

## Comparative study of heat-light soaking on KF- and CsF-treated CIGS solar cells

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**Introduction:** Alkali metal (like sodium, potassium, rubidium, caesium) deposition after CIGS growth, which is generally called as post-deposition treatment (PDT), is a novel way of improving the efficiency of CIGS solar cells. Until now, a little is known on the effect of alkali-PDT. There are still a lot of properties to be revealed. With this motivation, we have investigated the effects of heat-light soaking (HLS) on KF- and CsF-treated CIGS solar cells.

**Experimental:** Around 3.0 $\mu$ m-thick CIGS thin films were deposited using a water-cooled molecular beam epitaxy system at a maximum substrate temperature of 530°C. KF- and CsF- PDT were performed on air-exposed CIGS thin films at a substrate temperature of 350°C. Before CdS deposition, alkali-metal-treated CIGS thin films were rinsed in DI water. CIGS solar cells were fabricated with MgF<sub>2</sub>/Ni/Al/ZnO:Al(300nm)/ZnO (100nm)/CBD-CdS (60nm)/ CIGS(2.9~3.0 $\mu$ m) /Mo /SLG structure. HLS of the solar cells was performed at 130°C under AM 1.5, for 30 minutes in air.

**Results and discussion:** As shown in Table 1, improvement in both  $V_{oc}$  and FF were observed in KF- and CsF-treated CIGS solar cells after HLS. The CsF-treated CIGS cell kept the initial  $J_{sc}$  value and the  $V_{oc}$  and FF increased, thereby the efficiency improved after HLS at 130 °C for 30 min. In contrast, the  $J_{sc}$  deteriorated slightly for the KF-treated CIGS cells, resulting in a smaller gain in efficiency as compared to CsF-treated cells.

This result suggests that the effect of HLS is much more effective on CsF-treated CIGS solar cells than that of KF-treated solar cells. Limited improvement in efficiency of KF-treated CIGS solar cell after HLS is due to the reduction of  $J_{sc}$ . HLS of KF-treated CIGS solar cells reduced EQE at long wavelength region as compared to CsF-treated CIGS solar cells. Furthermore, the EQE of CsF-treated cell was slightly large at short wavelengths as compared to the CIGS cell before HLS. Details such as SEM, J-V, C-V, and J-V-T measurements will be presented during the conference.

Table 1. Basic cell parameters of KF- and CsF-treated CIGS solar cells before and after HLS.

	KF-treated CIGS solar cell				CsF-treated CIGS solar cell			
	$V_{oc}$ (mV)	$J_{sc}$ (mA/cm <sup>2</sup> )	FF	Eff. (%)	$V_{oc}$ (mV)	$J_{sc}$ (mA/cm <sup>2</sup> )	FF	Eff
<b>Before HLS</b>	<b>781</b>	<b>31.0</b>	<b>0.749</b>	<b>18.1</b>	<b>758</b>	<b>30.9</b>	<b>0.756</b>	<b>17.7</b>
<b>After HLS</b>	<b>797</b>	<b>29.9</b>	<b>0.775</b>	<b>18.5</b>	<b>768</b>	<b>30.9</b>	<b>0.774</b>	<b>18.4</b>
<b><math>\Delta</math></b>	<b>+16</b>	<b>-1.1</b>	<b>+0.026</b>	<b>+0.4</b>	<b>+10</b>	<b>0</b>	<b>+0.018</b>	<b>+0.7</b>