INTERDIGITATED BACK-CONTACT SILICON HETEROJUNCTION SOLAR CELL FOR LIQUID PHASE CRYSTALLIZED SILICON ON GLASS WITH 14.2% EFFICIENCY

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Liquid phase crystallization of Si on glass is a promising technique to produce high quality multicrystalline Si with less cost and energy consumption compared to other conventional Si cells [1]. It has been demonstrated that an open circuit voltage ($V_{oc}$) of up to 652 mV and an efficiency ($\eta$) up to 13.2 % can be achieved for interdigitated back-contact silicon heterojunction (IBC-SHJ) cells of 13 µm n-type LPC-Si crystallized by using a line-shape CW-diode laser [2]. However, limitation of effective diffusion length ($L_{eff}$) (<30 µm) causes a short circuit current loss of 11 % at back surface field (BSF) region. In this work, we focus on optimization of geometry of IBC cell, particularly, variation BSF width ($W_{BSF}$). TCAD-SentaurusTM tool was used to simulate IBC cell performance. A relevant front surface recombination velocity ($SRV_{front}$) of 200 cm/s and bulk carrier lifetime ($\tau$) of 1 µs were used to simulate for doping concentration ($N_D$) of 8x10^16 cm^-3. The result shows that for the current state of the absorber quality $W_{BSF}$ of 60 µm is optimum value to get a high efficiency cell, as shown in Figure 2. In experiment, we fabricated real IBC-SHJ cells with $W_{BSF}$ of 60, 120 and 240 µm. SiO$_2$/SiNx/SiO$_2$ and SiO$_2$/SiNx/SiNx$_2$ stacked layer with SiNx$_2$O$_x$ layer prepared by N$_2$O plasma treatment were used as intermediate layers. Figure 3 shows J-V curves of real IBC-SHJ cells with various $W_{BSF}$. An efficiency as high as 14.2% can be achieved for 13 µm-thick n-type LPC-Si. This value can be equivalent to state of the art a-Si:H/µc-Si:H/µc-Si:H triple junction cell [3]. The best $\eta$ obtained for $W_{BSF}$ of 120 µm might be due to this cell locates on a better grain or less boundary area compared to cell with $W_{BSF}$ of 60 µm. A $V_{oc}$ up to 661 mV, which is comparable to $V_{oc}$ of the best multicrystalline Si cell, can be reached [4]. High fill factor ($FF$) of 75% was obtained owing to low contact resistance. These remarkable results were obtained thanks to improvement in passivation technique for front surface and absorber quality. By 2D-simulation, a $SRV_{front}$ of 100 cm/s and $\tau$ of 1.16 µs, which correspond to $L_{eff}$ of 26 µm, were determined for the absorber. This study indicates the high potential of LPC-Si on glass in thin film solar cell application.

**Figure 1. Cross sectional structure of an IBC cell.**

**Figure 2. Simulated efficiency at various $W_{BSF}$.**

**Figure 3. J-V curves of real IBC cells with various $W_{BSF}$.**