

Preparations for in-situ electrochemistry and neutron scattering at the European Spallation Source

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Europe is currently building the world's brightest neutron source in Lund, Sweden – the European Spallation Source ESS. The facility will be starting operations in mid 2025 and will be open for first scientific experiments in 2026. Electrochemistry is recognized as one of the scientific areas that is of broad interest to the neutron scattering user community and to society in general as it relates to renewable energies, energy storage, industrial processes such as corrosion and many other fields.

Neutron scattering has become very attractive for researchers interested in in-situ techniques with several high-intensity neutron sources coming online and older sources upgrading. For the past decade, various neutron scattering methods have been applied to explore electrochemical problems with a lot of new developments having occurred in the past five years. One of the areas crucial for good in-situ electrochemistry experiments are suitable sample cells. Sample cells allowing for in-situ electrochemical measurements while exposing the sample to neutrons are different from those for X-rays applications – in design and in material choice. As a matter of fact, the sample cells even differ between those used for elastic neutron scattering (diffraction, small angle scattering, reflectometry) and those for inelastic neutron scattering (molecular vibrations, phonons, diffusion processes). The design of the sample cells for electrochemistry poses one of the main challenges as the desired signal -e.g. single proton hopping, changes in the solid-electrolyte interface- is often hard to observe and extra material in the beam path can add background to the signal.

The talk will introduce the European Spallation Source ERIC and the neutron scattering instruments of interest for electrochemistry. The focus will be split between the research already being performed involving in-situ electrochemistry combined with neutron scattering and the plans for further developments of sample cells as well as infrastructure needed to support state-of-the-art electrochemistry. The figure below illustrates two cells already at ESS that are suitable for in-situ electrochemical measurements using inelastic as well as elastic neutron scattering.

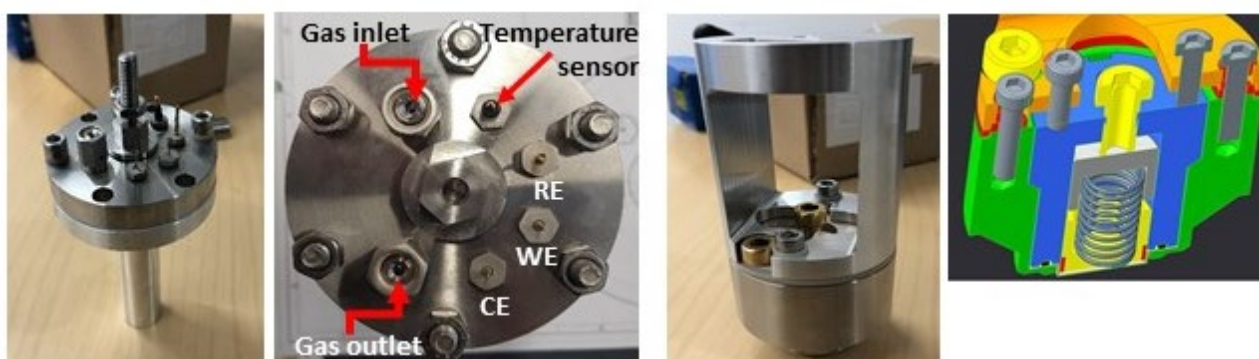


Figure 1: ESS is currently commissioning two electrochemical cells developed through an in-kind contribution from the University of Tartu, Estonia. The two pictures on the left show a versatile sample holder for electrode as well as electrolyte investigations. The two pictures on the right are of a pouch cell for battery measurements.