

# Shape-Selective Dependence of Room Temperature Ferromagnetism Induced by Hierarchical ZnO Nanostructures

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## Abstract

We report on the room temperature ferromagnetism of various highly crystalline zinc oxide (ZnO) nanostructures, such as hexagonally shaped nanorods, nanocups, nanosamoosas, nanoplatelets, and hierarchical nano “flower-like” structures. These materials were synthesized in a shape-selective manner using simple microwave assisted hydrothermal synthesis. Thermogravimetric analyses demonstrated the as-synthesized ZnO nanostructures to be stable and of high purity. Structural analyses showed that the ZnO nanostructures are polycrystalline and wurtzite in structure, without any secondary phases. Combination of electron paramagnetic resonance, photoluminescence, and X-ray photoelectron spectroscopy studies revealed that the zinc vacancies ( $V_{Zn}$ ) and singly ionized oxygen vacancies ( $V_{O+}$ ) located mainly on the ZnO surface are the primary defects in ZnO structures. A direct link between ferromagnetism and the relative occupancy of the  $V_{Zn}$  and  $V_{O+}$  was established, suggesting that both  $V_{Zn}$  and  $V_{O+}$  on the ZnO surface plays a vital role in modulating ferromagnetic behavior. An intense structure- and shape-dependent ferromagnetic signal with an effective g-value of  $>2.0$  and a sextet hyperfine structure was shown. Moreover, a novel low field microwave absorption signal was observed and found to increase with an increase in microwave power and temperature.