SYNTHESIS AND CHARACTERIZATION OF ZINC OXIDE NANOCOLLOID FOR TRANSPARENT CONDUCTING THIN FILMS

by

Swati Sharma

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Examining Committee:

Dr. Partha S. Dutta, Thesis Adviser

Dr. Ishwara Bhat, Member

Dr. Yannick Le Coz, Member

Dr. Toh-Ming Lu, Member

Rensselaer Polytechnic Institute
Troy, New York

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ABSTRACT

As technology advances, material research efforts need to keep pace with the changes. For example, new chemical precursors need to be continuously developed for synthesis of a variety of materials. Of late, there has been a great demand for flat panel displays that use plastic substrates. These substrates cannot handle processing temperatures greater than ~200^{o}C. Transparent conducting oxides (TCOs) are an important class of materials for such displays. TCOs constitute a "thin" layer in these devices, and provide optical transparency in the visible range and adequate electrical conductivity. So far, indium tin oxide (ITO) has been the TCO of choice because it offers excellent transparency and electrical conductivity. However, ITO requires high temperature processing, which plastic substrates cannot handle.

Zinc oxide (ZnO) is a potential candidate for TCO applications. Our research motivation was to develop a ZnO based TCO fabrication methodology utilizing the fundamental properties of ZnO nanoparticles. We have developed a new approach wherein ZnO nanoparticles suspended in a colloid could be used as a precursor in fabricating TCO thin films. The ZnO nanocolloidal precursor could be converted into a continuous ZnO film by heating and melting the ZnO nanoparticles after deposition onto any suitable substrate.

We developed a novel synthesis procedure with simultaneous steric stabilization and encapsulation. The stable ZnO nanocolloid was synthesized from ZnO bulk powder. ZnO 2-4nm nanoparticles have been achieved –enabling melting points of the ZnO nanoparticles in the 100-200^{o}C range. ZnO nanocolloid has been spin coated onto quartz substrates and annealed in air to coalesce the particles into a film. Depending on the particle size distribution and agglomeration, the annealing temperatures needed to obtain a continuous film could be as high as 550^{o}C, though individual particles may melt below 200^{o}C. We have achieved 85% transmittance in the visible range for the films fabricated by the synthesized nanocolloid and is ideal for TCO applications. Resistivity of the film is typical for intrinsic ZnO (~$10^{6}\Omega$-cm), and is not low enough for TCO applications.