Gentle method allows for eco-friendly recycling of solar cells

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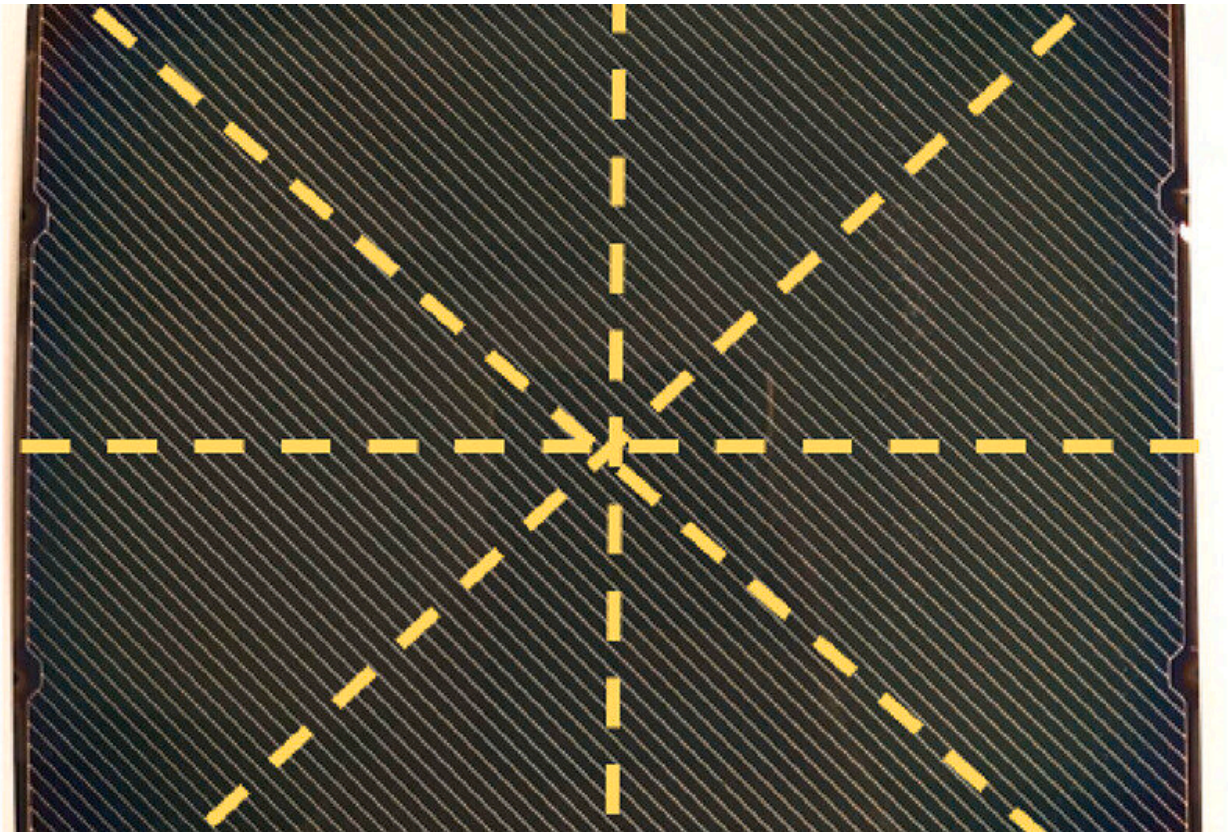

a) Division of a flexible CIGS solar cell (15.6 × 15.6 cm^2) into 8 identical samples and b) the way of cutting further each sample used in the experiments. Credit: *Solar Energy Materials and Solar Cells* (2023). DOI: 10.1016/j.solmat.2022.112178

By using a new method, precious metals can be efficiently recovered from thin-film solar cells. This is shown by new research from Chalmers University of Technology, Sweden. The method is also more environmentally friendly than previous methods of recycling and paves the way for more flexible and highly efficient solar cells.

Today there are two mainstream types of solar cells. The most common is silicon-based and accounts for 90% of the market. The other type is called thin-film solar cells which in turn uses three main sub-technologies, one of which is known as CIGS (copper indium gallium selenide), and consists of a layer of different metals, including indium and silver. Thin-film solar cells are by far the most effective of today's commercially available technologies. They can also be made bendable and adaptable, which means that they can be used in many different areas.

The problem is that the demand for indium and silver is high, and increased production is accompanied by a growing amount of production waste, which contains a mixture of valuable metals and hazardous substances. Being able to separate attractive metals from other substances, therefore, becomes extremely valuable, both economically and environmentally, as they can be reused in new products.

"It is crucial to remove any contamination and recycle, so that the material becomes as clean as possible again. Until now, high heat and a large amount of chemicals have been used to succeed, which is an expensive process that is also not environmentally friendly," says Ioanna Teknetzi, Ph.D. student at the Department of Chemistry and Chemical Engineering, who together with Burcak Ebin and Stellan Holgersson published their new results in the journal *Solar Energy Materials and Solar Cells.*

Now their research shows that a more environmentally friendly recycling

process can have the same outcome.

"We took into account both purity and environmentally friendly recycling conditions and studied how to separate the metals in the thin-film solar cells in acidic solutions through a much 'kinder' way of using a method called leaching. We also have to use chemicals, but nowhere near as much as with previous leaching methods. To check the purity of the recovered indium and silver, we also measured the concentrations of possible impurities and saw that optimization can reduce these," says Teknetzi.

The researchers showed that it is possible to recover 100% of the silver and about 85% of the indium. The process takes place at room temperature without adding heat.

"It takes one day, which is slightly longer than traditional methods, but with our method, it becomes more cost-effective and better for the environment. Our hopes are that our research can be used as a reference to optimize the recycling process and pave the way for using the method on a larger scale in the future," says Ebin.

The method

1. The film from the solar cell is analyzed with respect to material, chemical composition, particle size and thickness. The solar cell is placed in a container with an acid solution at the desired temperature. Agitation is used to facilitate dissolution of metals in the acid solution. This process is called leaching.
2. Leaching effectiveness and chemical reactions are assessed by analyzing samples taken at specific times during the leaching process. The different metals are leached at different times. This means that the process can be stopped before all the metals begin to dissolve, which in turn contributes to achieving higher purity.

3. When the leaching is complete, the desired metals are in the solution in the form of ions and can be easily purified to be reused in the manufacture of new solar cells.

More information: Ioanna Teknetzi et al, Valuable metal recycling from thin film CIGS solar cells by leaching under mild conditions, *Solar Energy Materials and Solar Cells* (2023). DOI: 10.1016/j.solmat.2022.112178

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