# Report of KU-UNIVIE Joint Grant Program

**Section 1**

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| **Project title:** | | Large-scale hierarchically-porous silica monoliths for rare earth element extraction from non-traditional feedstocks |
| **Project coordinator (KU)**<br>**Name**<br>**Position**<br>**Faculty, department** | | Kazuki Nakanishi<br>Program-Specific Professor<br>Institute for Integrated Cell-Material Sciences |
| **Project coordinator (UNIVIE)**<br>**Name**<br>**Position**<br>**Faculty, department** | | Freddy Kleitz<br>University Professor<br>Faculty of Chemistry, Department of Inorganic Chemistry – Functional Materials |
| **Period of project** | | From: July 2022<br>To: February 2023 |
| **Project location** | | KU: ☑ UNIVIE: ☑ Other: |
| **Approx. number of participants** | **For events**[*1] **(e.g. workshops, seminars, symposia)** | [KU] Faculty members: 1 Students: 0 Others: 0<br>[UNIVIE] Faculty members: 3 Students: 25 Others: 1<br>Other institutions: DualPore Solutions Inc.<br><br>*Please attach a participant list if possible. (the list will NOT be publicized) |
| | **For other exchange activities (such as researcher visits and online meetings)** [*2] | [KU] Faculty members: 2 Students: 5 Others: 1<br>[UNIVIE] Faculty members: 0 Students: 1 Others: 0<br>Other institutions: |
| **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.)** | | |
| **If available: Photographs with captions** | | |

[*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)**
*KU project coordinators are required to submit a summary of the project in Japanese in addition to the English summary (approx. 400 characters).

Kyoto University and University of Vienna researchers collaborated to study and to transfer expertise and experience related to the synthesis and application of hierarchically-porous silica monoliths for critical materials (CM) recovery. These monoliths offer numerous advantages for CM extraction and purification, most notably their high surface area for adsorption (with or without grafted ligands on the silica surfaces) and the possibility of rapid mass transfer through the sorbent in a continuous-flow system. Unfunctionalized silica is especially well-suited for scandium (Sc) extraction, given its naturally high affinity for that metal. For the project, monoliths of several different types were synthesized according to established KU methods, with an emphasis on larger monoliths in an effort to progress the technique closer to the industrial scale. Furthermore, powdered monoliths may offer even additional advantages for selective metal recovery. The application of the powders circumvents the challenges of producing very large monoliths for industrial use and offers a more flexible package that can be adapted to many different extraction systems. These monolith powders have here been systematically tested for Sc extraction in both batch and continuous-flow column systems, and they demonstrate excellent potential for Sc recovery at a range of conditions, even without the surface modification that is commonly applied to most advanced, synthetic sorbents.

京都大学とウィーン大学の研究者は、重要物質（CM）回収のための階層型多孔質シリカモノリスの合成と応用に関する専門知識と経験を共同で研究し、移転することに成功しました。このモノリスは、CM の抽出や精製に多くの利点をもたらします。特に、高い吸着表面積（シリカ表面へのグラフト配位子の有無にかかわらず）と、連続フローシステムにおける吸着剤を介した迅速な物質移動が可能であることが特徴です。特に、スカンジウム（Sc）に対する親和性が高いことから、無官能化シリカはスカンジウムの抽出に適しています。このプロジェクトでは、KU の確立された方法に従って、いくつかの異なるタイプのモノリスが合成されましたが、より大きなモノリスに重点を置いて、この技術を工業規模に近づけることを目指しました。さらに、粉末化したモノリスは、選択的な金属回収にさらなる利点をもたらす可能性があります。粉末を使用することで、工業用として非常に大きなモノリスを製造する際の課題を回避し、さまざまな抽出システムに適応できるより柔軟なパッケージを提供することができます。これらのモノリスパウダーは、バッチ式および連続フロー式カラムシステムで Sc 抽出のための系統的な試験を行い、最先端の合成吸着剤に一般的に適用されている表面改質なしでも、さまざまな条件で Sc 回収の優れた可能性を示しています。