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Life Cycle Assessment of purification and regeneration plating bath technologies with Magnetic Nanoparticles

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INTRODUCTION

The environmental burdens of the plating process within the electroplating industry are mainly related to the spend bath End-of-Life (EoL), i.e., the total discard of the aqueous solutions used in the process. To boost sustainability and circular economy, innovative technologies concerning a safe plating bath recirculation are being developed in the PureNano Horizon 2020 Project (Fig. 1)

The application of magnetic nanoparticles (MNPs) in the processing lines is tested to extend the lifetime of the baths, and, to increase economic and environmental performance within this industry.

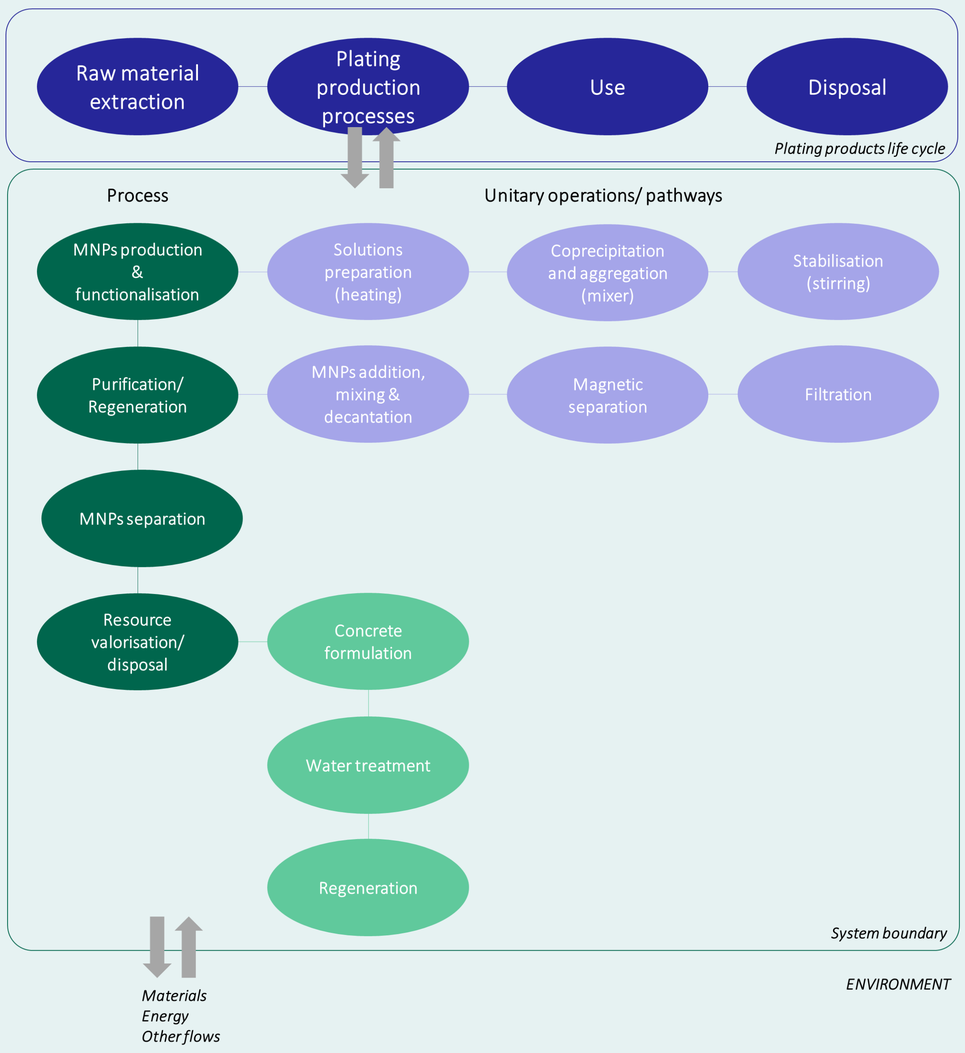

Fig. 1 – System boundaries concerning linear and circular economies for plating baths processes.

GOALS

The aim of in-situ purification/regeneration process of plating baths from pollutants and other undesired chemical compounds is:

- Extend the lifetime of baths by removing the undesired species
- Recover metal ions, that are pollutants from the electroplating process, to be used as secondary raw materials

METHODOLOGY

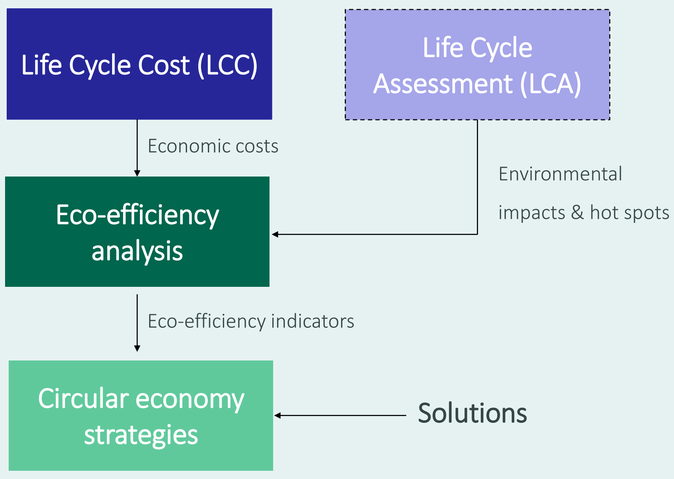

Fig. 2 – Methods used by ISQ for the sustainability assessment of industrial processes.

Through the life cycle analysis (LCA), and based on ISO 14040/ 14044, the environmental impacts of novel purification/regeneration pilot lines are determined using SimaPro and ReCiPe method. Life Cycle Cost (LCC) is also carried out to assess the costs incurred during the lifetime of the pilot line (equipment, energy, reagents and labor). With LCA and LCC results, the eco-efficiency of the pilot line is determined, to accomplish financial and environmental success, identify and track trends, prioritise actions and issues and highlight areas for improvement (Fig.2).

RESULTS & DISCUSSION

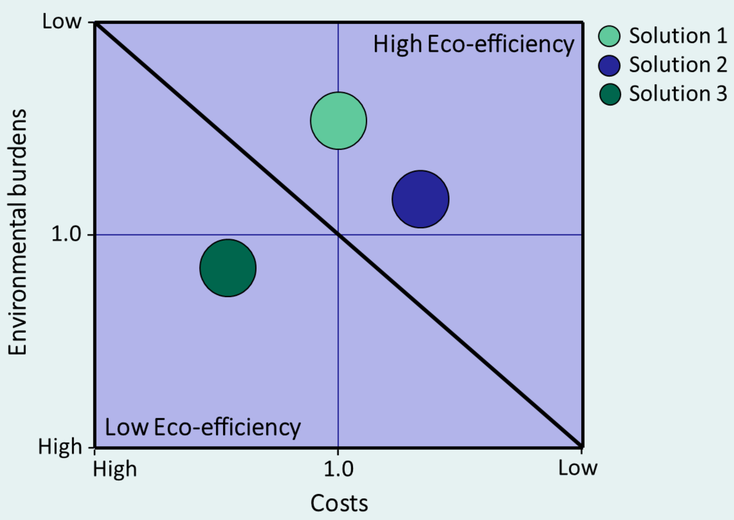

Fig. 3– Eco-efficiency analysis of 3 different solutions.

To allow in-place purification/regeneration of baths, different strategies have been tested, involving functionalized magnetic nanoparticles (MNPs). The application of MNPs in the processing lines are a key factor to extend the lifetime of the baths, and, consequently, an important factor to increase economic and environmental performance of this industry (Fig. 3). Depending on the nature of the pollutants to be removed from the spent bath, different MNPs coatings could be applied. ISQ has an important role on the identification of the main environmental hot-spots and strategies to overcome the potential impacts of these new technologies.

CONCLUSIONS

The plating baths purification/regeneration through innovative technological solutions is demonstrating promising results for the mitigation of the EoL environmental impacts, in comparison with business-as-usual options, as direct disposal in landfill. Additionally, the possibility of recovering and reusing the MNPs applied in the purification/regeneration process for different uses (e.g., concrete production and wastewater treatment) may represent an important benefit for the entire system.

ACKNOWLEDGMENTS

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