In situ electro-optical characterization of thin films for energy conversion applications

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Thin films are increasingly applied as functional layers in energy conversion and sensing devices, including photovoltaic cells, fuel cells, and automotive gas sensors. Understanding and thereby optimizing their electrical and optical properties is crucial for enabling next generation low-carbon and carbon-neutral technologies. In this talk I would like to present *in situ* characterization of the optical and electrical properties of such thin films as a means to: 1) study performance under operating conditions, 2) understand key defect concentrations as a function of temperature/ gas atmosphere/ potential, 3) measure surface reaction kinetics, and 4) identify degradation mechanisms. For example, in $ZnCo_2O_4$ thin films we identified the metastable origin of high p-type conductivity using in situ Van-der-Pauw resistivity measurements as a function of temperature and oxygen partial pressure[1]. These films have been demonstrated as potential hole transport layers in organic photovoltaic cells. Second, in the case of $SrTi_{1-x}Fe_xO_{3-\alpha}$ films, of interest as gas sensors and solid oxide fuel cell cathodes, combined simultaneous electrical and optical studies have enabled us to identify defect concentrations and surface reaction rates for oxygen incorporation over a wide range of oxygen activities and temperatures. Third, for $Ce_{0.9}Pr_{0.1}O_{2-x}$ films, which are also potential electrodes for solid oxide fuel cells, we have applied *in situ* optical absorption measurements to study performance degradation and successful surface treatments to mitigate the aging process. Potential applications of the technique to organic systems will be discussed.

1. A. Zakutayev, N.H. Perry, T.O. Mason, D.S. Ginley, and S. Lany, Applied Physics Letters 103 (2013) 232106