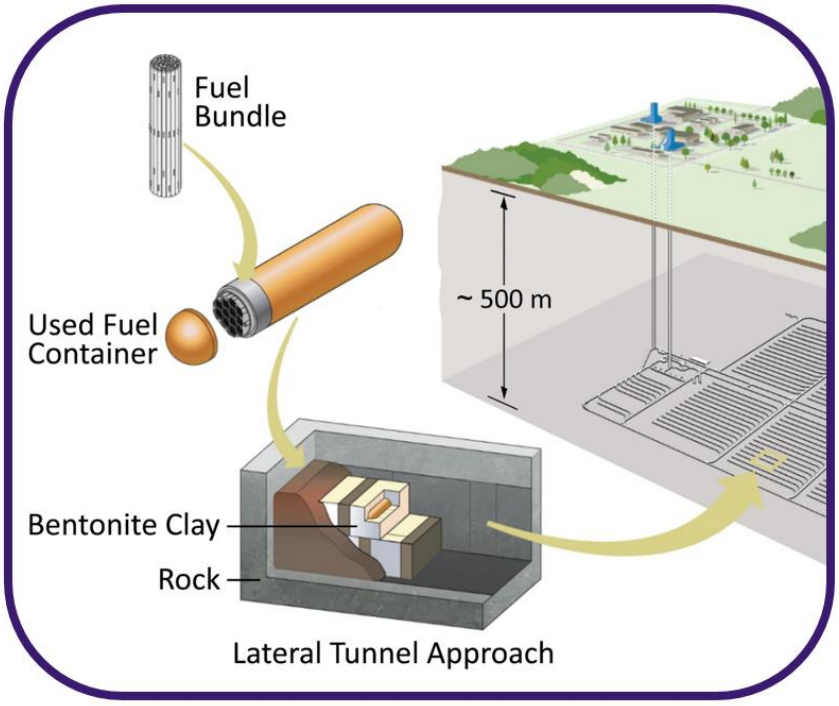
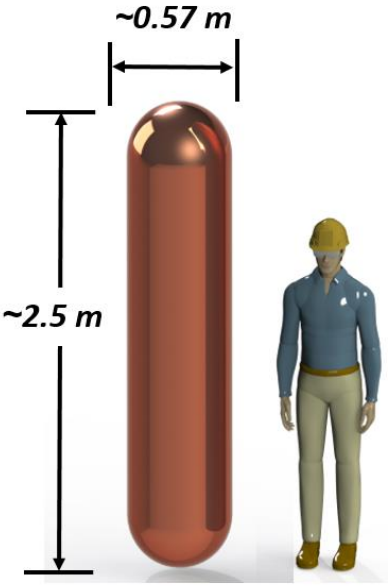
Jamie Noël
Western, Ontario, Kanada

General Overview of the Nuclear Fuel Waste Disposal Program in Canada (at 10.30.a.m)

The Canadian nuclear fuel waste disposal plan requires used fuel to be contained and isolated in a deep geological repository in a willing and informed host community. Previously, the Canadian concept was similar to that of Sweden/Finland: a two part container, consisting of an iron-based inner structure with a copper overpack for corrosion protection. In 2015, Canada changed the design of the used fuel container to a thinner and smaller copper-coated carbon steel vessel. Consequently, a series of reviews and corrosion programs have been designed to validate and verify the copper corrosion process. A brief overview of the Canadian container/emplacement strategy, as well as the corrosion programs underway, will be presented.





Cu-coated carbon steel container

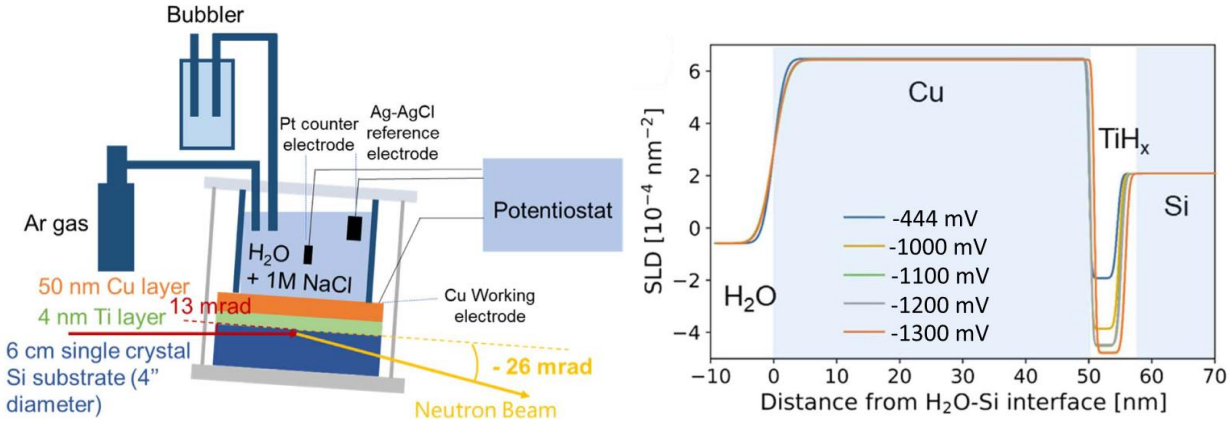
- Electrodeposited
- Cold spray

Atmospheric corrosion of Cu studied by quartz micro balance and hydrogen absorption by Cu measured by in situ neutron reflectometry (at 11 a.m.)

This lecture will cover two main topics: new techniques we have been developing for detecting and quantifying atmospheric corrosion and its precursors; and a modified, indirect means for observing and quatifying hydrogen absorption into Cu.

It is quite common for surfaces to become contaminated with salt deposits, from exposure to maritime aerosols, polluted air, contact with salt-bearing media, etc. The presence of salts may lead to the spontaneous formation of aggressive aqueous solutions on such surfaces at relative humidity well below saturation, via deliquescence processes. In this way, atmospheric corrosion attack could begin on a salt-contaminated metal surface. We have developed an approach, using a quartz crystal microbalance, to observe and quantify the deposition of pre-deliquescence moisture on metal surfaces, deliquescence, efflorescence, and corrosion attack, all with sub-monolayer sensitivity. The methodology will be described, illustrated with examples from investigations of potential Cu corrosion processes in the Canadian nuclear waste management program.

Aqueous corrosion processes frequently produce hydrogen atoms as a by-product. The majority of these tend to combine in pairs to make hydrogen molecules, but a small fraction of them may be absorbed into the metal upon which they were created, leading to generally undesireable changes in the metal's mechanical properties, and in some cases bubbling/blistering of the metal and delamination of layered materials. It is difficult to study hydrogen absorbed in metals because few analytical techniques can sense it. Non-destructive analysis of hydrogen in metals is particularly rare, but neutrons are known to interact strongly with hydrogen, and in situ neutron reflecometry is an analytical technique that allows the quantitative detaction of hydrogen, even inside a metal under electrochemical control in a corrosion cell, provided that the hydrogen concentration is above the detection limit (about 1 atomic %). This presentation will highlight our recent observations of hydrogen absorption into Cu in an electrochemical cell using in situ neutron reflectometry and a special trick that circumvents the need to have more than 1 at.% H dissolved in Cu.



Dr. James (Jamie) Noël

Education: B.Sc. (Chemistry, 1987, University of Guelph), M.Sc. (1990, Chemistry, University of Guelph), Ph.D. (2000, Chemistry, University of Manitoba)

Employment: 2021-present Associate Professor, Dept. of Chemistry, UWO, London, ON.

2016-2021 Assistant Professor, Dept. of Chemistry, UWO, London, ON.

(1998-2016) Research Scientist and Adjunct Professor of Chemistry, The University of Western Ontario, London, Ontario, Canada

(1991-1998) Research Officer, Atomic Energy of Canada Ltd., Pinawa, Manitoba, Canada

(1987-1991) Research Chemist, Ontario Hydro Research, Toronto, Ontario, Canada

Research: Dr. Noël is an electrochemist and corrosion scientist whose research is focused on the degradation of nuclear industry materials and on the development of innovative methodologies to study corrosion processes. He is particularly interested in coupling electrochemical and surface analytical methods, such as ion scattering and neutron scattering, to study otherwise inaccessible oxide film properties, and is internationally recognized for application of in situ neutron reflectometry to corrosion studies. Current research projects include the corrosion of: candidate materials for spent nuclear fuel containers (Cu, carbon steel, Ti alloys, Ni-Cr-Mo alloys); fuel cladding (Zr alloys); nuclear reactor components (carbon steel, stainless steels, Ni-Cr-Mo alloys, Cr-Co alloys); and nuclear fuel (UO_2).

Awards: Fellow of the Electrochemical Society, 2022 "For advanced individual technological contributions in the field of electrochemical and solid-state science and technology; and active membership and involvement in the affairs of The Electrochemical Society."

Western University Faculty Scholar, 2022-2024 and Western Faculty of Science Distinguished Research Professor, 2019-20 and 2020-21

R.C. Jacobsen Award of The Electrochemical Society, Canadian Section Canadienne, 2018 "Presented in recognition of significant contributions to the functioning of the ECS Canada Section and a passion for the advancement of electrochemistry in Canada."

Lash Miller Award (Electrochemical Society (ECS) Canadian Section, 2003) in recognition of excellence in electrochemical science and technology.

Service: Associate Editor of NACE CORROSION Journal, Chair of the ECS Education and Career Development Committees, ECS Corrosion Division Executive Committee member, and instructor of two popular ECS short courses on electrochemistry.

Publications: Author/co-author of 130+ peer-reviewed journal articles, 6 book chapters, 56 peer-reviewed conference proceedings papers and 22 company reports, and presenter of 25 invited lectures.

Selected Publications:
Most cited:

AC Lloyd, **JJ Noël**, S McIntyre, DW Shoesmith; Cr, Mo and W alloying additions in Ni and their effect on passivity, Electrochimica Acta 49 (2004) 3015-3027.

W Xu, K Daub, X Zhang, **JJ Noël**, DW Shoesmith, JC Wren; Oxide formation and conversion on carbon steel in mildly basic solutions, Electrochimica Acta 54 (2009) 5727-5738.

ME Broczkowski, **JJ Noël**, DW Shoesmith; The inhibiting effects of hydrogen on the corrosion of uranium dioxide under nuclear waste disposal conditions, Journal of Nuclear Materials 346 (2005) 16-23.

Recent:

A Situm, B Bahadormanesh, LJ Bannenberg, F Ooms, HA Feltham, G Popov, M Behazin, LV Goncharova, **JJ Noël**; Hydrogen absorption into copper-coated titanium measured by in situ neutron reflectometry and electrochemical impedance spectroscopy, Journal of The Electrochemical Society 170 (2023) 041503.

L Braithwaite, K Albrechtas, D Zagidulin, M Behazin, DW Shoesmith, **JJ Noël**; Galvanic coupling of copper and carbon steel in the presence of bentonite clay and chloride, Journal of The Electrochemical Society 169 (2022) 051502.

N Liu, F King, **JJ Noël**, DW Shoesmith; An electrochemical and radiolytic study of the effects of H_2 on the corrosion of UO_2-based materials, Corrosion Science 192 (2021) 109776.