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It is a matter of strategic independence for Europe to urgently find processes taking account of environmental and economic issues, when mining and recycling rare earth elements. Separation and recycling of rare earths from electronic waste is important for the success of present and future carbon-free technologies. Solvent extraction based on "water-poor" microemulsions is one of the first technologies allowing the take-off of circular economy. However, an optimized process on an industrial scale has not been established. One major reason is the lack of fundamental knowledge, therefore designing a cost-efficient, adaptive and predictive formulation is still out of scope of possibilities. Our objective is to develop the fundamental understanding involved in the process' complex fluids (experimental and theoretical) concerning liquid-liquid extraction of REE and in order to render environmentally friendly processes economically competitive.

In order to gain more comprehensive view between quaternary phase diagrams (macroscopic view), extraction properties and the molecular driving forces in solvent extraction (colloidal view at nanoscale), downscaling the extraction process to microfluidics proves to be a useful approach allowing accurate and rapid adaptation to such composition changes [1]. we describe here the first automated microfluidic tool integrated with X-ray fluorescence microanalysis allowing to measure with enough precision the free energy of transfer of ions along the lines in quaternary phase diagrams. Our contribution towards a more complete understanding in this matter is the analysis and comparison of the phase behavior, extracting efficiency and selectivity of such systems as well as the correlation of these findings with the colloidal "ienaics" approach by identifying the molecular driving forces favoring or quenching the transfer.

Keywords: Complex fluids, Liquid-liquid extraction, Microfluidics, X-ray Fluorescence, on-line measurement, Rare earths, Thermodynamics, Kinetics.

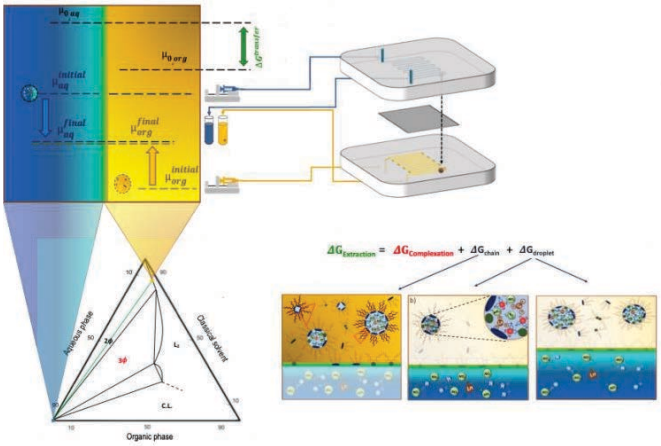

Figure 1. *Graphical free energy balance between supramolecular complexation, the chain reconfiguration term and the internal energy of the polar cores.*