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Synthetic Metals 103 (1999) 2689

SYNTHETIC METALS

Optical and Related Properties of Some Synthetic Low-Dimensional Semiconductors Based on Inorganic Units

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Abstract

The optical and related properties of $(Me_4N)_2Sn_3Se_7$, $K_2Cd_3S_4$ and similar low-dimensional semiconductors show excitonic quantum confinement effects.

Keywords: UV- visible absorption, photoluminescence, photoconductivity, semiconducting films.

During the last few years, a large number of low-dimensional (LD) semiconducting systems, i.e., quantum wells (2D), quantum wires (1D) and quantum dots (0D) have been prepared and studied (for a review see [1]). In this paper the room temperature optical absorption (OA), photoluminescence (PL), photoconductivity (PC) and resonance Raman excitation (RRE) spectra of $(Me_4N)_2Sn_3Se_7$ [2], $K_2Cd_3S_4$ [3] and similar semiconductors [2-4] based on inorganic units are described.

Crystals of $(Me_4N)_2Sn_3Se_7$ consist of Sn_3Se_7 units with a 2D (antidot-like) structure. Fig. 1 shows the OA and PL spectra of $(Me_4N)_2Sn_3Se_7$ thin deposits on quartz plates. The spectra exhibit strong excitonic bands, which are blue-shifted and more pronounced than those of the bulk (3D) material $SnSe_2$ [5].

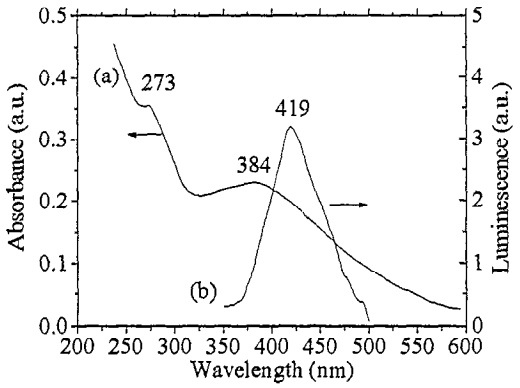

Fig. 1. OA (a) and PL(b) spectra of $(Me_4N)_2Sn_3Se_7$

Crystals of $K_2Cd_3S_4$ consist of Cd_3S_4 units with a quasi-2D structure. Fig.2 shows the PA, PL, PC and RRE (:1LO-mode) spectra of $K_2Cd_3S_4$ and those of bulk CdS(3D), for comparison. One can see that the excitonic peaks in the spectra of $K_2Cd_3S_4$ occur at shorter wavelengths (higher frequencies) than those of the bulk material (CdS). The spectra of $K_2Cd_3S_4$ are similar to those obtained from CdS-particles (0D-systems) of diameter ca 10 nm [6].

Similar results are obtained for other LD systems with inorganic units, e.g,, $(Me_4N)_4Ge_4S_{10}$ (0D), $Na_8In_4S_{10}$ (0D), $PbGeS_3$ (1D). In all cases the spectral peaks, related to the excitons, are more pronounced and shifted to higher frequencies

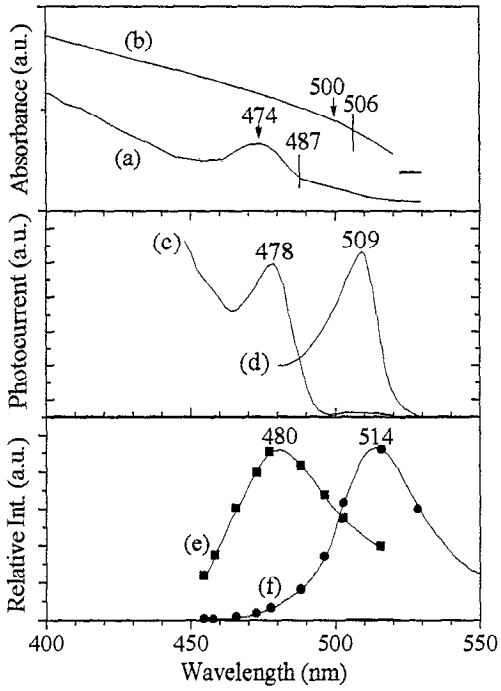

Fig.2. OA(ab), PC (c,d) and RRE(e,f) spectra of $K_2Cd_3S_4$ (a,c,e) and CdS(b,d,f) thin deposits (a,b) and/or single crystals (c,d,e,f); vertical bars indicate the PL peak positions of thin deposits or single crystals.

than those of the corresponding 3D materials (:quantum confinement effects) as in the cases of artificial systems based on conventional semiconductors (see for example [1]).

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PII: S0379-6779(98)00743-7