Solution Growth of Semiconducting Alloy Films: Their Study and Application in Photoconducting and Photoelectrochemical Cells

by
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ABSTRACT

A chemical solution growth technique has been developed to deposit metal selenide films on insulating, metallic and semiconducting substrates. The technique has been used to deposit CdSe, PbSe, CdSe doped with Cu, In and Ag, $CdSe_{1-x}S_x$ $(0 \leq x \leq 1)$ and $Cd_{1-x}Pb_xSe$ $(0 \leq x \leq 1)$ films. The kinetics of growth as a function of composition, pH and temperature of the bath and the nature of the substrate has been studied. The structural properties and the surface topography of the films have been studied. It has been concluded that the solution growth technique resembles the evaporation technique and the film formation takes place by the recombination of ions on the substrate surface via a nucleation and growth process.

From the measurements of optical constants such as absorption coefficient, extinction coefficient and refractive index it has been established that all the films have direct band gaps. The gap varies continuously with composition between the values in constituent compounds. Thus the band gap ranges from 2.44 eV to 1.74 eV in $CdSe_{1-x}S_x$ $(0 \leq x \leq 1)$ and from 1.74 eV to 0.26 eV in $Cd_{1-x}Pb_xSe$ $(0 \leq x \leq 1)$ films.

The electrical properties of the films depend on the deposition parameters and have been modified drastically by various post-deposition treatments. The changes in the

electrical conduction behaviour are due to the changes in the Se stoichiometry and incorporation of oxygen in the films.

The solution grown films have been sensitized by various post-deposition treatments. The photoconductors prepared by using these films have been characterised in terms of their gain, response time and spectral response. The energy of sensitizing centres and trap distribution has also been determined. It has been concluded that the photoconductivity in $CdSe_{1-x}S_x$ alloy films is due to intrinsic defects which act as sensitizing centres, while in the case of $Cd_{1-x}Pb_xSe$ ($x \gtrsim 0.2$) films, the photoconductivity is due to oxygen sensitizing centres.

The CdSe films have been used to fabricate photo-electrochemical cells. The effect of various post-deposition treatments on the cell characteristics has been determined. The cells have been characterised in terms of their I-V characteristics and spectral response. n-CdSe/Na_2S-S-NaOH/C photo-electrochemical cells with conversion efficiency of 2% (at 50 mW-cm^{-2}, white light intensity) have been fabricated.

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