The challenge for large-scale vapor-phase growths of not-catalyzed ZnO nanostructures: purity vs. yield

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ZnO nanostructures are today a very important research topic because their proved (or even just "potential") properties promoted huge studies in many different application fields, such as optoelectronics, photovoltaics, spintronics, gas sensing, photocatalysis, piezo-electric applications, etc. Since a reproducible large-scale production is essential for a likely use of these nanostructures in any industrial application, large efforts have been done to control and stabilize their synthesis processes.

Good results have been obtained in vapor phase growths of nanorods and nanowires, by mean of metal catalysts (such as Au, Pt or Ni particles). On the other side, large and controlled production of some ZnO nanostructures have been realized by wet chemical processes. Unfortunately both these approaches are intrinsically affected by the introduction of impurities in the nanocrystals' structure. Indeed, even very low impurity levels may have a strong effect on the physical properties of these semiconducting nanostructures.

Catalyst-free vapor-phase growth techniques should not be affected by the same impurity levels if high purity sources and gases are employed. Unfortunately, the synthesis control is generally more difficult in this kind of processes.

In the present work authors show the results obtained in the optimization of three different growth processes, for a large-scale oriented production of (i) ZnO tetrapods, (ii) ZnO nanorods and (iii) ZnO long nanowires. All the described processes share a catalyst-free growth and the use of high purity metallic Zn, O_2 and inert carrier gas (Ar) only. The properties of the obtained ZnO nanostructures have been characterized and, hence, pros and cons of the used approach have been discussed.

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Abstract

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