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Recovery of metals from waste 1st generation photovoltaic panels: leaching behaviours in H₂SO₄, H₂SO₄ with H₂O₂ and HNO₃

The recovery of metals (to which 'urban mining' refers) belongs to the topics that are closely related to the end of life of waste electrical and electronic equipment (WEEE). However, this recovery is not so simple because metals often appear in low concentrations in a large number of small scattered fractions. Moreover, some metals would be lost during the recycling process if mixed with others (e.g. copper in aluminium flow). The challenge is twofold: to recover these metals and to enable their selective recoveries.

The recast WEEE Directive, effective since February 2014, and its extended scope of application imply to deal with new types of WEEE, such as 1st generation photovoltaic panels (panels hereafter). The latter become thus a new source of metals. In our work, the potential selective recovery of metals from these panels has been studied.

The main components of panels are: glass, aluminium frames, polymers, connection elements (e.g. cables) and silicon cells with small amount of metals (around 1% by mass of the panels). Aluminium frames can easily be removed, as well as connection elements. In this work, the separation of glass has been achieved after degradation of polymers by thermal treatment and mechanical separation. The remaining product is a non-homogeneous powder composed of glass

residues, silicon and metals. A characterisation of elements by X-ray fluorescence (XRF) highlighted the presence of aluminium, copper, silver, lead and tin. The leaching behaviours of these metals in different solutions were studied to assess their potential selective recovery.

As a preliminary stage, three leaching treatments were performed: H₂SO₄ 20% (solution 1), H₂SO₄ 20% with addition of H₂O₂ (solution 2) and HNO₃ 20% (solution 3). A sample of initial powder (10 g) was immersed in each solution during 24 h and 10 samples of solution were extracted at different times, so as to obtain leaching kinetics. The amount of metals into samples was determined by inductively coupled plasma spectroscopy. At the end of the treatment, the remaining powder was filtered and analysed by XRF. The dissolution efficiency (DE) of each metal was then calculated. To further our aim of selective leaching, a sample of initial powder was then successively immersed in the three previously mentioned solutions during 24 h for each solution. The sample collection procedure was identical to the previous one. The remaining powder was only analysed after the third solution.

In the case of successive leaching treatments, solution 1 dissolves a large proportion of Al (DE: 85%) as well as some Sn and Pb. Solution 2, thanks to the oxidising effect of H₂O₂, enables the dissolution of Cu (DE: 95%) and Ag (DE: 88%). As in solution 1, Sn and some Pb are also dissolved. Solution 3 dissolves the remaining Pb (DE: 70%), Ag and Cu as well as some Sn.

Although this leaching sequence still need optimisations, first results shows that immerse the powder in these successive solutions allows selective dissolution of Cu and Ag in solution 2 (see figure below). Selective precipitations are being considered to finalise their recovery (e.g. by adding NaCl for Ag).

SUCCESSIVE LEACHING OF METAL FROM THERMALLY TREATED FRACTION

