ASIA-PACIFIC SOLAR RESEARCH CONFERENCE

Recovery of valuable metals from end-of-life solar panels using low-cost plastic chip electrodes for water splitting

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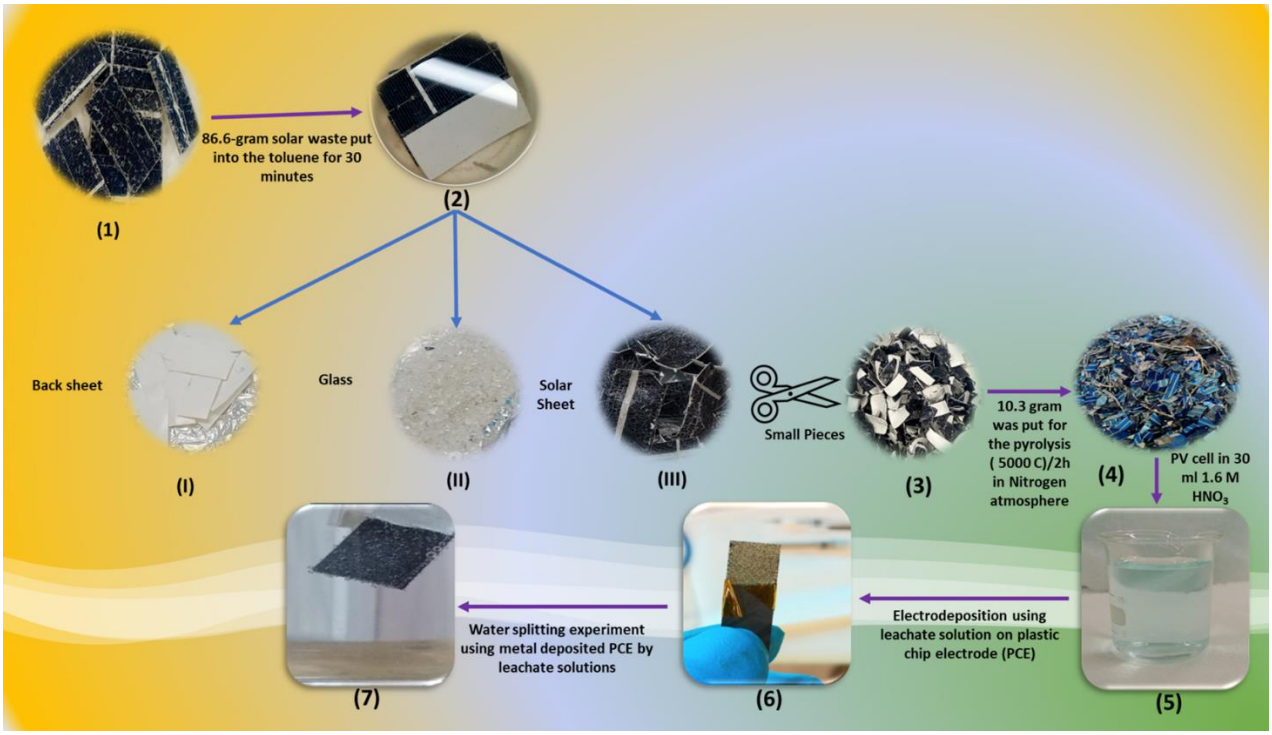
In recent decades, the installation of solar panels has expanded quickly as a solution to the problems of energy security and climate change. However, at their end of life (EoL) these solar panels or photovoltaic (PV) cells contain hazardous components that can be used as resources if recovered properly. Most of the traditional approaches like precipitation, hydrothermal, and chemical methods are reported for the recovery of valuable metals like Cu, Zn, etc. Additionally, silver is frequently utilised in solar cells, especially when metallizing silicon-based solar panels. Due to the high market value of this metal, recovering silver from solar cells is economically relevant. Silver from solar modules has been recycled using electrochemical techniques including silver electrorefining and electrowinning. In these processes, silver-coated materials are dissolved, and pure silver is deposited onto an electrode. [1,2]

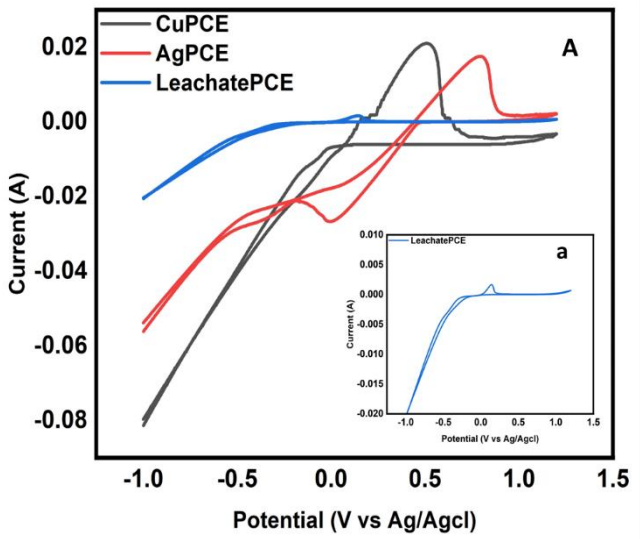
Electrochemical techniques have the potential to be extremely important in the creation of sustainable energy through the direct recovery of rich metals as well as through the splitting of water to produce hydrogen. Transport and industry may both benefit from using hydrogen, which is a safe and adaptable energy source. Water is split into hydrogen and oxygen using the electrolysis process, which needs electrochemical cells with catalysts to speed up the reaction. Platinum and palladium,[3] which are costly and highly inaccessible precious metals, are frequently found in the catalysts. It is possible to generate sustainable sources of catalyst materials for water splitting by recycling silver, copper and other metals from obsolete solar cells. This will help to advance the development of renewable hydrogen production technologies.[4,5]

Some electrochemical methods were also reported but they used commercial-based electrodes like glassy carbon electrodes, screen-printed electrodes, boron-doped diamond, and carbon-based electrodes. These materials either have efficiency or cost issues that render them unfeasible at large scale.



Scheme:1 *Outline the process of water splitting using electrochemical deposition with waste solar panel electrolyte*

Here we have reported three electrode, electrochemical methods for the recovery of Ag and Cu from PV cells, and we used working and counter electrode as a plastic chip electrode (PCE) and sat.Ag/Agcl as a reference electrode .PCE is a two-component low-cost, self-standing, and bulk-conducting electrode.[6] First, we separated glass, back sheet, wire, polymeric layer, and small solar cell pieces by a single solvent process. **Scheme 1.** Thereon, small solar cell pieces were dissolved in nitric acid and a 1.6 M leachate solution was prepared. As an electrolyte, we used leachate solutions as well as compared with standard solutions of Ag and Cu. The reduction potential has been controlled by cyclic voltammetry **Fig. (1)** and found selective potential for the Ag (0.2V) and Cu (0.4V) that has been applied to chronoamperometry techniques. **Fig. (2)** Scanning Electron Microscopy (SEM) with Energy Dispersive X-ray analysis (EDX) **Fig. (3**) techniques have found the surface morphology and elemental distribution of the pre- and post-deposit. Analysis of pre- and post-electrolyte has been done by Inductively coupled plasma mass spectrometry (ICP-MS).



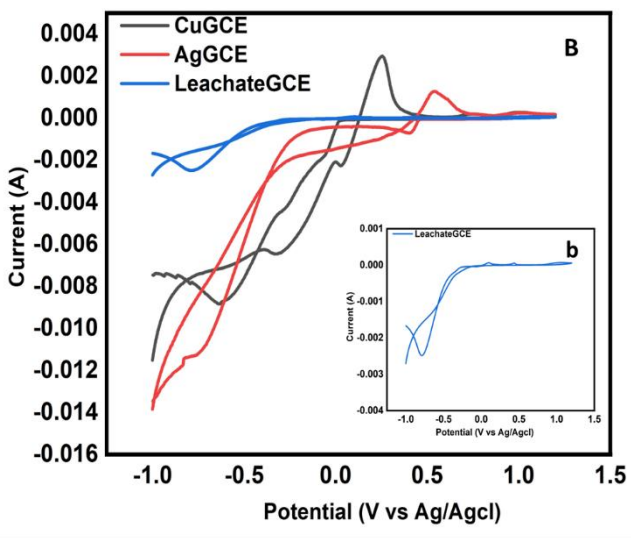


Fig.1 *Cyclic voltammetry performed using three electrode system on both a A)PCE and B)GCE electrodes in the presence of electrolyte containing 50 mM $Cu(NO_3)_2.3H_2O$, 50 mM $AgNO_3$ and 1.6M leachate in HNO_3 [Inset:- Zoom image of leachate solutions (a, b)]*

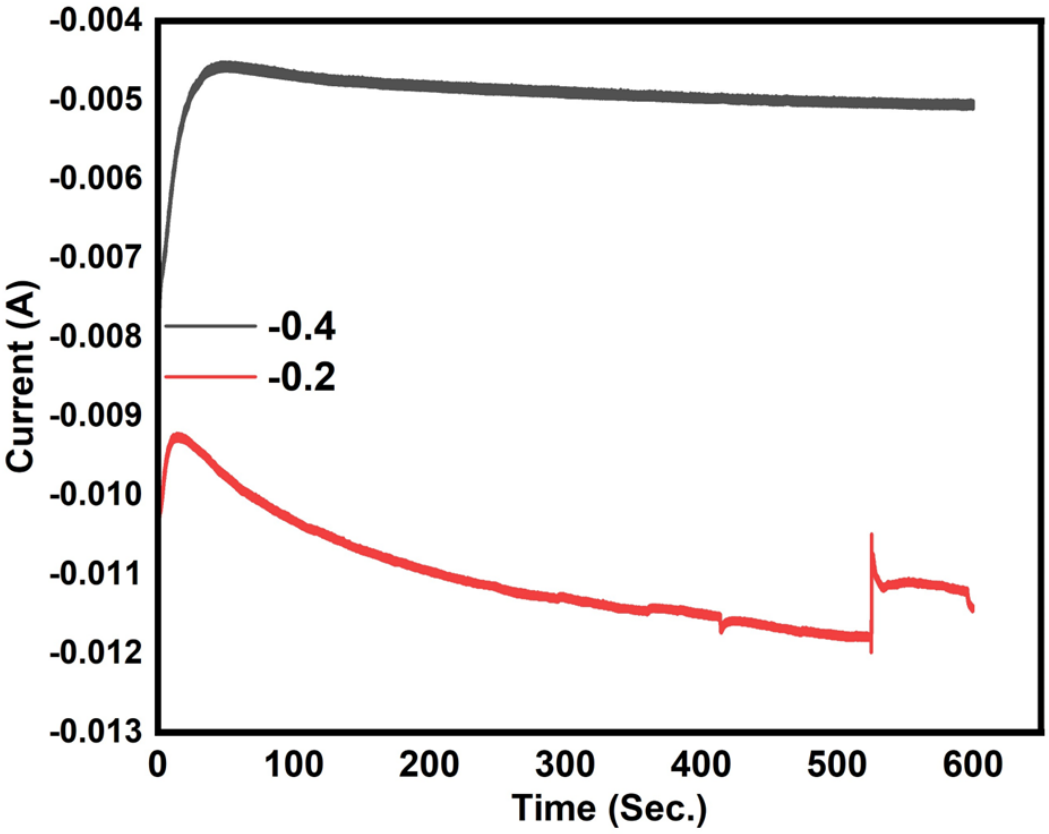


Fig.2 *Electrochemical deposition through1.6M leachate HNO_3 using constant potential three electrode system*

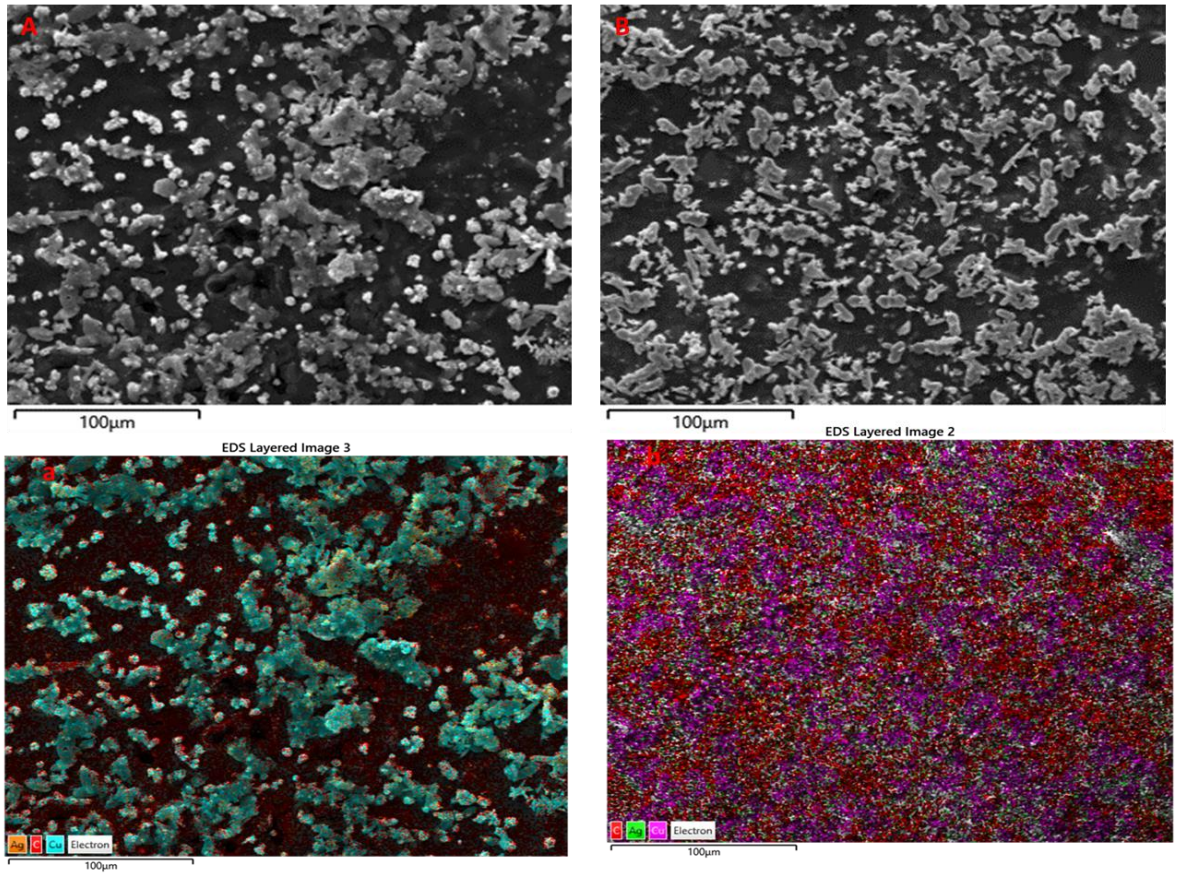


Fig.3 *Surface morphology and elemental distribution of Ag , Cu deposited PCE at 0.2V (A,a)and 0.4 V (B,b) .*

The electrodeposited PCE used as a working electrode for water splitting in aqueous medium (1M KOH). The kinetic of the electrode has been done by Tafel plot as well as linear sweep voltammetry techniques. **Fig. (4)**

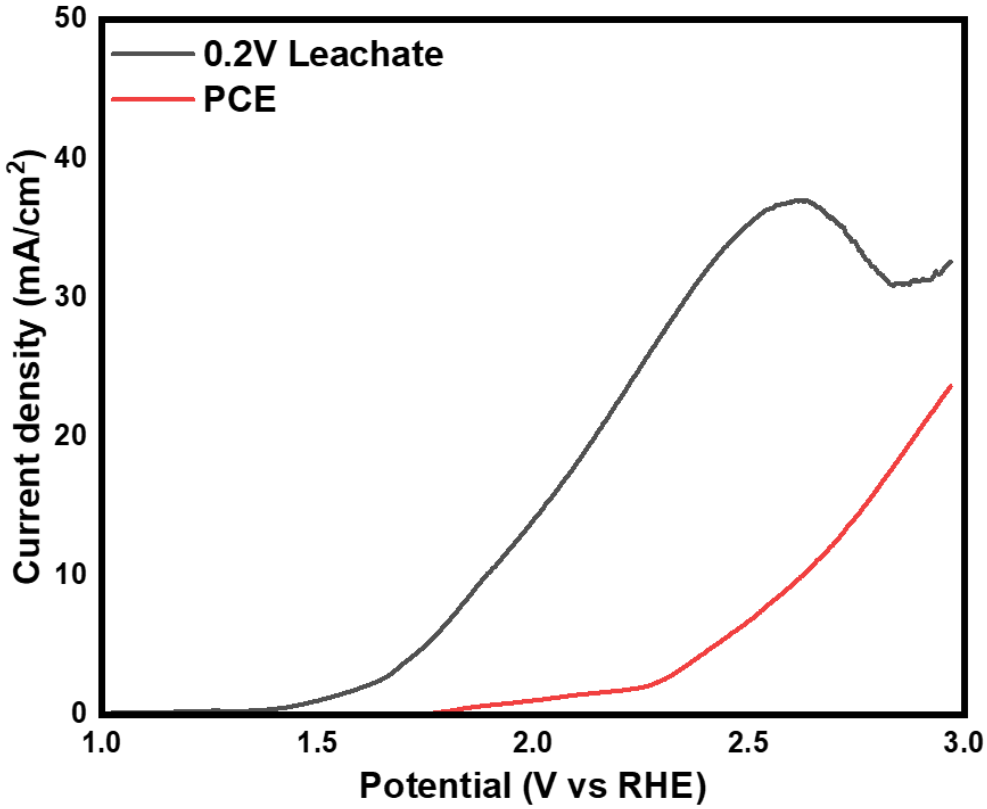


Fig.4 *Linear sweep voltammetry by three electrode system using 1 M KOH at 5mV/sec*

To sum up, recycling used photovoltaic panels is a developing problem that can be solved by electrochemical methods for metal recovery from solar cells. Selectivity, environmental sustainability, and the potential to support the creation of renewable hydrogen are all features of these techniques. To reduce waste and ensure a steady supply of important metals for future solar cell manufacture and other new technologies, as the solar industry expands, it is critical to create effective and sustainable recycling techniques.

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