CONTROLLED ENERGY PROPERTIES OF NANO-MATERIALS

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Control of energy properties were investigated for the semiconductor nano-materials, such as ternary chalcogenide and metal sulfide, by utilizing the confinement with long range ordered MCM-41 (MCM: Mobils Composition of Matter, 41: serial number) nano-channels. The ternary chalcogenide of Ni3(SbTe3)2 which has the potential applications of magnetic and opto-magnetic storage media shows interesting novel properties induced by insertion of the ternary chalcogenide into aluminum doped MCM-41 nanotubes. Powder XRD patterns indicate long range ordering and increased crystallinity of Ni3(SbTe3)2 inside of the nanotubes. As the channel diameter decreases, the strain is enhanced in the nano-size guest while the estimated size of the nano-guest is still preserved. The characteristic energy states of the nano-guest is gradually red shifted due to the strain with decreasing the channel diameter of the nanotube and such structural confinement causes the suppression of phonon coupling to the photo-excited carriers in the ternary chalcogenide incorporated in the aluminum doped MCM-41. It is also revealed that the coupling is even more suppressed in the nanocomposite of smaller channel diameter.

Nano-size metal sulfide semiconductors confined in siliceous MCM-41 channels were prepared by using reversed micelles as an insertion carrier. The insertion efficiency of the reversed micelles containing semiconductor nanoparticles depends on the size of the reversed micelles and the surface properties of the nano-channels. Calcinated semiconductor nanoparticles in the host present relatively more suppressed surface emission compared with band-edge emission. Such emission characteristics after calcination is ascribed to the relatively reduced recombination probability of excitons through deeply trapped surface defect states compared with the direct excitonic recombination, which is due to surface capping of the nanoparticles by the nano-channels,.

As one of practical applications of nano-effect, photocatalytic reaction of olefin is studied with the semiconductor nanoparticles. Such nano-phase enables more efficient photo-oxidative reaction than bulk semiconductor does, which is mainly resulted from enhanced energetic coupling induced by the quantum size effect and large surface area. The semiconductor nanoparticle confined in mesoporous channel, however, results reduced photochemical yield, which is due to surface capping of semiconductor nanoparticles by the host channels.

(This work has been financially supported by grant No. 1999-2-121-004-5 from the interdisciplinary research program of the KOSEF)