Applying selective emitter to industrial PERC cells using a screen-printed resist masking combined with wet chemical etch-back process

Supawan Joonwichien, Yasuhiro Kida, Satoshi Utsunomiya, Maasaki Moriya,
Katsuhiko Shirasawa, and Hidetaka Takato
National Institute of Advanced Industrial Science and Technology (AIST)
E-mail: s-joonwichien@aist.go.jp

We report on our attempt to improve the performance of passivated emitter and rear cell (PERC) performance by introducing a selective emitter technology using a screen-printed resist masking combined with wet chemical etch-back process. Applying selective emitter concept is aimed to decrease the recombination losses at the front surface of the cell. Two types of PERC cell with different structures are sketched in Fig. 1.

A heavily doped emitter (n^{++}) region with a sheet resistance (R_{sheet}) of 60 Ω/sq was initially formed on the 200-μm thick 2.0-2.2 Ω-cm p-type CZ-Si wafers, after texturing and cleaning processes. The screen-printed acid resist masking is then printed on the areas intended for front Ag metallization, aiming to protecting the n^{++} regions during wet chemical etch-back process to form selective emitter. This etch-back process can be done by immersing the samples into an etching solution to obtain selectively etched-back regions (lightly doped emitter, n^{+}).[1] The final R_{sheet} of n^{++} regions depends on the etching times. The mask was subsequently stripped, resulted in n^{+} regions with R_{sheet} values of 158 Ω/sq. Then, the samples were fabricated and the processing sequence of PERC cells is already reported elsewhere.[2]

Resultantly, the selective emitter structure has greatly impacted the performance of PERC cell, showing an increase in the open-circuit voltage (V_{oc}) by 10 mV, and the short-circuit current density (J_{sc}) by 0.3 mA/cm^2, but a decrease in fill factor (FF) by 1.5%, compared to the homogeneous emitter cells. The increased V_{oc} and J_{sc} mainly attributed to the reduced emitter saturation current density (J_{0e}) in the n^{+} regions. The decline in FF is due to the higher sheet resistance in the n^{+} regions, resulting higher series resistance (R_s). To improve FF, a narrower front-side Ag finger spacing should be modified in order to reduce the R_s. These results suggest that selective emitter concept is a very promising technology to improve the conversion efficiency of the industrial-sized PERC solar cell.

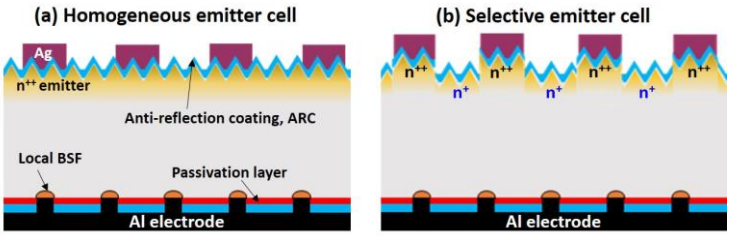

Fig. 1. PERC cell with (a) homogeneous emitter structure, and (b) selective emitter structure.

1. Y. Tao *et al.*, *Appl. Phys. Lett.* 110 (2017) 021101.

2. S. Joonwichien *et al.*, *Proceedings of 32nd EUPVSEC* 2016, 660-663.