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# Evaluation of solution parameters for $CdCl_2$ solutions to be used in post-deposition treatments of CdTe thin films in CdS/CdTe solar cells

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Owing to its high absorption coefficient and the near ideal band gap, CdTe has become one of the topmost solar energy materials available for conversion of solar energy into electricity. It exhibits excellent power conversion efficiencies, when coupled with the CdS window material to form CdS/CdTe heterojunction solar cells. Further, $CdCl_2$ treatment has been identified as one of the promising post-deposition treatments available for achieving drastic improvements in the performance of CdTe material. However, no extensive investigations have yet been carried out to identify suitable solution parameters for the $CdCl_2$ solutions used in the post-deposition treatment process. Hence, the present study was designed to investigate the effect of concentration and pH of $CdCl_2$ solutions used for post-deposition treatments of CdTe material grown on glass/FTO/CdS surfaces. In this study, CdTe layers were potentiostatically electrodeposited on glass/FTO/CdS substrates in electrolytic baths containing 1.0 mol/L $CdSO_4$ and 1.0 mmol/L $TeO_2$ at pH 2.3. A cathodic deposition potential of 650 mV with respect to saturated calomel electrode and temperature of 65 °C at a continuous stirring rate of 60 rpm were maintained through the deposition. At the end of electrodeposition process, all the glass/FTO/CdS/CdTe samples were rinsed in de-ionized water and dried under a high purity nitrogen gas stream and conveyed for the $CdCl_2$ treatment followed by air annealing at 390 °C for 15 min. For $CdCl_2$ treatment, three different $CdCl_2$ concentrations (1.0, 0.5 and 0.1 mol/L) were used. For each concentration, three different pHs; as prepared (5.6, 6.3 and 7.1 for 1.0, 0.5 and 0.1 mol/L $CdCl_2$ solutions respectively), 2.0 and 6.5 at 25 °C were selected. Hence, nine sets of samples with two replicates in each were subjected to the $CdCl_2$ treatment. Once the treatment process was over, samples were inspected for their optical, electrical and morphological properties using the techniques of optical absorption spectroscopy, photo-electrochemical cell studies and scanning electron microscopy. The results revealed that, two solutions; one with 1.0 mol/L $CdCl_2$ solution at pH of 5.6 and the other with 0.1 mol/L $CdCl_2$ solution at pH of 2.0 can be effectively used for the post-deposition treatment of CdTe material for improving its properties and eventually to produce power efficient CdS/CdTe based solar cells with ~80 % efficiency improvement compared to the untreated devices.

**Keywords:** Cadmium chloride treatment, Cadmium telluride, Electrodeposition, Solar cells