2010 Taste of Research Summer Scholarship Program

High Efficiency Inkjet Printed Solar Cells

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Research Theme: Resources and Infrastructure for the Future

Background

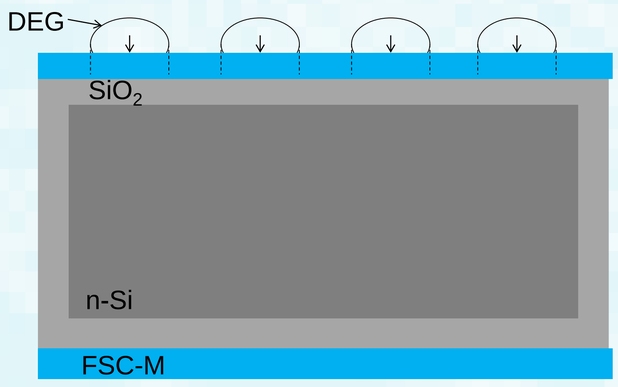
For photovoltaic cells to become a viable source of renewable energy, high efficiency devices must be created at lower costs. Existing high efficiency devices currently require expensive patterning techniques. Inkjet printing is a potential alternative to these techniques.

Aim

To explore the issues associated with using inkjet printing methods to create solar cells with both selective emitters (for enhanced current collection) and surface texturing (for increased light trapping).

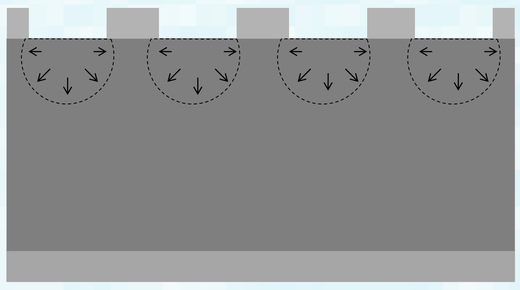
Method

• Silicon wafers with a thick oxidized layer (SiO_2) of ~0.6μm were spin coated with HMDS followed by Microposit FSC-M resist. A FUJIFILM Dimatix Materials Printer (DMP-2831) was used to uniformly deposit 1pL droplets ~70 μm apart of DEG on the wafer surface.

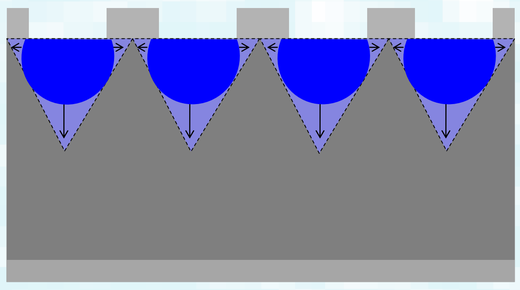


•The DEG plasticized the printed regions of the FSC-M so that buffered HF could selectively etch through the SiO_2. The resist was also removed with a 'piranha' etching solution.

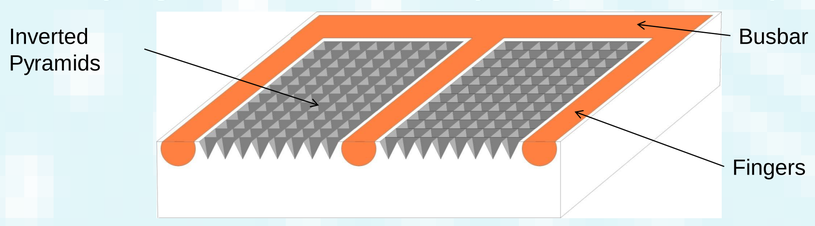
•Each wafer was isotropically etched using HNO_3 and HF until there were holes in the silicon ~5μm apart.



•These hemispherical holes were then anisotropically etched into pyramids using a 20% KOH solution.



•The cells were lightly doped with phosphorus, re-oxidised to a thickness of ~3μm and re-spun with HMDS and FSC-M. A pattern for fingers and busbar (to form the selective emitter) was printed and the underlying oxide etched away to give the final pattern.



Results

•The DEG ran unevenly around the pyramids and therefore did not form straight lines or smudged in some places as in figure 1.

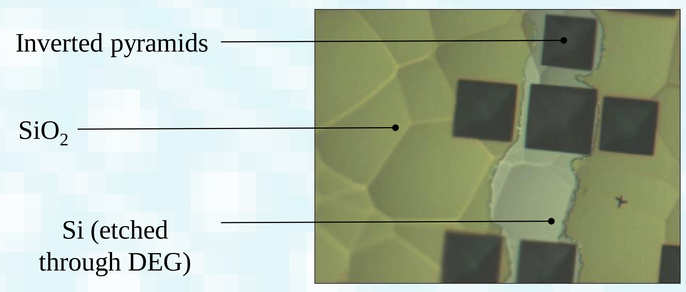


Figure 1. DEG runs unevenly around the inverted pyramids.

•FSC-M did not spin into all of the pyramids causing the oxide to be etched in unwanted areas which is evident in figure 2.

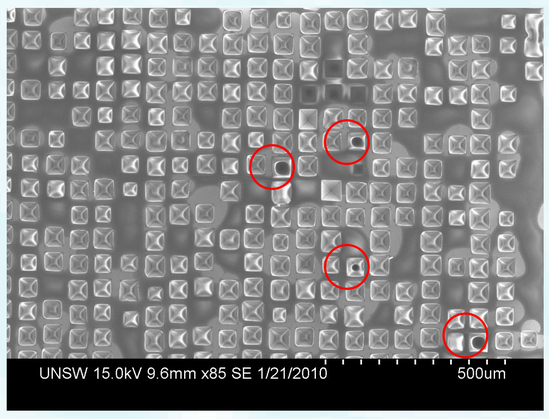


Figure 2. SEM image of cell surface after spin coating. Holes indicate missing FSC-M from inside of pyramid.

•DEG pooled into pyramids leaving the oxide at the edges un-etched as evident in figure 3.

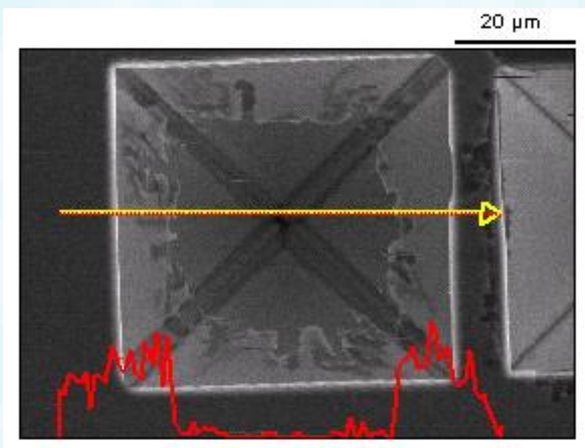


Figure 3. SEM micrograph of a single pyramid. The red line indicates the amount of oxygen across the arrow above. Notice that the oxide layer remains at the edges of the pyramid.

Conclusion

Inkjet printing can be used to create a selective emitter and surface texturing when developing high efficiency solar cells. However using both techniques on a single wafer presents many issues resulting in undesirable etching. With further research, inkjet printing will be a potential solution to reducing costs involved with high efficiency cell production.

Acknowledgements

Borojevic N, 2008, "Inkjet texturing for high efficiency commercial silicon solar cells", *Proceedings of 23rd European Photovoltaic and Solar Energy Conference (Valencia).*

Utama R, 2009, "Inkjet Printing for Commercial High Efficiency Solar Cells," *PhD Thesis*, University of New South Wales, Kensington.

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