USE OF SOLUTION PROCESSING FOR REDUCED COST PHOTOVOLTAICS

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Photovoltaics are becoming an increasing part of the energy supply mix, however to have a really significant impact they must become cost competitive with more conventional energy sources. Atmospheric processing methods could help toward this significant cost reduction. At NREL we are investigating solution precursors and ink based atmospheric deposition approaches to a variety of solar cell materials. There are two main fields in photovoltaics in which atmospheric processing techniques can be applied; Contacts and absorber materials. At NREL we studied inkjet printing and aerosol jet spraying of contacts for Si and CIGS photovoltaics. We have developed metal organic decomposition inks for metals such as: silver, nickel, copper and aluminum. All of these can be deposited in lines with 30-40 µm width and conductivities close to that of bulk metals. Cell efficiencies similar to those with contacts deposited by alternative means were obtained. Solution processing has been used to deposit various photovoltaic absorber materials, i.e. Cu-In-Ga-Se (CIGS), Cu-Zn-Sn-S (CZTS) and CdTe. Liquid based precursors have been developed that can be solution deposited and processed under atmospheric conditions by i.e. ultrasonic spraying. Various precursors were identified to produce the full absorber material at once or subsets of the absorber, i.e. In_2Se_3, Cu_2Se, Ga_2Se_3, $InGaSe_3$, $CuInSe_2$ and $CuIn_xGa_{1-x}Se_2$. All of these can be deposited without a selenization step on various substrates. The inks can be deposited to create dense absorber films with large grains, which is essential for high efficiency solar cells. Inks for solution processing of transparent conductive oxide materials (i.e. In-Zn-O) have also been developed. These materials can be used in photovoltaic cells to form a transparent contact. Solution processing of transparent and metallic contacts and absorber materials will be enabling for creating a process for all solution processable photovoltaics.

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