Recovery and Valorization of metal components from spent printed circuit boards

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A major need of our high technological society relates to an increasing need for critical materials, such precious metals required, for the fabrication of electronic devices. On the other hand, a huge amount of spent electronic devices and components are dismissed, resulting in relevant waste disposal and environmental issues.

Components such as printed circuit boards (PCBs) contain a number of relevant metals, ranging from Pb, Ni, Fe, to more precious metal components, such as Cu, Ag, Au. Based on specific and selective processing approaches, the recovery of these metals can be performed, and the leaching solutions can be regarded as precursors for the production of new materials.

The present work is a part of a wide collaborative project inspired by circular economy principles and has received support through the SMART PCBs project, funded within the framework of the RAEE 2020 call from the Italian Ministry of Ecological Transition. [*1, and references therein]* Here, leaching solutions which are rich in a specific recovered metal from PCBs obtained from spent electronic devices have been tested as sources of metal-based nanoparticles, which may then serve as functional materials for other applications enabling therefore recycle and reuse of the metallic component.

We present here the case of processing of leachate solutions containing either gold or copper, which are mainly in the form of $[AuI_n]^-(aq)$ and $Cu(NH_3)_4]^{2+}(aq)$ respectively. The leachates were treated by processing in aqueous media and the role of readily available common oxidizing, reducing, and complexing media were tested in view of producing metal-based nanoparticles. The outcome of processing was characterized by X-ray diffraction and Transmission Electron Microscopy. It was observed that gold nanoparticles are obtained, although a broad distribution is observed. To test the potential of the Au nanoparticles obtained from recovered leachate solutions, preliminary conductivity tests were performed by depositing the nanoparticles onto glass-supported gold electrodes.

In the case of copper-rich leachate, the effect of oxidizing and/or reducing conditions were tested, with the aim of producing different phases as different functional copper-based phases (such as metallic Cu, Cu_2O, CuO) can be desirable based on the target application (antibacterial agent, catalyst, and so on). Indeed, it was found that copper-based nanoparticles can be produced from the leachate precursor and that the structure and morphology of the produced nanoparticles depends on the processing conditions.

Although the recovered leachate solutions represent systems with a much higher degree of complexity as compared to commercial precursors, our study contributes to explore the potential of recovered components from spent electronic devices, in the framework of circular economy approaches.

REFERENCES

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