NSYSU physics 書報討論

Weekly Seminar

Development of High Performance Crystalline and Amorphous Transparent Conducting Oxides (TCOs)

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Abstract

Many post-transition metal oxides such as ZnO, CdO, In_2O_3 and SnO_2 have wide band gaps (>3 eV) and a proclivity for high conductivity with appropriate doping. They belong to a unique class of materials that combine two seemingly contradictory properties: optical transparency and electrical conductivity. These oxides, also known as transparent conducting oxides or TCOs have been widely used in a variety of electronic and optoelectronic devices such as displays, thin film transistors, low emissivity windows, and thin film solar cells. More recently, because of their tunable epsilon near zero properties in the near to mid infrared region, TCOs are also explored for nonlinear optics and plasmonic applications. In conventional TCOs such as Sn doped In_2O_3 (ITO) and Al doped ZnO (AZO), their good electrical conductivity stems from their high electron concentration ($\sim 10^{21} cm^{-3}$), since their mobility is limited ($\sim 10-60 cm^2/Vs$). Consequently, strong free-carrier absorption and plasma reflection at $\lambda > 1000nm$ limit their transparency for long-wavelength photons. This drawback limits their application in devices that utilize near-infrared photons, such as Si solar cells and high efficiency multijunction solar cells. In order to extend their applications, much research efforts have been devoted to the search for new high mobility TCOs.

In this talk, I will highlight some of our previous and ongoing work in the development of high mobility crystalline and amorphous TCOs. In particular, recent work on the development of p-type TCOs using the concept of band structure engineering will be discussed, namely we will discuss the difficulty in p-type doping of wide bandgap oxides and the additional requirements of using TCOs for flexible electronic devices. Furthermore, the application of newly developed CdO-In_2O_3 amorphous TCOs in organic and perovskite solar cells will be presented.

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