A Maskless Patterned Plasma Etching Process for Silicon Heterojunction Interdigitated Back Contact Cells

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The combination of a-Si:H/c-Si heterojunction (HJT) passivated contacts with an interdigitated back contact (IBC) architecture currently produces the record efficiency for crystalline silicon PV devices [1]. This enhancement in efficiency comes at the cost of more complex and expensive fabrication, and so this design is not currently industrially implemented.

We have developed a novel, contactless patterning technique to form the doped fingers required for IBC architectures [2]. The technique involves using a patterned powered RF electrode in a custom-designed RF-PECVD chamber to perform localized etching on a well-designed stack, also deposited by PECVD (as shown in Figure 1), targeting a high-performance, low-cost IBC HJT structure.

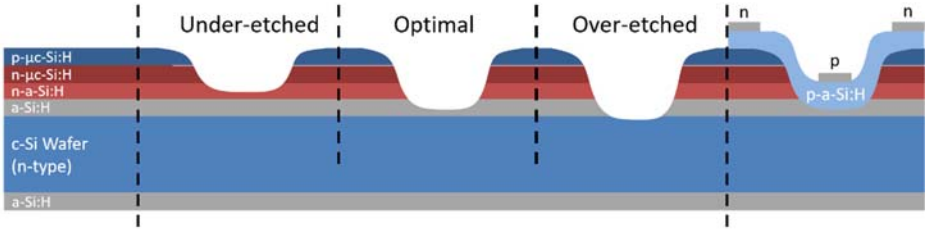

Fig. 1. Schematic of process. Layer stack (including recombination junction) must be optimally etched before final p-layer is deposited.

In this presentation, we will demonstrate how we have performed the contactless optimization of the entire process using spectroscopic ellipsometry, photoluminescence (PL), and surface photovoltage measurements (done with a macroscopic scanning Kelvin probe performed under dark and illuminated conditions). These measurements enable one to see the etching depth accuracy, zones of degraded passivation, and the effectiveness of the doped regions in generating a V_{OC} under illumination (as shown in Fig. 2). We demonstrate using rudimentary co-planar contacting that optimization of the structure using these measurements also optimizes the devices' current-voltage characteristics and photovoltaic performance.

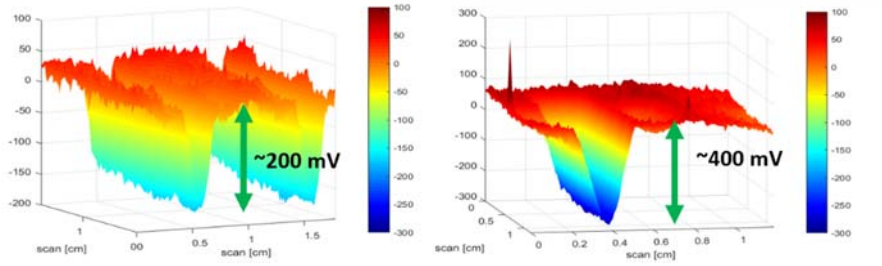

Fig. 2. SPV measurements of two samples using different etching parameters. Cell showing greater ΔV also shows vastly greater photovoltaic performance.

[1] Yoshikawa et al., "Silicon heterojunction solar cell with interdigitated back contacts for a photoconversion efficiency over 26%," Nat. Energy, vol. 2, p. 17032, Mar. 2017.

[2] R Léal, B Bruneau, P Bulkin, T Novikova, F Silva, N Habka, and EV Johnson, Maskless and contactless patterned silicon deposition using a localized PECVD process, Plasma Souces Sci. Tech. 29 (2020) 025023. DOI: 10.1088/1361-6595/ab5e2c