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# Modeling and characterization of high-efficiency silicon solar cells fabricated by rapid thermal processing, screen printing, and plasma-enhanced chemical vapor deposition

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**Abstract:**

This paper presents, for the first time, the successful integration of three rapid, low-cost, high-throughput technologies for silicon solar cell fabrication, namely: rapid thermal processing (RTP) for simultaneous diffusion of a phosphorus emitter and aluminum back surface field; screen printing (SP) for the front grid contact; and low-temperature plasma-enhanced chemical vapor deposition (PECVD) of SiN for antireflection coating and surface passivation. This combination has resulted in 4 cm/sup 2/ cells with efficiencies of 16.3% and 15.9% on 2 /spl Omega/cm FZ and Cz, respectively, as well as 15.4% efficient, 25-cm/sup 2/ FZ cells. Despite the respectable RTP/SP/PECVD efficiencies, cells formed by conventional furnace processing and photolithography (CFP/PL) give /spl sim/2% (absolute) greater efficiencies. Through in-depth modeling and characterization, this efficiency difference is quantified on the basis of emitter design and front surface passivation, grid shading, and quality of contacts. Detailed analysis reveals that the difference is primarily due to the requirements of screen printing and not RTP.

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