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Next – generation interdigitated back-contacted silicon heterojunction solar cells and modules by design and process innovations

NextBase - Deliverable report

D5.1- Selection of suitable patterning schemes for > 26.0 %-efficient devices

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Publishable summary

The NextBase project aims at demonstrating an IBC-SHJ device with > 26.0 % efficiency using lab-scale processes. Along these lines, several patterning techniques have been investigated, namely photolithography, various laser-based patterning techniques, and shadow-masking. These techniques were benchmarked regarding (i) the minimum width of the patterned features, (ii) the shape of the patterned features, and (iii) the number of process steps required to pattern a given layer. Photolithography demonstrated features down to 5 µm in width, laser patterning down to 50 µm, whereas shadow-masking resulted in features in the range of 300 to 600 µm in width. The shape of the patterned features was found to greatly differ between the different patterning schemes. Whereas a perfectly or nearly perfectly accurate shape is achieved for most of the photolithography- and laser-based features, shadow-mask patterning results in strongly tapered and shadowed fingers. Interestingly however, several experimental levers, such as PECVD deposition parameters and shadow-mask properties were found to efficiently mitigate these tapering effects. The number of patterning process steps shows a great variation among the investigated techniques. For photolithography, more than 10 steps are required to pattern a single layer. Laser-based patterning requires from 2 to 7 steps depending on the approach. Shadow-mask patterning is clearly the simplest one, especially when combined with a tunnel-IBC architecture, as in this case both the electrons and the holes collecting layers are patterned in one single step.

Since the kick-off of the NextBase project, regular progresses have been recorded with each patterning technique. As of March 2018, shadow-mask-based IBC-SHJ devices demonstrated up to 24.1 % efficiency, photolithography-based ones up to 23.3 %, and laser-based ones up to 22.5 %. The learning rates over this time frame are within 1 to 2 %/year for all the investigated patterning techniques, therefore giving confidence that the final WP5 deliverable of 26.0 % efficiency is within reach in the project schedule.

Eventually, it was found that no down selection of the patterning schemes is required at this stage of the project, as all of them feature interesting assets in the chase to 26.0 % efficiency. Rather, the NextBase partners will focus on reducing the transport losses at the hole collecting hetero contact, as these losses were found to be the limiting factor towards the achievement of IBC-SHJ devices with > 26.0 % efficiency.