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Introduction of Lithium into the Front Surface of Solar Cells

The problem:

Techniques for fabricating lithium-doped solar cells ordinarily require application of lithium to the back surface of the cell and use of rather severe temperature–time cycles to diffuse sufficient lithium into regions near the front surface. Moreover, the resulting gradient of lithium (decreasing toward the front surface of the cell) is such that the ionized lithium atoms can be moved toward the P-layer by the high electric field around the PN junction.

The solution:

Introduce lithium through the front surface; a less severe time–temperature cycle is needed to provide sufficient lithium in the active regions of the cell. Also, the gradient of lithium now decreases toward the back surface and may be less subject to alteration by the PN junction field.

How it's done:

A slice of N-silicon is first treated to form a P-layer by boron diffusion, for if the lithium were to be introduced first, the high temperature required for boron diffusion would remove most of it and form a lithium atom gradient that would decrease toward the front of the cell. Lithium is then introduced through the boron layer from a source that provides sufficient lithium atoms for diffusion but which will not seriously degrade PN junction properties. For this purpose, there is required a source which does not form large aggregates of lithium; lithium vapor itself or vaporized lithium compounds dispersed in inert carriers are satisfactory. Although these lithium sources will not degrade the P-layer significantly, lithium at high temperature attacks front contacts and coatings; thus, they must be applied after lithium diffusion. Unfortunately, because of the volatility of lithium, contacts and coatings cannot be sintered as usual; however, the properties of unsintered contacts and coatings have been found to be acceptable. Further development of this type of solar cell structure may require use of contacts and coatings that do not need to be sintered.

The lithium concentrations in the body of the cell that are obtained by the front diffusion process in 10 minutes at 425°C are similar to those obtained by diffusion from the back in 45 to 90 minutes at 425°C. It has been found, however, that if some lithium is diffused into the cell from the back surface, cell output is improved. This short diffusion of lithium from the back can be performed simultaneously with the front surface diffusion. Measurements of the lithium concentration profile obtained by front diffusion agreed with theory, except very near the front surface where the atom concentration was found to fall off – perhaps because of a reverse diffusion that occurs during processing of the cells.

Notes:

1. The gradient of lithium atoms produced by front diffusion (decreasing toward back surface) is more matched to the probable density of defects introduced by irradiation; superior cell performance may be observed.

(continued overleaf)

2. Requests for further information may be directed to:

   Technology Utilization Officer
   NASA Pasadena Office
   4800 Oak Grove Drive
   Pasadena, California 91103
   Reference: B72-10086

Patent status:

No patent action is contemplated by NASA.

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under contract to
NASA Pasadena Office

(NPO-11404)