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MoS $_2$-ZnO nanocomposites as highly functional agents for anti-angiogenic and anti-cancer theranostics

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Abstract

Due to its excellent properties, 2D-MoS_2 finds potential applications in the fields of electronics, optoelectronics, energy storage and conversion, biomedicine, etc. This work deals with the incorporation of ZnO into 2D-MoS_2, its structural, morphological, optical, and magnetic studies and its application as an efficient cancer therapeutic agent. The MoS_2-ZnO nanocomposite exhibits remarkable excitation wavelength dependent down-conversion and up-conversion photoluminescence. The observation of wasp-waisted magnetism in the MoS_2-ZnO nanocomposite indicates the coupling of ZnO and MoS_2 materials inducing multimodal population. The MoS_2-ZnO nanocomposite showed cytotoxic properties with a safety index reaching up to ~2. An in ovo xenograft assay revealed that the MoS_2-ZnO nanocomposite retards tumor growth by specifically activating caspase-3 and thereby inducing cellular apoptosis. Moreover, the treatment of xenografts with the MoS_2-ZnO nanocomposite down regulated the expression of major pro-angiogenic genes such as VEGF, VEGFR2 etc. thereby curtailing vascularization into the tumor intima. Treatment of tumor xenografts with the MoS_2-ZnO nanocomposite caused reduced expression of mesenchymal specific genes and elevated expression of epithelial specific genes, implying a role of the MoS_2-ZnO nanocomposite in retarding the process of epithelial to mesenchymal transition (EMT). This study highlights that the introduction of ZnO into MoS_2 nanostructures offers a unique idea to design efficient MoS_2-based multifunctional nanocomposites that provide opportunities in advanced biomedical and optoelectronic applications.

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