Recovery of Solder from Printed Circuit Boards

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There is an exponential demand for electronic equipment but, unlike other consumer products, the useful lifetime is relatively short which means that there is an urgent need to improve the recycling of electronic scrap. In Europe, about 1million tonnes of electronic scrap are generated every year and the majority of the scrap material either ends up in landfill or is treated in a copper smelter. In both cases, the value of the components is lost and not all of the valuable elements are recovered.

At present, the only way the components can be recovered is to melt the solder but the heat required frequently shortens the life of the components. An alternative route is to selectively dissolve the solder but it is important that the leachant is selective otherwise other metals, such as copper and precious metals, will dissolve and contaminate the leachant. In the present work, fluoroboric acid, containing an oxidising agent, was selected as the leachant. Initially, hydrogen peroxide was used as the oxidising agent but this encouraged the co-dissolution of copper as well as the solder. Finally Ti4+ ions were used as the oxidising species so that the overall reaction was:

Pb-Sn + 2Ti4+ = Pb2+ + Sn2+ + 2Ti2+

It was found that the ratio of the lead ions to tin ions in the leachant was identical to that in the original solder.

In order to re-deposit the lead and tin a Nafion membrane cell was used but it was found that it was very easy to deposit the lead but the tin could only be deposited via the Sn2+ ion and not the Sn4+ ion. This problem was completely overcome by working with anaerobic conditions both in the leaching and electrowinning stages with the tin and lead being deposited in the ratio found in the electrolyte. At the end of the electrodeposition process, the lead and tin contents were as low as 1 g/l and the Ti2+ could either be converted to Ti4+ electrochemically in the anode of the cell or by passing air through the depleted electrolyte.

After the solder had been removed the components from the printed circuit board could easily be removed and were found to be completely unaffected by the leaching process and could be reused.