

FRONT METALLIZATION FOR NEXT GENERATION CRYSTALLINE SILICON SOLAR CELLS

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Currently, several metal contact fabrications techniques are commonly used for industrial solar cell front metallization, but each has its own limitations. Screen-printing is normally used for commercial silicon solar cells and allows for speedy metallization at relatively low cost. Nevertheless, there are several unwanted features such as low aspect ratio of the grid lines which creates large shading area on the front of the PV devices, and a high line resistance which lowers the final efficiency. Photolithography and metal evaporation techniques are often used for high efficiency cells since they offer improved gridline quality, however the processes are time-consuming and expensive. For the next generation of crystalline silicon solar cells when the wafer size increases from 100 cm² to 243 cm², a low cost metallization with low resistivity and high aspect ratio is needed.

Recently, light induced electroplating (LIP) of silver (Ag) metal on top of the front contact grid has shown promise in reducing line resistance and increasing cell power output but received limited acceptance in the industry due to the cost of plating a precious metal layer, Ag. The feasibility of using this LIP technique to plate non-precious metals, such as nickel (Ni), copper (Cu), or tin (Sn) is well desired for PV fabrication process due to the ease of the process and the use of a lower cost material. Cu has higher electrical conductivity compared to Ag and is much cheaper material.

We developed a two-layer metallization process that deposited Cu as current-carrying electrodes by LIP technique on thin screen-printed Ag paste seed layers. A Ni layer was also deposited by LIP as the barrier and Cu adhesion layer. By optimizing the thickness of the plated Ni and Cu layers, line resistivity of 1.75 $\mu\text{Ohm-cm}$ comparable to that of bulk Cu, 1.68 $\mu\text{Ohm-cm}$ and bulk silver (Ag), 1.59 $\mu\text{Ohm-cm}$ was achieved. A 25% increase in fill factor was also achieved due to the reduction in the solar cells series resistance. We also found that Ni layer played much bigger role than being just a barrier layer to the overall line resistivity.