Materials Design of High Carrier Transport Oxide Films for Various Applications

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We have developed highly transparent conductive oxide (TCO) films based on *n*-type-doped zinc oxide (ZnO) and indium oxide (In_2O_3) with thicknesses (*t*) ranging from a few nanometers to micrometers [1]. Our main concern is achieving high carrier transport (e.g., 145 $cm^2/(Vs)$) at high carrier concentrations (N) ranging from 2×10^{20} to 2×10^{21} cm^{-3}, independent of *t*. The N and *t* values depend heavily on the application. Transparent conductive electrodes, for example, require *t* values ranging from 100 to 150 nm for solar cells [2] and liquid crystal displays (LCDs) [3,4]; electromagnetic shielding requires *t* values greater than 1 μm; gas sensors [5] require *t* values of 50 nm; γ-radiation resistance [6] requires *t* values of 200 nm; and antibacterial applications require *t* values of 50 nm. Recently, we achieved high Hall mobility in polycrystalline W-doped In_2O_3 (IWO) with *t* below 10 nm [7]. We have successfully fabricated continuous, 2-nm-thick amorphous IWO films on glass substrates [1]. In this talk, we will discuss how to achieve TCO films with high carrier transport and explain the physics of the free electron system in IWO films, which differs from that of most metals, and discuss dominant factors governing carrier transport.

References

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