Possibilities for the concentration of silver in the recycling of photovoltaic panels

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Introduction

Photovoltaic (PV) solar panels are one of the most promising technologies for renewable energy production. The installation of PV panels started two decades ago and increased massively in recent years, with a huge boom in 2017 (Chowdhury, 2020). In 2022, the installed capacity of PV was 1,053 GW worldwide. Nowadays, the silicon type of panels dominates the market (Włodarczyk, 2022). The lifetime of PV is estimated at 25 years. It is expected that the total amount of end-of-life PV panels will reach 9.57 million tonnes by 2050 (Xu, 2018). Silicon PV consists of silicon wafers, metal conductors, a glass cover and polymers that act as adhesives (see Figure 1). The recycling of PV panels is complicated by their multilayer and multi-component nature. The panel is a thin sheet and the individual layers, five in total, are tightly bonded together. The most valuable components are the silicon solar cells and the metal conductors. A rough mass balance of PV is shown in Figure 2, but it is clear that the bulk of the value is in the metals, especially silver (Peplow, 2022).

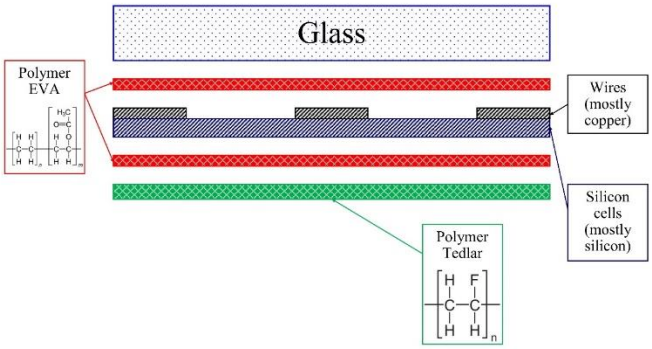

Figure 1. Structure of a silicon-type solar photovoltaic panel.

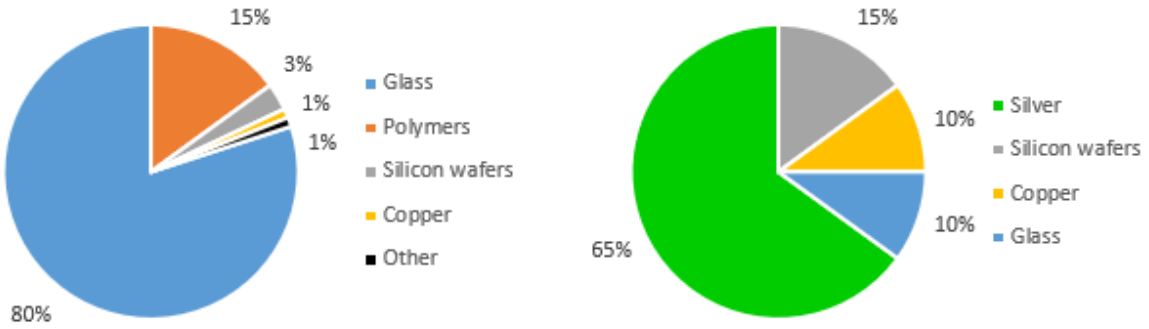

Figure 2. Mass balance (left) and economical balance (right) of PV panel components

There are different methods and approaches for PV recycling, as shown in a comprehensive review by Xu et al. (Xu, 2018). Dismantling is a critical step in terms of the utilisation of the produced materials, for example, the utilisation of glass is partly determined by its particle size. Chemical processes, mainly using organic solvents to dissolve EVA and glue, are often studied, but industrial utilisation is rather limited. Thermal treatment is also often considered. Various types of crushing or grinding, whether of whole PV or selected parts, can also be used as a first step in the recycling process. In this case, mechanical or hydrometallurgical treatment is required as a second step for efficient separation and recovery of multi-material grit. In our work we have focused on the up-concentration of silver using a Knelson separator from the fine fraction obtained from a pilot scale PV crushing process.

Materials and methods

A Knelson separator was used for the experiments (see scheme in Figure 3). The principles of separation can be found elsewhere (Chen, 2020).

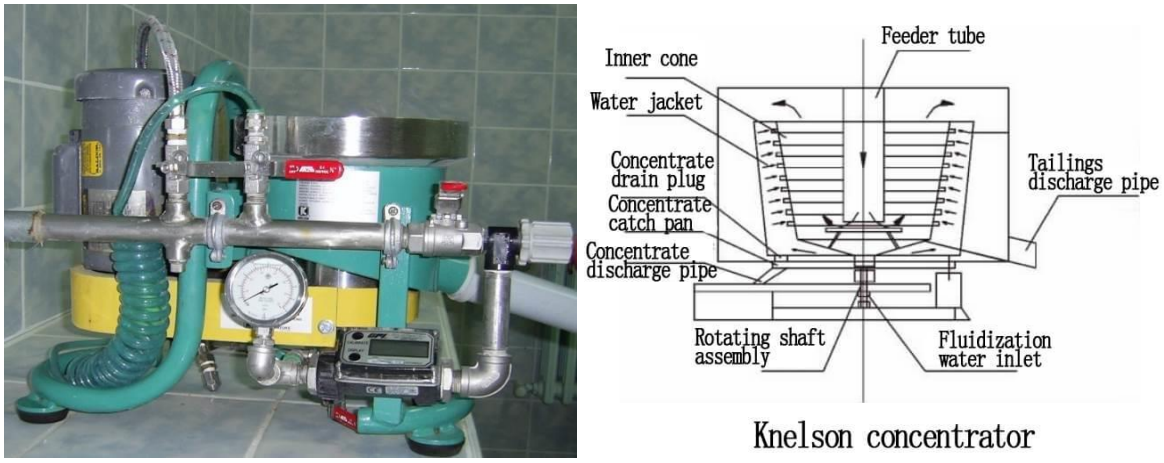

Figure 3. Knelson separator and schematic operating principle of it

Results and discussion

The fine dust fraction from the crushing of PV panels was used as the input fraction for the treatment. The silver content of this fraction was 3-5 g/kg. One-step Knelson treatment using standardised operating parameters allows 6-fold up-concentration with recoveries of around 50%.

The presentation will summarise all other results and outline further steps for process optimisation as well as the overall approach for PV panel recycling.

Acknowledgements

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