



End-of-Life Management of Photovoltaic Panels: Trends in PV Module Recycling Technologies

Introduction

- When a product cannot be repaired or reused, recycling is the next best option.
- In the case of PV modules, recycling has become an important emerging topic and various activities have been conducted and developed.
- The purpose of this study is to provide an international survey of trends related to the development of PV module recycling technology.

Approach

- Patent analysis
 - Database used: online WIPS (worldwide intellectual property service) system covering Jan. 6, 1976 – Dec. 9, 2016.
 - Countries covered: EP, DE, FR, GB, US, CN, JP, KR, and the PCT
- Overview of technology R&D
 - Survey of literature published by firms implementing R&D projects.



Patent Analysis

• Procedure

Initial search → 6,465 patents → Screening → 178 effective patents* → analysis (based on targeted components, processing method, and recovered materials)

*directly related to PV recycling

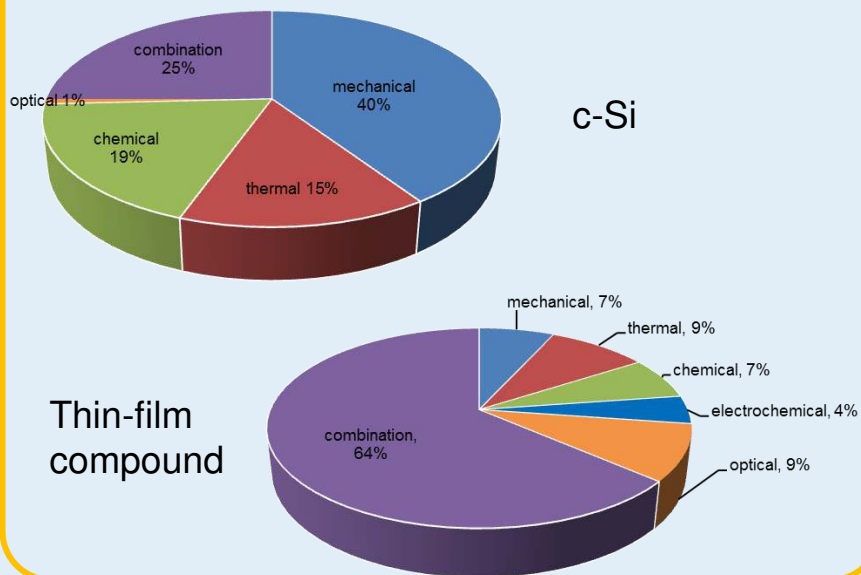
• Analysis results

c-Si – 128 effective patents

- 45% focusing on module separation
- Mechanical method for 40%
- Many patents for recovery of components, not for recovery of individual materials.

Thin-film compound – 44 effective patents

- High value recycling recovers higher fraction of the mass
- Combination method for 64%
- Total recycling from module separation to material recovery.

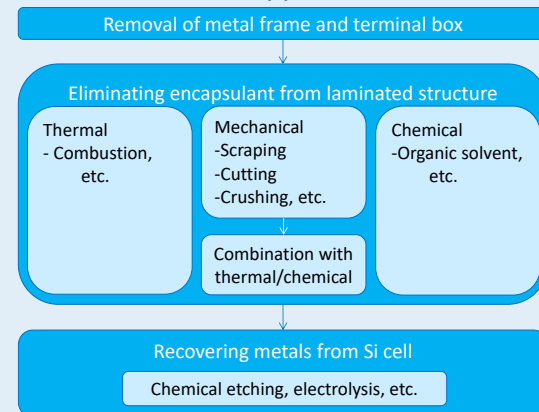


Overview of Technology R&D

Delamination is a key recycling step including:

c-Si

- Separation and recovery of glass, Si cells, and other metals
- Thermal, mechanical and chemical approaches can be used.



Thin-film compound

- Recovery of cover and substrate glass with the semiconductor layer
- Thermal, mechanical and optical approaches can be used.

