

Materials Science & Engineering Doctoral Defense

Recycling Valuable Materials from Crystalline-Si Solar Modules

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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. Over 95% of a module by weight can be recovered with this process. 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 over \$12/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.

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