The effect of copper concentration on CdS/CZTS heterojunction properties

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\textbf{Abstract} — Cu:ZnSnS\textsubscript{4} (CZTS) / CdS heterojunctions have been prepared by a successive deposition of CZTS and CdS thin films on glass substrates by spray pyrolysis and chemical bath deposition techniques respectively. The concentration of cupric chloride in the starting solution has been varied in order to investigate its influence on device properties. The realized CZTS/CdS heterojunctions were characterized by recording current and from 300 to 2500\textdegree C, the series resistance and the ideality factor of the device are deduced from I-V characteristics.

The performed I-V measurements as a function of temperature from the ambient to 100\textdegree C, the solution feeding rate was fixed at 10ml/h and the deposition time is 45min. Cadmium sulfide (CdS) was used as an n-type material, low cost solar cell absorbers to replace CIGS has attracted much attention. Among the materials that have been investigated, quaternary Cu:ZnSnS\textsubscript{4} (CZTS) and Cu:ZnSnSe\textsubscript{2} (CZTSe). CZTS has become the subject of intense interest because it is an ideal candidate absorber material for thin-film solar cells with an optimal band gap 1.5 eV, high absorption coefficient (>10\textsuperscript{4} cm\textsuperscript{-1}), abundant elemental components, and is adaptable to various growth techniques [2–9]. The energy conversion efficiency of CZTS based solar cells has increased from 0.66% in 1996 to close to 7% recently [8]; however, it is still well below the Shockley –Queisser limit 32% [10].

The present work deals with electrical properties of CZTS/CdS heterojunction deposited by spray pyrolysis and chemical bath systems. Series resistance, saturation and ideality factor of the device are deduced from I-V characteristics.

\textbf{II. EXPERIMENTAL}

CZTS films used in this work were prepared by using spray pyrolysis method. Aqueous solution containing \textit{CuCl\textsubscript{2}.2H\textsubscript{2}O} as source of Cu, \textit{Zn(C\textsubscript{2}H\textsubscript{3}O\textsubscript{2})\textsubscript{2}.2H\textsubscript{2}O} as source of Zn, \textit{SnCl\textsubscript{2}.2H\textsubscript{2}O} as source of tin and \textit{SC\textsubscript{2}(NH\textsubscript{2})\textsubscript{2}O} as sulfur source, were used in order to vary the Cu content in films the molarity of Cu salt was varied three values were used 0.005, 0.01 and 0.015M. Excess \textit{SC\textsubscript{2}(NH\textsubscript{2})\textsubscript{2}O} is required to prevent oxidation and S deficiency in CZTS film through the spray deposition. Aqueous solutions containing precursor elements were sprayed onto glass substrate heated at temperature of 280\textdegree C, the solution feeding rate was fixed at 10ml/h and the deposition time is 45min. Cadmium sulfide (CdS) was used as an n-type layer, which was synthesized using chemical bath deposition. The thicknesses of CdS and FTO were around 90 nm, 100 nm respectively.

Finally a small golden dots of 2cm\textsuperscript{2} were deposited onto absorber layer by DC sputtering system. I-V, characteristics of the realized devices were achieved by using Tektronix 370 curve tracer to visualize and recorder I-V curves. The I-V measurements were carried at different temperature from the ambient to 100 \textdegree C.

\textbf{III. RESULTS AND DISCUSSION}

Characteristic I-V is the principle characteristic of the heterojunction. The exploitation of this characteristic leads to certain parameters such as the saturation current, series resistance and the ideality factor. The electrical measurements were carried in dark at different temperatures.

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