this region, the Stokes shift increases as decreasing size, which is testimony to the highly quantum confinement effect of ultra-small sized PbS NQDs. To find out the electrical properties, we fabricate self-assembled films of PbS NQDs using layer by layer (LBL) spin-coating method and replacing the original ligands with oleic acid to short ligands with 1, 2-ethandithiol (EDT) in the course. The use of capping ligands (EDT) allows us to achieve effective electrical transport in the arrays of solution processed PbS NQDs. These high-quality films apply to Schottky solar cell made in an glass/ITO/PbS/LiF/Al structure and thin-film transistor varying the PbS NQDs diameter 1.5～6 nm. We achieve the highest open-circuit voltage (＜0.6 V) in Schottky solar cell ever using PbS NQDs with first exciton energy 2.58 eV.

Keywords: PbS, quantum dots, solar cell, transistor