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Strategy and technology to recycle wafer-silicon solar modules

Wen-Hsi Huang ^a ... Meng Tao ^b

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Highlights

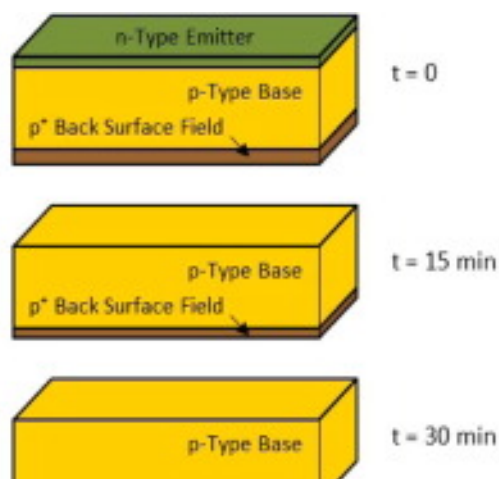
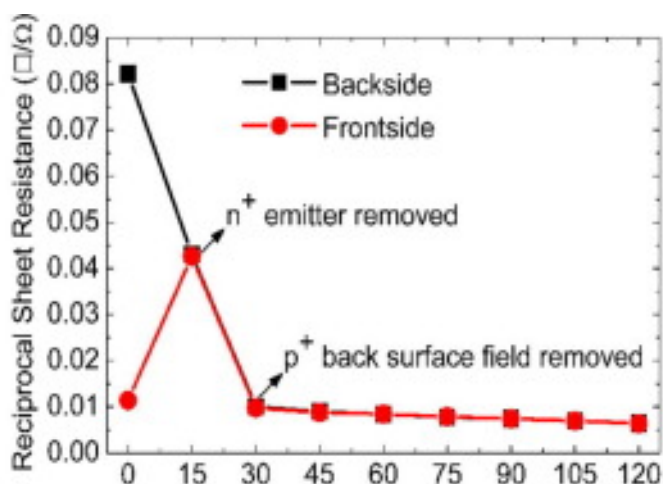
- A multi-step process proposed for profitable recycling of wafer-Si solar modules.
- Sequential electrowinning to extract valuable/toxic metals one by one from modules.
- Sheet resistance monitoring to maximize the amount of solar-grade Si recovered.
- Recovered Si and Ag are new feedstocks to the industry generating \$11–12/module.

Abstract

A major obstacle to sustainable solar technologies is end-of-life solar modules. In this paper, a recycling process is proposed for wafer-Si modules. It is a three-step process to break down Si modules and recover various materials, leaving behind almost nothing for landfill. Two new technologies are demonstrated to enable the proposed recycling process. One is sequential electrowinning which allows multiple metals to be recovered one by one from Si modules, Ag, Pb, Sn and Cu. The other is sheet resistance monitoring which maximizes the amount of solar-grade Si recovered from Si modules. The purity of the recovered metals is above 99% and the recovered Si meets the specifications for solar-grade Si. The recovered Si and metals are new feedstocks to the solar industry and generate \$11â€“12.10/module in revenue. This revenue enables a profitable recycling business for Si modules without any government support. The chemicals for recycling are carefully selected to minimize their environmental impact. A network for collecting end-of-life solar modules is proposed based on the current distribution network for solar modules to contain the collection cost. As a result, the proposed recycling process for wafer-Si modules is technically, environmentally and financially sustainable.

Graphical abstract

A multi-step process is proposed to break down Si modules and recover almost all the materials. New technologies are demonstrated for the recycling process including sequential electrowinning to recover multiple metals one by one from Si modules, Ag, Pb, Sn and Cu, and sheet resistance monitoring to maximize the amount of solar-grade Si recovered from Si modules. The recovered Si and metals are new feedstocks to the solar industry. They generate \$11â€“12/module in revenue to cover the cost of recycling.



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Keywords

Wafer-Si solar modules; End-of-life Si solar modules; End-of-life management; Recycling

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