

## Report of KU-UNIVIE Joint Grant Program

### Section 1

<b>Project title:</b>		Powdered hierarchically-porous silica monoliths for critical materials recovery from non-traditional feedstocks
<b>Project coordinator (KU)</b> Name Position Faculty, department		Kazuki Nakanishi Program-Specific Professor Institute for Integrated Cell-Material Sciences
<b>Project coordinator (UNIVIE)</b> Name Position Faculty, department		Freddy Kleitz University Professor Faculty of Chemistry, Department of Functional Materials and Catalysis
<b>Period of project</b>		From: July 2023 To: March 2024
<b>Project location</b>		KU: <input checked="" type="checkbox"/> UNIVIE: <input checked="" type="checkbox"/> Other:
<b>Approx. number of participants</b>	<b>For events</b> <sup>*1</sup> (e.g. workshops, seminars, symposia)	[KU] Faculty members: 1      Students:      Others: [UNIVIE] Faculty members: 5      Students: 25      Others: 2 Other institutions:  *Please attach a participant list if possible. (the list will NOT be publicized)  5 [UNIVIE] Faculty (Profs) were F. Kleitz, K. Hultzsch, R. Woodward, J. M. Chin, and M. Reithofer
	<b>For other exchange activities</b> (such as researcher visits and online meetings) <sup>*2</sup>	[KU] Faculty members: 2      Students: 5      Others: 2 [UNIVIE] Faculty members: 1 (Kleitz)      Students:      Others: 1 (Florek) Other institutions:
<b>If applicable: URL at which project outcomes can be viewed (e.g. workshop notifications/programs/reports, evidence of academic papers published or otherwise made available, etc.)</b>		<a href="https://pubs.acs.org/doi/10.1021/acssuschemeng.3c04672">https://pubs.acs.org/doi/10.1021/acssuschemeng.3c04672</a>
<b>If available: Photographs with captions</b>		Please submit digital files (such as JPEG or GIF files) of the photographs used in your report as attachments. The size of each image should be approx. 4MB, so that it can be used for printed materials. Please ensure that none of the photographs submitted will cause any issues relating to portrait rights.

\*1 Please enter the number of participants for each event.

\*2 Please count each individual participant once only, even if they participate multiple times.

## Section 2

### Summary of the project (approx. 200 words)

Critical Materials (CMs) are a group of resources, mostly metals, that have been deemed important to the modern economy, but which face current or potential supply limitations, often for political reasons. The rare earth elements (REEs) and the platinum group metals (PGMs) are examples of raw materials given the CM label in Europe, Japan, and North America. Scientists at Kyoto University and University of Vienna fostered their joint collaboration to transfer knowledge and experience related to the development of hierarchically-porous silica monoliths for CM recovery. These monoliths offer great advantages for CM extraction and purification, most notably their high surface area for adsorption and the possibility of rapid mass transfer through the sorbent in a continuous-flow system. For the project, expertise and laboratory experience were shared between KU (experts in powdered monolith synthesis) and UNIVIE (experts in ligand synthesis and grafting, and design of CM extraction systems) to produce advanced hierarchical macroporous-mesoporous silica-based sorbents. Monoliths of several different types and sizes were synthesized according to established KU methods. Especially, we have developed powdered hierarchically-porous silica monoliths as a practical CM recovery system, as a proof-of-principle for extraction from recycled/secondary feedstocks, in an effort to progress the technique closer to the industrial scale. Unfunctionalized monolith powders were confirmed to be well-suited for scandium (Sc) extraction in both batch and continuous-flow column systems, and they demonstrate excellent potential for Sc recovery over a range of conditions, while ligand-functionalized systems were tested for extraction of lanthanides and noble metals (PGMs). Joint publications between the two groups have been produced, facilitating innovation and further collaboration. Efforts to obtain joint funding for further collaborative research are pursued.