Selective recovery of Li, Ni, Mn and Co from LiBs black mass by solvent extraction

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The energy and climate transition is accompanied by a growing demand for mineral resources. With governments showing a clear determination to decarbonize mobility and industry, massive electrification is expected in the years ahead. As a result, (i) a sharp increase in the need for metals should happened, particularly for lithium, manganese and cobalt and (ii) more and more batteries will have to be recycled. In a context of high dependence and fierce competition for raw materials, securing critical metals supplies is thus a crucial issue for European sovereignty. The recycling of scraps or End-of-Life batteries can provide a partial solution. In this context, European regulations have been updated to define average Li-ion batteries (LiBs) recycling target as well as a level of recovered material and percentage of recycled material per cell to contribute to a more circular economy. Battery recycling offen begins with the comminution, and physical separation of battery components to isolate the black mass fraction, a black powder which concentrates the valuable metals. Li, Ni, Co and Mn can then be extracted and purified from this black mass after hydrometallurgical processes which combine leaching, precipitation and liquid-liquid extraction steps.

In order to design and optimize such a recycling process and produce initial process diagrams LiBs recycling, solvent extraction experiments were carried out at CEA ISEC and thermodynamic models were developed. Selective extraction of Mn, Co, Ni and Li from synthetic solutions was successively studied using various extracting molecules. Distribution of metals between aqueous and organic phases were determined for different operating conditions of acidity, metal concentrations and extractants. Physicochemical characteristics of the organic phases were also measured. In a second step, phenomenological models were developed to simulate the behavior of Mn, Co, Ni and Li with each extracting molecule. The aqueous phase was described by taking into account the acid-base equilibria and the complexation equilibria. In the organic phase, hypotheses were made on the complexes stoichiometry to fit experimental data. All the models developed were then integrated into the PAREX+ simulation tool, offering the possibility of process flowsheet calculations for the separation and purification of Mn, Co, Ni and Li salts.