

Second SAAR-LOR-LUX Meeting on Advanced Materials and Nanocomposite Techniques

Extended Abstracts

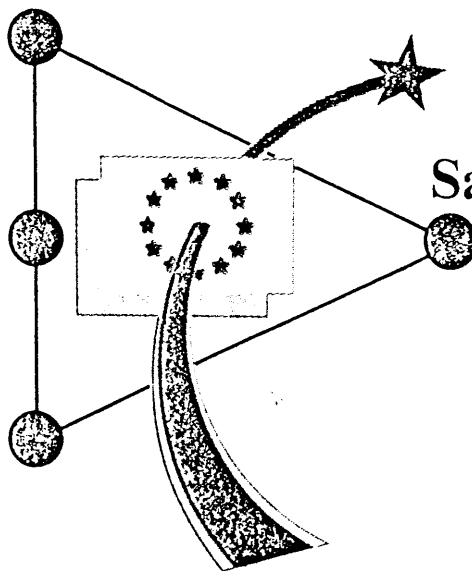
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New optical materials with semiconductor and metal quantum dots and their application potential

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The sol-gel process is an interesting route for the preparation of small particles like semiconducting materials (semiconductor quantum dots) or metal colloids. These materials have interesting optical properties attributed to their small dimensions (band gaps and plasmon absorptions) showing also optical non-linearities. The fabrication of films by incorporation into transparent matrices becomes possible by stabilizing the colloids by multifunctional ligands, as shown for CdS as an example. In this case, amino groups and sulfides are used for stabilizing the CdS colloids and the bifunctional silanes can be used to incorporate the dots into sol-gel matrices [1]. As one can see from fig. 1, too, the variation of ligands changes the absorption spectrum (band gap). A synthetic route of converting CdS sols into compact nanocomposites has been developed. In ethanolic CdS sols containing bifunctional silanes as cluster stabilizers and inorganic-organic network formers, hydrolysis and condensation produces an inorganic skeleton and the final organic cross-linking at $T < 100^\circ \text{C}$ results in optically transparent materials.

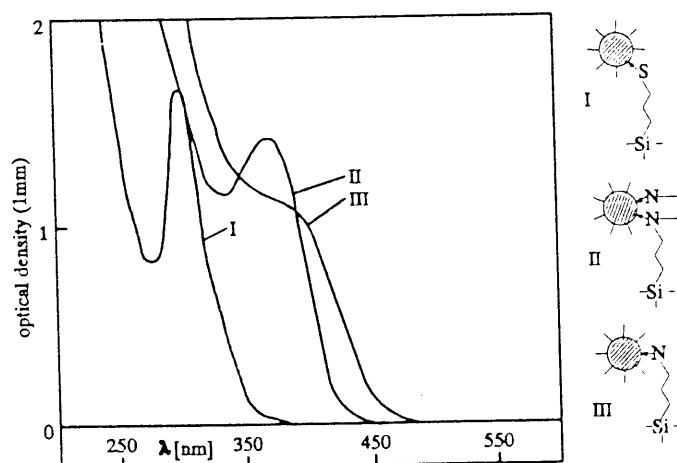


Figure 1. Ligand effect on UV/VIS spectra of CdS.

Another class of materials is represented by metal cluster containing composites which can be synthesized photochemically or photothermally. In this synthesis route Au(III) compounds in organic solvents and complexed by bifunctional silanes are exposed to the UV light and by photoinduced organic radicals a reduction step to Au⁰ takes place [2]. The size of the resulting gold colloids ranges from 2 nm to 10 nm as determined by transmission electron microscopy. Cluster size and spectroscopic properties can be controlled (similarly as in the case of chalcogenide quantum dots) by the use of differently functionalized silanes and irradiation conditions. The Au-UV/VIS of the colloidal solution spectra exhibit pronounced surface plasmon bands peaking between 380 nm and 540 nm depending on ligand type and cluster size [3]. The precursor solutions can be solidified if additionally polymerizing components like methacryloxy silanes and photoinitiators are used. In case of CdS/PbS two-component systems and on Au colloid systems the χ^3 coefficient was determined by self-diffraction from laser induced gratings using optically transparent films prepared via sol-gel dip coating procedures.

The maximum first order diffraction efficiency, measured on CdS-PbS samples at different wavelengths between 490 and 520 nm, was of about 10^{-4} and the corresponding calculated effective third order susceptibility was of the order of 10^{-9} esu [3]. Gold containing samples exhibit susceptibilities up to 10^{-5} esu, depending upon the film thickness and volume fraction. The detailed result of these studies will be published in the near future [4].

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