Instrumented microfluidic tools for complex fluid phase diagram determination: Inline and real-time screening of solvent extraction.

Friday September 27th 2019 14h, CEA Saclay/CNRS NIMBE/LIONS
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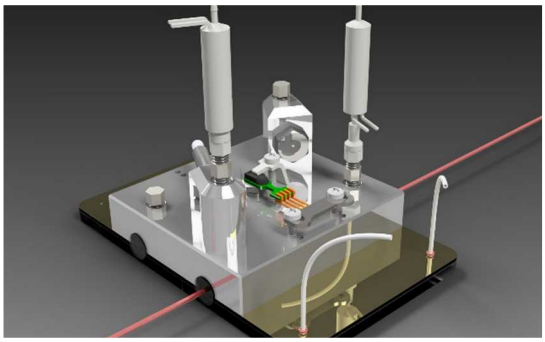
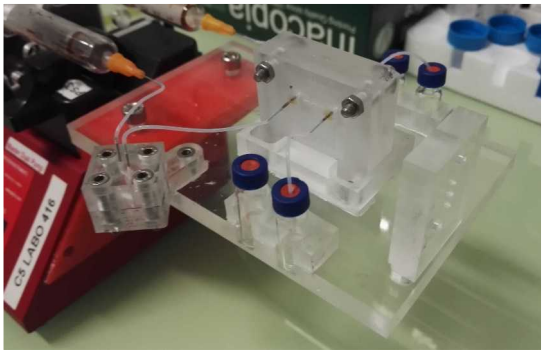
To increase performance of electronic components, manufacturers in many cases fall back on new materials using rare earths, e.g. for flat-screens, diodes, magnets. Despite their name, rare earths are present in a quantity close to copper on the terrestrial globe, however are evenly diluted in the mined ores. The effective extraction of these elements is based on huge amounts of acid and carried out to over 80% in China where the chemical processes of separations employed are in many cases disrespectful of the environment. Moreover European manufacturers are economically constrained by the Asian market for the purchase of these raw materials.

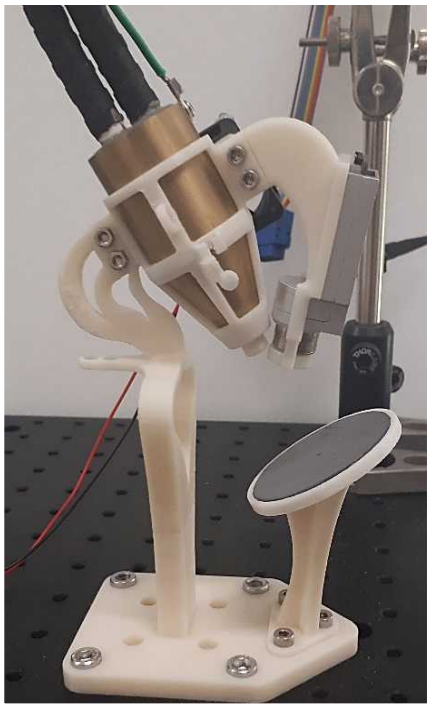
On the other hand, Europe has a large amount of electronic waste containing these elements of interest. Recycling processes are therefore essential to reduce economic dependence and meet the needs of a future circular economy. Recycling processes such as, for example, liquid-liquid extraction already exist. But the diversity of present waste requires adapting processes according to the individual batch of waste to yield optimization. This process optimization requires experiments that are for the moment semi-empirical and can take several years of study. The aim is to find innovative ways of reducing time needed to study a liquid-liquid extraction system from a few years to a few weeks. For this, the domain needs dedicated instrumentation that can analyze processes quickly, automatically and deductively.

The work carried out during the ERC advanced project “REE-CYCLE” (Rare-Earth-Element reCYCling with Low harmful Emissions, 2013-2018) and presented in this seminar focused in its first working package on the development of a microfluidic liquid-liquid extraction device associated with two main online analysis techniques. The first analytical technique is based on X-ray fluorescence (XRF) to determine extraction performance and chemical potential differences pre-/post-extraction. The second method is based on Fourier-transform infrared spectrometry (FTIR) to study the activity of solvents (aqueous and organic), providing information on chemical activity and therefore eventually phase aggregation and extraction mechanisms.

The seminar is extended with an outlook to later work of Jean-Christophe Gabriel’s lab at NTU SCARCE laboratory (NTU Singapore-CEA Alliance for Research in Circular Economy), a common project between CEA and NTU Sinapore.







Left top:
CAD sketch of microfluidic FTIR setup for online chemical activity analysis

Left bottom:
Microfluidic chip for miniaturized membrane-assisted solvent extraction.

Right:
Lab-made X-ray tube and detector for elementary analysis and REE concentration measurement.