Cleaning Up Clean Energy: Sustainable End-of-Life for Photovoltaic Panels

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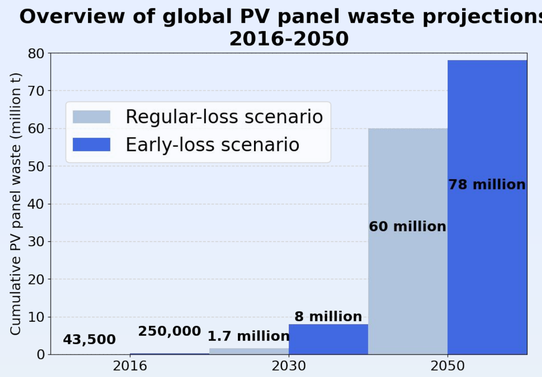
Motivation

Photovoltaic waste is an emerging and urgent issue. By 2050, projections estimate as much as 80 million tons of waste worldwide[1].

Developing cost-effective, environmentally sound recycling methods is a challenge, with many methods being destructive and toxic. Key steps in this process include:

- Panel disassembly
- **Dissolution ethylene vinyl acetate (EVA)**
- Purification of silicon wafers



An adapted figure of projections of photovoltaic waste mass into 2050[1].

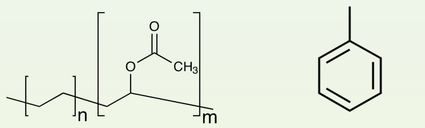
Methodology

How can we develop and test a sustainable, cost-effective process for recycling photovoltaic cells?

Solvent Testing Procedure

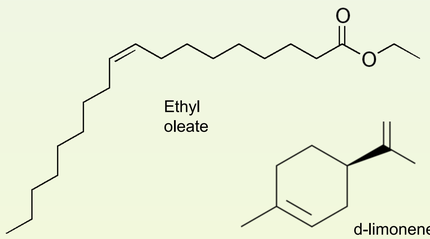
EVA film or solar panel piece → Record initial weight → Immerse piece in solvent at **70 ºC for 5 h** → Weigh remaining material once dry

Chosen solvents



Ethylene-vinyl acetate (EVA)

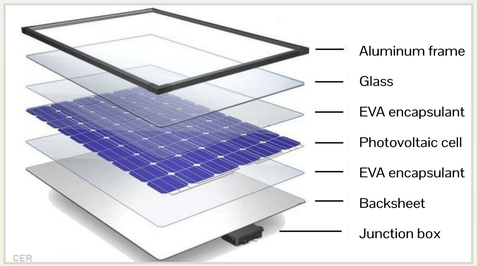
Toluene



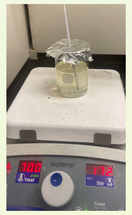
Ethyl oleate

d-limonene

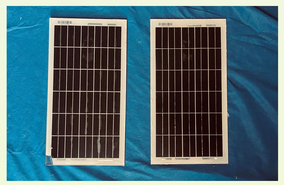
Solvent selection criteria included **low toxicity** and **chemical similarity to toluene** based on the Hansen Solubility parameters.



The anatomy of a standard silicon photovoltaic panel[2].



Thermal testing setup.



Disassembled panels.

Current Results and Analysis

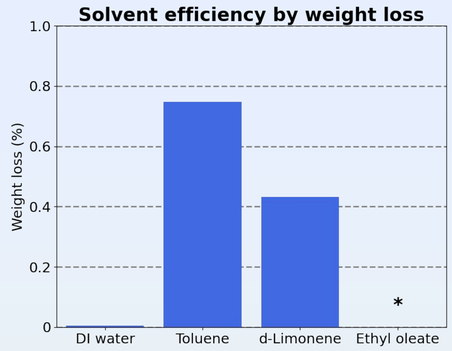
Solvents

DI water: Control.

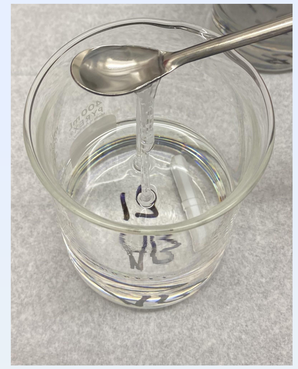
Toluene: Highly effective solvent based on literature.

d-Limonene: Trial solvent with fewer environmental hazards than toluene.

Ethyl oleate: Additional low-hazard trial solvent.



Change in EVA film mass after five hours in various solvents at 70ºC.
*Ethyl oleate resulted in a gain in weight.



EVA in the later stages of toluene treatment.

Preliminary data shows that d-Limonene could serve as a lower-toxicity alternative to toluene for EVA removal. Ethyl oleate, however, proved ineffective.

Future Plans

Additional solvent testing

- Investigation of 1-2 additional alternative solvents using solubility parameters for selection
- Solvent treatments on full panels (small size) with the goal of recovering intact wafers

Thermal treatment

- Pre-gasification thermogravimetric analysis and on EVA to determine decomposition behavior and compounds released
- Gasification/pyrolysis of EVA and panel

Alternative polymer testing

- Selection (and potential testing) of an alternative polymer that is easier to remove than EVA, or a more resilient encapsulant

References and Socials

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