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Optimization of ZnO:Al properties for $CuInSe_2$ superstrate thin film solar cell

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While the substrate-type solar cells with Cu(In,Ga)Se2 absorbers yield conversion efficiencies of up 20%[1], the highest published efficiency of Cu(In,Ga)Se2 superstrate solar cell is only 12.8% [2]. The commerciallized Cu(In,Ga)Se2 solar cells are made in the substrate configuration having the stacking sequence of substrate (soda lime glass)/back contact (molybdenum)/absorber layer (Cu(In,Ga)Se2)/buffer layer (cadmium sulfide)/window layer (transparent conductive oxide)/anti reflection layer (MgF2) /grid contact. Thus, it is not possible to illuminate the substrate-type cell through the glass substrate. Rather, it is necessary to illuminate from the opposite side which requires an elaborate transparent encapsulation. In contrast to that, the configuration of superstrate solar cell allows the illumination through the glass substrate. This saves the expensive transparent encapsulation.

Usually, the high quality Cu(In,Ga)Se2 absorber requires a high deposition temperature over 550C. Therefore, the front contact should be thermally stable in the temperature range to realize a successful superstrate-type solar cell.

In this study, it was tried to make a decent superstrate-type solar cell with the thermally stable ZnO:Al layer obtained by adjusting its deposition parameters in magnetron sputtering process. The effect of deposition condition of the layer on the cell performance will be discussed together with hall measurement results and current-voltage characteristics of the cells.

Keywords: Thin film solar cell, Superstate, CuInSe2, co-evaporation,Al:ZnO

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Effects of NaF evaporation rate on the properties of $CuInSe_2$ thin-film solar cells

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A small amount of Na incorporated in $CuInSe_2$ (CIS) absorption layer has become widely accepted as a requirement for efficient polycrystalline CIS solar cells. However, there is ongoing argument on the role of sodium incorporated in the absorber. In this paper, CIS absorption layers have been deposited using the three-stage co-evaporation process on Mo coated non-Alkali glass substrates. The NaF was evaporated during the second-stage with various fluxes.

This paper is focusing on differences of micro-structure and composition ratio of the absorber realized with different Na contents and the variation of electrical properties of the cells with the corresponding absorbers.

The analytical results of x-ray diffraction (XRD) patterns, field emission scanning electron microscope (FE-SEM), energy dispersive spectroscopy (EDS) and current-voltage characteristics will be discussed to investigate the effect of NaF flux on the CIS absorber formation and its cell performance.

Keywords: Thin film solar cell, CuInSe2, NaF, sodium fluoride, co-evaporation