Method for large area deposition of ZnO tetrapod nanostructures

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Among several morphologies ZnO presents one quite characteristic nano-crystalline structure, usually reported as "tetrapod" (TP), which consists of four needle-shaped "legs" connected at one common end and respectively arranged as axes of a tetrahedron (Fig. 1).

Using an appropriate vapor-solid process, ZnO TPs are produced in large quantity (tens of mg per run) and, when removed from the growth reactor, they appear well assembled like a light white-grey "sponge". These aggregate structures mainly consist of TP nanocrystals, though usually they might also include unreacted Zn metal particles, nanosized ZnO powders and/or partially oxidized ZnO_{1-x} nanostructures/powders. In order to "purify" as-grown TPs from the other undesired structures, the authors propose a multi-step process summarized as following: (1) post growth thermal annealing in vacuum (evaporation of metal Zn) and, subsequently, in oxygen atmosphere (oxidation of not completely reacted particles of ZnO_{1-x}); (2) suspension of all the reaction products in appropriate liquids, in which ZnO is insoluble, in order to decant and to separate TPs from spurious structures; (3) room-temperature deposition of purified ZnO TPs on proper substrates (glass, silicon, alumina, etc., depending on the final application), whose sizes can vary from a few square mm up to many square cm; (4) heating at moderate temperature under low vacuum to remove traces of organic solvent and to favour the sticking of ZnO TPs on the substrates.

The described procedure is highly valuable as it allows the achievement of homogeneous distribution of purified ZnO nanostructures on large substrates and a room-temperature deposition process which avoids detrimental interaction of ZnO TPs with substrate material, or with metal contacts previously deposited on the substrates. In practice, the proposed method is a new way to prepare large area films of metal oxides nanostructures, ready for device production. Application of the process to gas sensor fabrication and hybrid compounds (ZnO-MeS) preparation is also reported.

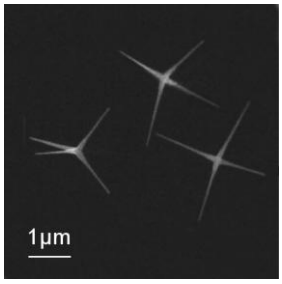

Figure 1. SEM image of obtained ZnO tetrapods