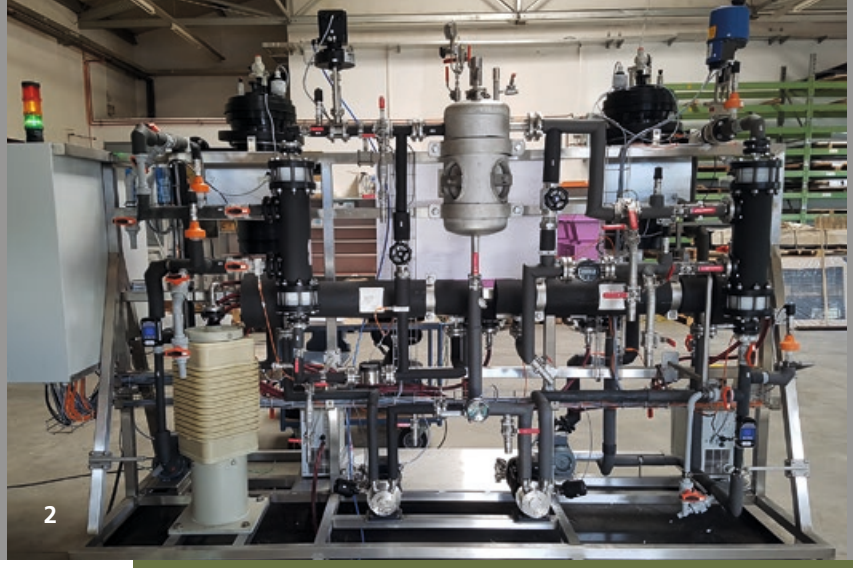

RECYCLING OF RARE METALS WITH CERAMIC MEMBRANES

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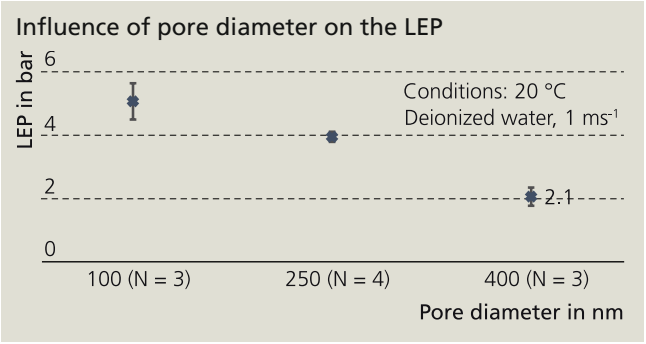
The German high-tech industry's demand for rare metals such as Gallium and Indium is set to keep rising. However, the recycling rate of these elements in Europe remains low. For companies, the recovery of these raw materials from their own process waste water is usually not economically feasible due to their low concentration. Moreover, the recycling processes used today are complex and costly. For the recovery of metals from aqueous solutions, liquid-liquid extraction is often used. It involves dispersing a metal-containing aqueous solution (aqueous phase) and an organic extractant (organic phase). The transition of the metal into the extractant takes place at the contact surface of the two phases.

Fraunhofer IKTS has developed a new membrane-supported liquid-liquid extraction process in which both phases are continuously brought into contact with each other via a porous ceramic membrane. The step of dispersing is omitted and both phases are contactable regardless of their volume ratio. The new process should make it possible to recover even very low concentrations of rare metals from process waste water. This process is centered around a ceramic membrane with a hydrophobic surface, for which different coatings (for instance with carbon, silanes or silicones) were tested on ceramic support membranes of different pore sizes. The hydrophobic properties of the membranes were demonstrated by contact angle measurements and by determining the liquid entry pressure (LEP). The LEP is known as the breakthrough pressure, at which the membrane is wetted by the liquid (Figure 1). Hydrophobic single-channel tubes with contact angles greater than 125 ° were produced. The LEP result – and thus process reliability at a later stage – depended strongly on the pore diameter of the supporting membrane.

The ceramic membranes allow a defined contact of both phases within the pores, which is where the mass transfer takes place. The organic phase wets the hydrophobic membrane completely. A slight overpressure on the side of the aqueous, non-wetting phase prevents the organic phase from breaking through the membrane. The phase boundary in the membrane pores is thus stabilized and the entire pore surface is active in the mass transfer of the metals from the aqueous to the organic phase.



Together with Andreas Junghans – Anlagenbau und Edelstahlbearbeitung GmbH & Co. KG, the IKTS team developed an extraction module equipped with ceramic single-channel tube membranes as well as a pilot plant for the selective extraction of different strategic metals. The process is currently being tested with real process waters at Nickelhütte Aue GmbH with the aim of demonstrating the performance of membrane-assisted liquid-liquid extraction.

Bundesministerium für Bildung und Forschung

1 *Breakthrough of the aqueous phase during LEP measurement.*
2 *Pilot plant for membrane-assisted liquid-liquid extraction.*

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