A new approach for the synthesis of ZnO nanoparticles sensitized with metal chalcogenides

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The present communication is a response to renewed interest in nanostructure based "coupled compounds", like ZnO-MeX (where Me = Cd, Pb,... and X = S, Se) which can find extensive use in the fabrication of a number of solid state devices, such as photoconductive, solar cells, electroluminescent cells, photocatalysts.

Various oxide semiconductors, like TiO_2 and ZnO, are known to have appropriate properties for these applications, although there are some drawbacks associated with their use: (i) charge carrier recombination occurs within a few nanoseconds, (ii) band edge absorption threshold does not allow the utilization of visible light. One of the main approaches to overcome these particular limitations involves the contact of the semiconductor particle with another semiconductor, called "sensitizer". For example, this is the case of nanostructured ZnO particles combined with metal chalcogenides.

Infact it is known that in these coupled systems the absorption threshold is extended to the visible region and the photogenerated electrons are quickly transferred from sulphide/selenide layer into to the lower lying conduction band of ZnO, thus limiting recombination effects.

In order to produce this type of material we have combined ZnO nanoparticles, in the specific "tetrapod" morphology, with nanoparticles of metal chalcogenides. The main innovative aspects of the preparation procedure are the following:

- the use of appropriate organic solvents to keep both ZnO and the formed metal chalcogenides completely suspended and dispersed in the liquid;
- an *in situ* direct formation of metal chalcogenides keeping pH value in the range 6-8 (no use of ammonia salt or complexing agents);
- the limited use of chemical reagents, i.e. only metal and sulphur/selenium precursors are involved;
- the possibility to deposit the "coupled compounds" in form of thin films directly from the liquid suspension onto the substrates (silicon, alumina, glass, TCO layers, etc.).

This paper reports details on the preparation procedure, results of morphological and structural investigations (XRD, SEM), compositional analysis (EDS microanalysis) and optical-electrical measurements (I-V, impedance spectroscopy, etc.), which point out the great potentiality of the proposed method for the synthesis of different "sensitized nano-compounds".