Research topic #4-4

1 Topic name	Electrochemistry of Homologues of Superheavy Elements
ERC research field descriptor	7.8 Inorganic chemistry (ID 54) 7.0 Chemistry Other – Nuclear chemistry (ID 63)
2 Link to topic / project page	https://jaderna-chemie.cz/postdoc-2023/
3 Short description of the topic	Exploration of the Super-heavy Elements (SHEs) is one of today's research frontiers that recently drew wide public attention after discoveries of four new elements. Although most chemistry investigations on SHEs use the "easier" gas-phase methodology, many fundamental properties can best be studied in liquid phase. After preliminary test in 2016, a new joint Czech Technical University (CTU) – University of Oslo – Nuclear Physics Institute SHE laboratory was set-up at the U-120M cyclotron beamline in Řež (Czechia) in 2017/2018. The laboratory is equipped with a new Modular Robotic Gas-Jet Target System (MARGE) and a microfluidic liquid-liquid extraction (LLX) system developed at the CTU. The main focus of the new lab is on the chemistry of SHE homologues and on building an on-line versatile fast microfluidic aqueous chemistry apparatus.

	The topic of the proposed post-doctoral research will focus on electrochemistry of the homologues of transfermium actinoids and transactinoids. Main attention will be paid to the study of redox behaviour of Mo and W, as homologues for element Sg (Z=106), Tl and In, as homologues for element Nh (Z=113), and selected lanthanoids as models for the transfermium actinoids Md, No and Lr. The overall aim is to develop a system where the redox behaviour of seaborgium, nihonium and/or transfermium actinoids can be studied by observing the changes in liquid-liquid extraction (LLE) behaviour as a function of reduction potential in an electrochemical cell prior to the extraction stage. This approach is proposed since ordinary electrochemical approaches such as cyclic voltammetry are not available for the single-atom chemistry. Thus, one needs to investigate redox properties of the heaviest elements based on partition behaviour of the single atoms between two phases instead of measurement of electric currents arising from a redox reaction. For these studies a dedicated flow-through electrochemical cell will be developed for the initial stage of the project that should be later miniaturized for application in micro- or minifluidic systems. When applied to the target SHEs, these oxidation-reduction studies are expected to give valuable information on e.g. valence electron states. However, prior to performing very costly and time-consuming studies with the SHEs, the experimental techniques, devices and chemical hypotheses will be tested using SHE homologues that can be produced with smaller accelerators, e.g. the U-120M accelerator in Nuclear Physics Institute ASCR in Rez (NPI Rez) where the laboratory is hosted. Contrary to using long-lived tracers for "off-line" experiments, the small accelerator delivers radionuclides "on-line" identically to how the SHEs will be delivered. The project proposed here will be fundamental for strengthening the established collaboration in Europe for resurrecting research on liquid phase in the field of SHE chemistry and prepare background data for actual experiments in one of the SHE laboratories. *References to CTU publications:* 1. JOHN, J. Chemistry of Superheavy Elements – Test of the Limits of Validity of the Periodic Law. *Chemické listy*. 2019, **113**(4), 205-215. ISSN 0009-2770. 2. BARTL, P., et al. Microfluidic studies of SHE homologues in new facility at NPI REZ. *Czech Chemical Society Symposium Series*. 2018, **16**(2), 268. ISSN 2336-720 3. J.P. Omtvedt, NPI in Rez - New Site for Performing SHE-homologue Experiments. In: *Contributions*. TASCA 17, 16th Workshop on Recoil Separator for Superheavy Element Chemistry, Darmstadt, 2017-09-01. Darmstadt: GSI Darmstadt, 2017. 4. ČUBOVÁ, K., et al. Extraction of thallium and indium isotopes as the homologues nihonium into the ionic liquids. *Journal of Radioanalytical and Nuclear Chemistr* 2018, **318**(3), 2455-2461. ISSN 0236-5731. DOI 10.1007/s10967-018-6270-x. 5. BARTL, P., et al. Fast microfluidic extraction of Sg homologues at new joint CTU, UiO and NPI facility in Rez (CZE). In: *Book of Abstracts*. 6th International Conference on the Chemistry and Physics of the Transactinide Elements, Wilhelmshaven, 2019-08-25/2019-08-30. Darmstadt: GSI Darmstadt, 2019. 6. BARTL, P., et al. Rychlá kapalinová extrakce homologů seaborgia. *Czech Chemica Society Symposium Series*. 2020, **18**(3), 150. ISSN 2336-7202. 7. TERESHATOV, E.E., et al. Valence states of cyclotron-produced thallium. *New Journal of Chemistry*. 2021, **45**(7), 3377-3381. ISSN 1144-0546. DOI 10.1039/d0nj05198e.

CTU Global Postdoc Fellowship

4 Description of the ideal candidate	The ideal candidate must hold a PhD in chemistry. They should have a good background in nuclear and radiochemistry, working knowledge of electrochemistry, and practical hands-on experience from the work in a radiochemical laboratory. Experience with the work at particle accelerators will be an advantage.

Mentor

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Salary: CZK 62 000 per month
Application deadline: 30 November 2023
Start date: 01 January 2024