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Microfabrication of Thin-Film Solar Cell Contacts Through Photolithography

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Solar energy has emerged as an inexpensive and powerful means for clean energy production and draws much research interest. In particular, thin-film solar cells often rely on the use of permanent shadow masks to pattern their front metal contacts for energy transport. However, these machined masks are not adjustable, and currently limit the scope of experimentation. In addition, the essence of fabricating these contacts lies in generating grids thin enough for optimization, which helps advance higher device efficiencies. Thus, a need for a more versatile method arises. Photolithography, traditionally used in the micro-conductor industry, provides a method of fabricating flexible and readily interchangeable contact designs onto thin-film solar cells. First, the photoresist is applied through spin-coating onto a molybdenum or tin-doped indium oxide (ITO) layer. Second, the photoresist is exposed in a dark environment using high-intensity, full-spectrum light in order to polymerize the photoresist according to the pattern on the photomask. Third, the photoresist is developed and deposited with Ni/Al as metals for the contacts. Finally, the photoresist is stripped through sonication in solution, while leaving the desired contacts intact. Parameters were optimized at each step of the process to determine the optimal conditions for generating smaller grid designs with feature sizes on the micro-scale. Overall, the results show promise for the implementation of photolithography in engineering more efficient thin-film solar cells through the technique's flexibility, affordability, and precision. Future work will establish these findings through device efficiency comparisons using photolithography and traditional methods.

Research advisor Rakesh Agrawal writes, "Yusheng's work leads to the ability to create more efficient solar cells by optimizing the grid patterns on completed devices. His work creates an excellent starting point for future photolithography projects in our lab and replaces current inflexible and limiting grid deposition techniques."

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