A Comparison of the Effects of H2 Incorporation on the Stability and Opto-Electronic Properties of ZnO and Mg:ZnO Thin Films

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The purpose of this experiment was to see how hydrogen (H2) incorporation during production of thin films affects the stability and opto-electronic properties of various thin films. It was predicted that, with H2 incorporation, resistivity of the film would be reduced. I reached this hypothesis through an extensive examination of other studies on this subject. As shown in studies such as that of Gottardi et al. incorporation of H2, even as little as 3%, has an effect on the conductivity of a zinc oxide (ZnO) film, and additional H2 incorporation increases the conductivity by multiple factors of 10 (2011). To extend Gottardi's study, rather than only using a ZnO target, a Mg0.1:ZnO0.9 target was used, and samples were produced at various substrate temperatures. Devices were produced in a radio frequency (rf) sputtering system, which deposits thin films of materials using ionized gasses. The data show a difference in the stability of ZnO samples over time, and an overall reduction of both the Mg:ZnO and ZnO film resistivities. This is attributed to filling of oxygen vacancies by H species and an increase in carrier concentration, respectively, as seen in other studies (Shantheyanda et al. 2012, Chen et al. 2004). To extend this study it would be interesting to use targets of varying percent compositions of Mg, use different methods of H2 incorporation such as water vapor, and sputter films with varying substrate temperatures, as well as measure resistivity at regular intervals.

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