Title: Metalorganic Chemical Vapor Deposition of $Mn_xZn_{1-x}O$ as a Spintronic Material

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Description: New Technologies that utilize spin of electrons require semiconductors that are magnetic at ambient temperatures. Such materials would make possible the synthesis of a variety of nanostructures, such as spin-FETs and spin-LEDs, and would represent a critical advance in quantum computing. A great deal of work has been done in this area and thus far, diluted magnetic semiconductors (DMSs) have proven to be more efficient spin sources than ferromagnetic metals. This is because the conductivities of DMSs are better matched to those of the channel material in the semiconductor device. However, because of the very low ferromagnetic ordering temperature of current DMSs, efficient spin injection is only observed at cryogenic temperatures. A recent calculation predicts that heavily nitrogen-doped $Mn_xZn_{1-x}O$ will exhibit a Curie temperature of ~320K1, for x = 0.05, and serves as partial motivation for this work. We have grown $Mn_xZn_{1-x}O$ films by metalorganic chemical vapor deposition (MOCVD). Rutherford Backscattering Spectrometry (RBS) and X-ray photoelectron spectroscopy (XPS) show that compositions ranging from pure ZnO to $Mn_{0.30}Zn_{0.70}O$ are achievable on Al_2O_3(0001) substrates, without carbon contamination. X-ray diffraction (XRD) was used to confirm that there was no phase segregation. XRD also indicated that all films grown below 500°C had a preferred (0001) orientation, while epitaxy of ZnO was possible at 575°C on both Al_2O_3(0001) and ZnO(0001). Preliminary attempts at nitrogen incorporation shown that NH_3 is a promising nitrogen source. The ultimate goals of this work include (1) the synthesis and characterization of N-doped p-$Mn_xZn_{1-x}O$ single-crystal films that are ferromagnetic at room temperature and (2) the development, for the first time, of novel epitaxial ZnO quantum well structures into which spin-polarized carriers can be electrically injected and recombined to produce circularly, polarized, ultraviolet light at room-temperature. Such devices are important because they would represent the first demonstration of a room temperature spin-LED and because they would strongly suggest that other nanostructure devices are possible using $Mn_xZn_{1-x}O$-based DMSs.