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Mechanistic model for the influence of Ag thickness on the electrical and optical properties of ZnO/Ag/ZnO nanoscale multilayers TERRY ALFORD, HAUK HAN, School of Materials and Flexible Display Center at Arizona State University, N. THEODORE, Analog & Mixed-Signal Technologies, Freescale Semiconductor Inc. — In this study, we have engineered TCO structures with greatly improved electrical conductivity by introduction of a thin layer of Ag. Results show that carrier concentration, mobility, and conductivity increase with Ag thickness. The electrical conductivity decreased from 1 Ω-cm to 8×10^{-5} Ω-cm for a 14 nm Ag middle layer, by increasing carrier concentration and mobility. AFM and TEM results indicate that low Ag thickness results in Ag island formation. The optical transmittance of the composite structure decreases when compared to a single ZnO layer of comparable thickness. However, we demonstrate that an optimum Ag thickness exists (12 nm) to fulfill the conductivity and transmittance requirements for optoelectronic devices. Moreover the optical band-gap of ZnO/Ag/ZnO composite multilayer films decreases with increasing the Ag thickness and also increases with carrier concentration. Based on these results, we propose a mechanistic model for the influence of Ag thickness on the electrical and optical properties of this system.

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