APPLICATION OF INKJET PRINTING TO BACK CONTACT PATTERNING OF THIN IBC-SHJ SOLAR CELLS

Hideyuki Takagishi1,2, Hiroshi Noge1, Kimihiko Saito1, Michio Kondo1,3

1Fukushima University, Japan, 2Japan Advanced Institute of Science and Technology, Japan, 3Fukushima Renewable Energy Institute, Advanced Industrial Science and Technology, Japan
e-mail: kimihiko-saitou@sss.fukushima-u.ac.jp

We have fabricated the interdigitated back contact silicon heterojunction (IBC-SHJ) solar cells on a thin silicon (Si) substrate by drawing the etching masks using inkjet (IJ) non-contact printing. Usually, the accuracy of IJ printing is inferior to that of photolithography (PL), therefore, the cell should have the overlap of p and n layer (OLn/p) in order not to etch the passivation layer in the patterning process and to have the enough margin between the edges of Indium Tin oxide (ITO) electrodes and of the doped layer (gap(p) and gap(n) for p and n layers, respectively) to prevent the electrical short. On the other hand, the 2D simulation predicts that widening of OLn/p decreases the short circuit current (Jsc) due to broadening the weakened drift field in Si under OLn/p. It becomes remarkable as the surface recombination velocity (SRV) becomes fast. The simulation also shows that widening of the gap(p) decreases Jsc owing to the high resistivity of amorphous Si (a-Si:H) p-layer. These properties were actually observed in the experiments as shown in Figure 1, where Jsc of the cells fabricated by IJ and PL patterning on the two groups of passivation with the SRV of 3–17 cm/sec and of 78–95 cm/sec decreases as the length of OLn/p + gap(p) increases and as the SRV increases. The optimization of IJ process by using the photoresist ink improved its printing accuracy within ±0.05 mm, which leads the minimum widths of OLn/p and gap(p) to be around 0.10 mm and 0.15 mm, respectively. Almost comparable current-voltage (I-V) characteristics of the IBC-SHJ cell fabricated by the IJ patterning process to those fabricated by PL were obtained as shown in Figure 2. Furthermore, we have successfully fabricated the IBC-SHJ cells with the efficiency of 10.7% by the direct printing of IJ masks on the free-standing flat substrate with the thickness of 53 μm and the size of 50 mm × 19 mm.

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References:

Figure 1. OLn/p+gap(p) length dependence of Jsc with the two groups (lines for eye guide) of passivation quality. Cross sectional diagram of the fabricated cell structure is also illustrated indicating OLn/p and gap(p).

Figure 2. I-V characteristics of the cells fabricated by IJ and PL patterning processes.