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Multifunctional 1D α-Fe2O3/ZnO Core/Shell Semiconductor Nano-Heterostructures: Heterojunction Engineering

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Abstract : This study reports the facile fabrication of 1D ZnO/α-Fe2O3 semiconductor nano-heterostructures (SNHs), and we investigate the strong interfacial interactions at the heterojunction, resulting in novel multifunctionality in the hybrid structure. ZnO-coated α-Fe2O3 nanowires (NWs) have been prepared by combining electrodeposition and wet chemical methods. Significant improvement in electrical conductivity, photoluminescence, and room temperature magnetic properties have been observed for the ZnO/α-Fe2O3 SNHs over the pristine α-Fe2O3 NWs because of the contribution of the ZnO nanolayer. The increase in electrical conductivity in ZnO/α-Fe2O3 SNHs is because of the increase in free electrons in the conduction band of the SNHs due to the formation of type-II n-n band configuration at the heterojunction. The SNHs are found to exhibit enhanced visible green photoluminescence along with the UV emission at room temperature. The band-gap emission of the α-Fe2O3 NWs coupled to the defect emissions of the ZnO in SNHs can be attributed to the profound enhancement of the visible green luminescence. Ferromagnetism of the SNHs is found to be increased nearly five times in magnitude over the primeval α-Fe2O3 NWs, which can be ascribed to the exchange coupling of the interfacial spin at ZnO/α-Fe2O3 interface, the surface spin of ZnO nanolayer, along with the structural defects like the cation vacancies (VZn) and the singly ionized oxygen vacancies (Vo•) present in SNHs.

Keywords : nano-heterostructures, photoluminescence, electrical property, magnetism
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