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Revisiting the electrical and optical transmission properties of co-doped ZnO thin films as n-type TCOs

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Abstract

A transparent conducting oxide (TCOs) thin film exhibits a very high electrical conductivity and high visible light transparency with considerable practical applications in solar cells and in transparent electronics. As a promising substitute to Sn-doped In₂O₃ (ITO), doped ZnO thin films are widely considered due to low-cost, non-toxicity and high durability against the H plasma compared with ITO. In this review, by 'co-doping', we mean cation-cation (two iso-valent or heterovalent cations) and cation-anion (one higher valence cation and one lower valence anion) double doping in ZnO film. This article commences with a generalized description of TCOs, ITO and single-doped ZnO followed by a discussion on co-doped ZnO. We systemically present the current progress in both co-doping studies with critically summarized results to gain an overview, especially regarding the electrical properties. The cation-cation co-doping results in a wide range of carrier concentrations and resistivity values due to the competitive Zn site substitution by two different cations simultaneously. Cation-anion co-doping leads to an

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