

Physical and Chemical Beneficiation for Recycling of Photovoltaic Materials

A new generation of low-cost products based on thin films of photoactive materials (e.g., amorphous silicon, copper indium diselenide (CIS), cadmium telluride (CdTe), and film crystalline silicon) deposited on inexpensive substrates, increase the prospects of rapid commercialization. The PV industry has adopted a pro-active and long-term strategy to preserve the environmentally friendly nature of the industry. Manufacturing solar panels, especially CdS/CdTe thin-film PV modules, presents some health, safety and environmental (HSE) concerns which were the focus of numerous studies. One issue is decommissioning of PV modules at the end of their use. Modules are expected to last about 30 years and then will have to be decommissioned and disposed or re-used in some way [1]. Therefore, waste problems resulting from the large spread of solar cell modules, will most likely occur in the future.

Some of the major elements or compounds used in photovoltaic cells are cadmium, selenium, tellurium and indium. Cadmium is the principal material used in the process of making photovoltaic cells, particularly CdTe modules, and is a secondary component in CIS photovoltaic modules. CIS photovoltaic modules generally contain between 5 and 14g of Cd or Se per square meter of module. CdTe modules contain between 7 and 12g of Cd or Te per square meter of module.

Photovoltaic (PV) module waste is expected at two levels: (a) in-plant generated manufacturing waste and (b) end-of-life module waste. An efficient module recycling method can reduce the environmental impacts of manufacturing waste as well as end-of-life module waste and recover the materials for future use [3,4]. A typical PV module manufacturing facility generates a significant amount of scrap at the start of its operation but, within a few months to a year, reaches a steady-state level of production generating relatively little waste. The manufacturing waste typically includes CdS, CdTe and various nonstoichiometric mixtures containing Cd, Te and Zn.

Project objective:

The objectives of this research program were to evaluate and develop innovative PV recycling technologies. Recycling technologies are divided into three general categories: physical beneficiation, hydrometallurgical processing and pyrometallurgical processing.

The research team with the industrial members, critically evaluated the use of physical and chemical beneficiation on PV scrap. Based upon these discussion, two aspects were identified that served as the basis for this project: design for delamination of thin films and the utilization of pyrometallurgical approaches to recycling PV scrap.