



Hybrid silica-based materials for hydro metallurgy and recycling of critical elements

Gulaim Seisenbaeva^[a]

^[a] Department of Molecular Sciences, Swedish University of Agricultural Sciences, 75007 Uppsala, Sweden

Surface of sol-gel silica is very attractive for further modification through condensation with functional silanes. Further modification via organic condensation and click-reactions opens prospects for creation of highly specific functional layers, displaying selectivity towards target metal cations.

Development of fossil-free economy and modern electronics have set strong demand for a large number of critical elements, such as, in the first hand, Rare Earth Elements (REE) and Late Transition Metals (LTM). This has set quest on both their primary production from ores and on development of recycling methodology [1]. Principal challenge in separation of REE is the small difference in their chemical behavior caused by close size of cations. Selective adsorbents can be created by tailoring the structure of the surface layer via choice of chelating ligands and their placement [2]. Combined with engineered porosity this can offer superior capacity and selectivity for, in particular, chromatographic separation of REE [3]. Most important application domains for REE are going to be the electric power generators and motor components of electric vehicles. In these materials REE are cased in or even alloyed with LTM.

Major quest in large-scale recycling of critical elements lies then in the separation of REE from LTM. In our studies, we have developed a successful strategy for this goal employing poly amino ligands. Here, we will present the molecular mechanism behind the selective action and the approaches to production and exploitation of adsorbents for this purpose (Fig. 1) [4-6].

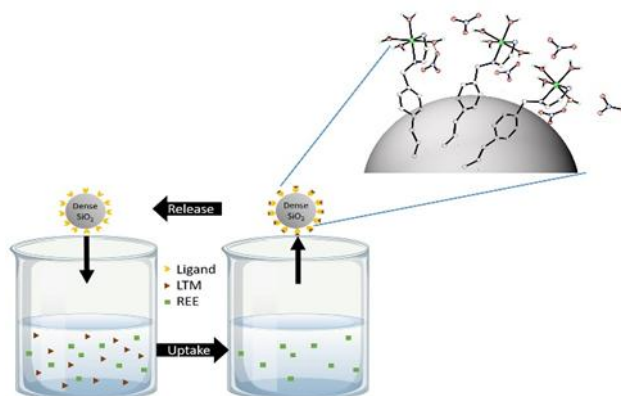


Fig. 1. Strategy in design of specific silica-based adsorbents for separation of LTM from REE

References

1. E.Balomenos, P.Davis, E.Deady, J.Yang, D.Panias, B.Friedrich, K.Binnemans, G.A.Seisenbaeva, C.Dittrich, P.Kalvig, I.Paspaliaris, *Johnson Matthey Technol. Rev.*, **2017**, 61, 142–153.
2. E.Polido Legaria, M.Samouhos, V.G.Kessler, G.A.Seisenbaeva, *Inorg. Chem.*, **2017**, 56, 13938–13948.
3. R.M.Ashour, E.Polido Legaria, M.Svärd, J.Höglblom, K.Forsberg, M.Palmlöf, V.G.Kessler, G.A.Seisenbaeva, A.C.Rasmuson, *ACS Sustainable Chem. Eng.*, **2018**, 6 (5), 6889–6900
4. A.Vardanyan, A.Guillon, T.Budnyak, G.A.Seisenbaeva, *Nanomater.*, **2022**, 12, 974.
5. O. Dudarko, N.Kobylinska, V.G. Kessler, G.A.Seisenbaeva, *Hydrometallurgy*, **2022**, 210, 105855.
6. M.Lakic, V.G.Kessler, G.A.Seisenbaeva, *Sep. Purif. Technol.*, **2023**, submitted