Catalyst-free synthesis of coaxial-shaped hexagonal ZnO nanocolumns by thermal evaporation: Growth mechanism, Structural and Optical properties

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Single crystalline with the perfect hexagonal-shaped ZnO nanocolumns have been synthesized in a large quantity, for the first time, on steel alloy substrate through the thermal evaporation of metallic zinc powder at low temperature of 490°C without the use of metal catalyst or additives. SEM and TEM observations clearly reveal that the grown products exhibiting an interesting morphology i.e. coaxial-shaped structure at their tips. A new layer-by-layer three-step growth mechanism was proposed for the formation of these hexagonal coaxial-shaped tips of the nanocolumns. Detailed structural analyses confirm that the formed nanocolumns are exhibiting a wurtzite hexagonal phase and preferentially oriented in the c-axis direction. Presence of a sharp, strong and dominated optical-phonon Raman-active E2 mode in the spectrum demonstrate that the grown products are good in crystal quality and proved a hexagonal crystal structure for the synthesized ZnO nanocolumns. Moreover, the optical properties of the deposited products were examined in detail by the temperature-dependant photoluminescence (PL) spectra.