KN1300

Recent developments in the field of transparent conductive oxide films for oxide electronics and photovoltaics

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The material class of transparent conductive oxides (TCO) has shown to be of crucial importance for optoelectronic devices in the last decades. The combination of metallic conductivity and high transmittance has been an enabling factor for all types of flat panel displays and thin films solar cells at present time. Polycrystalline n-type TCOs such as In_2O_3:Sn (ITO), SnO_2:F and ZnO:Al are still the main materials for these applications with a strong emphasis on In based materials for display applications.
Current R&D is towards two main directions: In the field of n-TCOs, advanced control of layer properties and low cost large area deposition is necessary to fulfill the market needs for large area photovoltaics, flat panel displays and solid state lighting. Our emphasize is here on ZnO:Al based materials which allow for tailored light scattering for a-Si:H/µc-Si:H tandem solar cells, improved encapsulation for CIGS solar cells and even for substitution of ITO in display applications.
The second main direction opens up even new perspectives on the industrial use of oxides: Here, we address the development of active semiconductive oxide (ASO) films which have the potential to revolutionize the current microelectronics industry. This industry is currently almost exclusively based on Si semiconductors, either as crystalline or as amorphous material. However, the perspectives for further developments are limited since the constraints of the material such as non-availability for flexible devices; optical opacity and need for high temperature processing are obvious. The emerging class of oxide semiconductors is able to overcome many of those restrictions, especially because some of them can be prepared as thin (transparent) films under comparatively moderate conditions. We report on the state of the art on large area oxide electronics and we outline the development on further products such as oxide based p-n junctions for UV LED and oxide based CMOS applications.
The third part addresses the modeling of material properties and growth phenomena. Here we describe our multiscale approach to achieve understanding and control of process conditions and material properties.

Keywords
Transparent Conductive Oxides