ReSiLex

Newsletter

Year #2 update | July 2024

Development of technological solutions for reusing Silicon, recycling PV modules and designing new products

The RESILEX project has just concluded its second year of activities. Here we are summarizing the achievement so far and the ongoing work.

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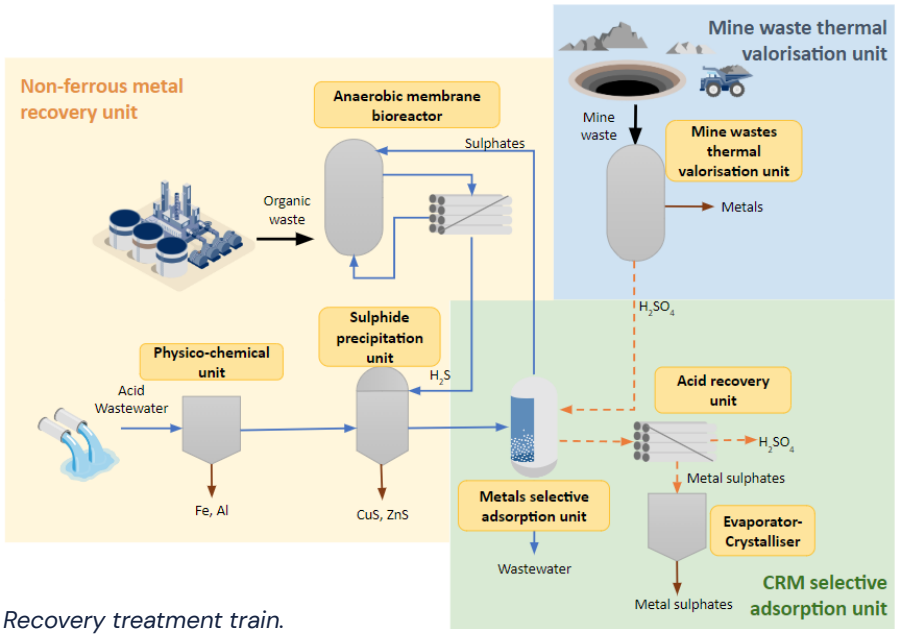
1. Recovering Mine waste

Cetaqua and Tharsis Mining analysed wastes from the mineral extraction and industrial by-products as a baseline for the replicability of the Resource Recovery treatment train in other sites. In addition, Cetaqua characterised the organic wastes to be used as a carbon source in the biological hydrogen sulphide generation process and performed the modelling of metals precipitation in the chemical treatment units in order to define the operational conditions of the treatment train. The first parts of the treatment train (i.e. physico-chemical and mine wastes thermal valorisation units) were constructed and are currently working. In the next few months, the rest of the treatment stages will be put into operation with the objective of recovering critical or valuable metals such as Cu, Zn, Co or Ni.



Recovery treatment train.

2. Sustainable Silicon production

During the second year of the project, Resilex partners have worked to test a new way for the production of silicon. The new process developed consists on the purification of silicon produced by a carbon-free, sustainable, aluminothermic reduction of molten silicates (oxide melts) by aluminum scrap. The purification is based on a slag refining process that was tuned and optimized for the production of pure Si suitable for solar applications.

Slag tapping where metal pearls are visible on the top of casting as round pearls.

Slag, Kerf, Quartz and a Silicon alloy obtained by aluminothermic reduction of molten silicates (oxide melts) by aluminum scrap or dross are inserted in the furnace for smelting. Once the process is terminated and the slag is removed, the silicon obtained showed a 98.91% rate of purity. During this year, NTNU performed research on techniques for further purification of the acquired product. Directional solidification of Si allowed to achieve, a purity of 99.86%. CEA will evaluate in the following months the suitability of the waste material for the production of solar cells and will define the best way to produce ingots.

Final purified ingots.

Another application that is demonstrated in Resilex is the use of silicon from discarded PV modules in battery application. Comet has collected End of Life PV modules and sent to NanoPow who has purified the material following the metallurgical process. During the second project year NanoPow has successfully purified the silicon material to 99.99% and reduced its size to 75 nm.

Crystalline silicon nano-powder with 10% carbon coated.

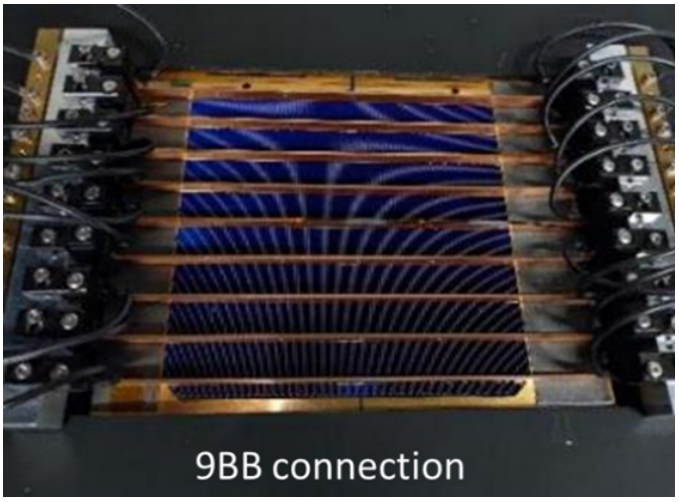
The particles have then been carbon coated. In addition, NanoPow has received almost 99.94% purity silicon from Group Comet which has been used to produce 10 g of crystalline silicon nano-powder.

The nano-powder has been sent to University of Liege for evaluation in battery applications. Crystalline carbon coated silicon nano-powder will be registered in REACH by NanoPow.

Crystalline silicon nano-powder with 2% carbon coated.

3. Sustainable, eco-designed solar cells & modules

The design of new kind of PV modules in Resilex continues to make significant strides, showcasing notable advancements across four dedicated areas. First, in the topic of indium reduction, CEA demonstrated the possibility to reduce the indium content above 70% in heterojunction (SHJ) solar cells by reducing the thicknesses of the transparent conductive oxide (TCO).



Interconnection of the "low-Indium" (>70% of Indium reduction) and "low-silver" SHJ solar cells with Cu-plated metallization for the light IV curves measurement to assess the final solar cell performances.

This major result was validated on the CEA SHJ pilot line and disseminated in international conferences. In addition, promising results were obtained on the development of In-free TCO layers.

At CEA, the deposition of AZO layers by PVD was developed this year along with the optimization of a bilayer AZO/SiNx for solar cell integration and first results on In-free TCO deposited by SALD were presented by LMGP.

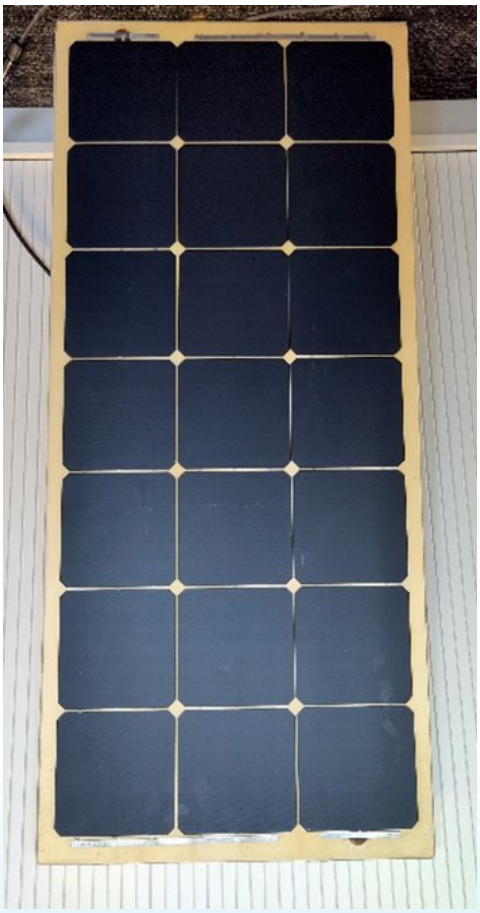
Secondly, CEA demonstrated a 40% reduction in Ag quantity in SHJ cells without compromising the efficiency using Ag/Cu pastes.

Additionally, CSEM successfully combined copper plating metallization with In-less SHJ solar cells.

Third, concerning interconnection tasks, promising results on ECA bounding of In-less and Ag-less SHJ solar cells were achieved at CEA with UV and DH tests that pass the standards and hundred "In-less" SHJ solar cells were interconnected at CEA to test eco-design module bill of material at CSEM and CEA.

Finally, concerning the eco-design modules developments, promising results of eco-designed modules integrating flax and wood backsheets were demonstrated by CSEM.

A successful integration of CSEM encapsulant was achieved at CEA with mini modules that pass the standard. Based on these developments, additional investigations in the different topics are undertaken supported by a strong collaboration between the CEA, CSEM and LMGP.



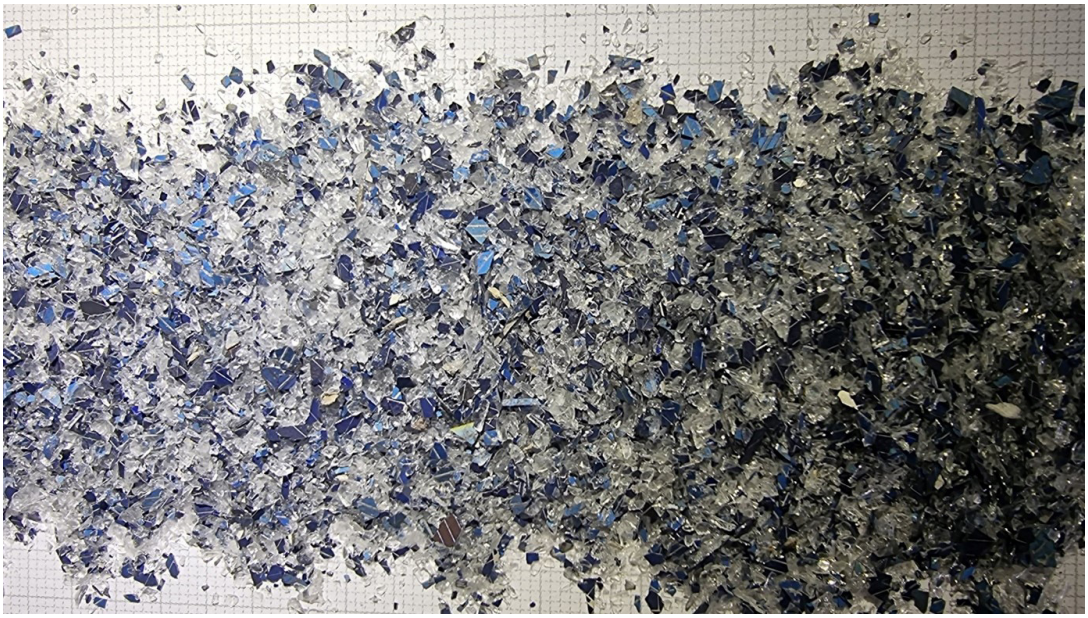
Cells wood backsheet module.

4. Silicon recycling from PV modules

Partners Recma and ENVIE2E have provided Comet with the photovoltaic panels from which Comet mechanically recovers the Silicon cells. In the upcoming months, Recma will be able to upgrade their current dismantling bench and acquire a new one, able to accommodate a wider range of panels to take the aluminium frames and the junction boxes off.

At Comet, pieces of silicon cells are found mainly in the ultimate metal concentrate fraction recovered (composed of the connectors and silicon), but they are also present in the ultimate glass fraction and in the light residues. New separating techniques are under investigation, to recover as much silicon as possible in those fractions. The first results are very promising and will be validated at an industrial scale in the upcoming year.

The GeMMe laboratory (University of Liège) performed tests to purify the silicon from PV modules, by leaching the contaminants (like aluminium and iron) off the pieces of silicon cells recovered, and demonstrated the possibility to obtain a silicon purity above 99.5%. The first tests of battery manufacturing using such purified materials were conclusive.



Pieces of silicon cells (in blue) mixed with glass.

5. Silicon composite for Li-ion batteries

The University of Liege (Greenmat Labo-rataory) have successfully produced and tested prototype coin cells. 500 g of silicon composite powders have been produced by Greenmat and sent to CEA for use in the 2 Ah multilayer pouch cells. Another 500 g of silicon composite powder will be delivered by September and this will complete an important project milestone.

Uliege is working on producing and testing the single layer 20 mAh pouch cell.

Cleancarb has finalised the battery design and specification succesfully. Over the next period Resilex activities in this domain will focus on producing single and multi-layer pouch cells that will be tested for up to 500 cycles.

6. Impact assessment and Policy

Resilex partners have been working together to define the scenarios to be assessed from economic and environmental point of view. Based on experts meetings with CEA and CSEM, scenarios to be investigated were defined for the innovation at the cells and module level.

With respect to solar grade silicon production, analysis of the updated information on the baseline scenario and corresponding data inventory (provided by NTNU) was performed as starting point for the LCA. Based on expert meetings with COMET and CEA, an overview of all processes and sub-processes of the end of life treatment of solar panels is made.

As for the Social Impact assessment analysis, the work done so far has earned some interesting results. They show that Chinese supply chain reflects the highest and most negative social impacts, i.e. "Health and safety of workers", "fair salary" and "forced labour".

Also, in this period the design of Quintuple Helix approach has been completed based on the literature and the required innovations by European Innovation Score board, European environmental agency, European commission and EU solar energy strategy.

As for the development of an open platform that serves as a vital support tool for formulating policy recommendations and engaging stakeholders, an open survey was launched in June 2024. The aim is to gather inputs from industrial stakeholders regarding the sourcing and recycling of Critical Raw Materials. The data gathered in such way will allow Resilex to draft a series of Policy recommendations destined to the Europan Commission, Parliament and Council.

Click here to contribute

Promo card of the survey.

7. The Brussels workshop

On the 23rd of May 2024, the Horizon Europe projects Resilex and EverPV organized a highly participated workshop in Brussels. The several speakers discussed the challenges and opportunities for advancing circular thechnologies and value chains relevant for the PV industry.

Stakeholder engagement: engaging the right stakeholders is crucial to bridge the gap between research and industry, and to identify synergies across sectors. This is essential due to the limited number of companies in Europe capable of taking recovered materials, especially Silicon.

Cost and profitability: the high costs of the recycling process, managing small quantities of certain materials (Indium and Gallium), and ensuring sufficient waste flows need to be addressed, to enhance the sector's profitability.

Standardisation and policy: standardisation should be implemented at multiple stages, including with eco-design rules to make it easier to recycle PV modules and exclude certain materials, such as fluoropolymers. Recycling processes across the industry should be harmonised. Policy support can help increase the sustainability of the PV industry.

Group picture of the attendees of the workshop.

Project consortium

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