Insights on the low temperature growth mechanism ZnO Nanowires

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The present work provides a comprehensive picture of the precise mechanism of ZnO vapor-solid-solid (VSS) nanowire growth at low temperatures and gives the fundamental reasons responsible [1]. We demonstrate by using a combination of synchrotron XRD and high resolution TEM that the growth dynamics at low temperatures is not governed by the well-known VLS mechanisms. Based on the Au-Zn phase diagram, temperature measurement and temperature size effects, we show that growth occurs via VSS. The precise composition of the Au-Zn catalyst nanoparticle has been determined to be γ-AuZn. Furthermore, we experimentally observe that there is an indication of an epitaxial relationship between the ZnO nanowires and the γ-AuZn seed particle. A critical new insight on the driving factor of VSS growth is proposed in which the VSS process occurs by a solid diffusion mechanism that is driven by a preferential oxidation process of the Zn inside the alloy catalyst induced by an epitaxial match between the ZnO(10-10) plane and the γ-AuZn(222) plane. We believe that these results are not only important for the understanding of ZnO nanowire growth but could also have significant impact on the understanding of growth mechanisms of other nanowire systems.

[1] L. C. Campos et al, Advanced Materials, 20, 1499 (2008).