MOCVD of zinc and cadmium stannates for the next generation of PV solar cells

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Over 85% of the world production of PV (photovoltaic) solar modules are made from crystalline silicon wafers. The remainder is comprised of various thin film solar cell materials such as amorphous silicon, cadmium telluride and copper indium gallium diselenide (CIGS). The production costs for thin film PV are potentially a lot lower than for crystalline silicon due to less of the expensive semiconductor materials per unit area and lower temperature processing. However, this is offset by lower module efficiencies, generally around 10% or less compared with 15-20% for crystalline silicon. An essential part of thin film solar cells is a transparent conducting oxide (TCO) which is used as the front contact. The TCO layer has to transmit a broad spectrum of radiation from the near infrared through to the ultraviolet and not contribute significantly to the series resistance of the device, which can significantly degrade the conversion efficiency. The current generation of thin film PV modules use either fluorine dope tin oxide (FTO) or indium tin oxide (ITO). These films are highly doped to achieve a low spreading resistance (around 10 Ohm per square or less) and this can reduce the optical transmission. This talk will review the potential for alternative TCOs such as Al doped ZnO, CdO and their stannates. The approaches for using metal organic chemical vapour deposition (MOCVD) will be described and particular challenges in growing the ternary compounds and alloys. One advantage that is emerging for the MOCVD approach is the ability to control grain size. This can help in improving the electron mobility and hence achieve high conductivity without the need for extremely high doping concentrations. Finally the issue of surface morphology of the TCO will be considered and the potential for producing nano-structured surfaces for advanced thin film solar cells.