

## Electrochemical Behaviour of Copper-coated Carbon Steel

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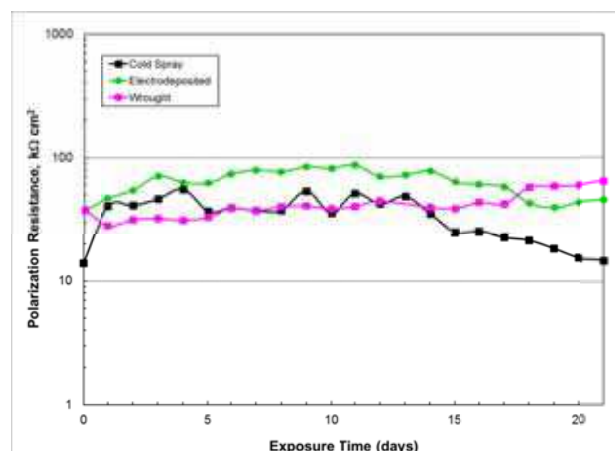
### Abstract

In the current Canadian design for nuclear waste disposal containers, an inner steel vessel is surrounded by 2.5 cm thick outer copper vessel. Current fabrication procedures under consideration include extrusion, pierce-draw processing, and forging. However, there are possible creep issues that could affect the integrity of the container, due to the loads resulting from glaciations and the swelling of wet clay backfill materials. As a result, alternative fabrication methodologies are under consideration, in particular cold spray and electrodeposited copper coatings. The advantage with the cold spray process is that coatings of reasonable thickness can be produced in relatively short times. The electrodeposition process, though slow, would produce coatings that are relatively free of strain.

The corrosion behaviour of both types of coatings is being investigated in this study. Cold spray coatings were applied by the National Research Council Laboratory (Montreal, Canada) and the electrodeposited coatings by Integran (Toronto, Canada). For comparison, a very high purity oxygen-free copper is also being examined.

The coating morphology was characterized using scanning electron microscopy coupled with energy dispersive X-ray (SEM/EDX) analysis. The surface and cross sections of samples were examined. The oxygen content within the coating was qualitatively evaluated using Time-of-flight secondary ion mass spectrometry (ToF-SIMS). Hardness and microstrain distribution at the coating/steel interface were also determined.

Electrochemical investigations were conducted in 3 M NaCl solution at room temperature. The open circuit potential was monitored as a function of immersion time, and linear polarization and electrochemical impedance spectroscopy (EIS) measurements were performed to determine the changes in the corrosion behaviour during immersion. Experiments were conducted in an anaerobic chamber (representing the oxygen-free conditions anticipated under disposal conditions), under argon purging (a few ppm of oxygen) and under oxygen purging (representing the initial disposal conditions). The results from the argon-purged experiment are presented in Figure 1. This figure shows the changes in polarization resistance ( $R_p$ ) as a function of the immersion time and shows similar values were obtained for all the specimens examined.



**Figure 1.** Effect of immersion time on the polarization resistance ( $R_p$ ) for the copper samples of interest.

After electrochemical experiments, the surfaces were examined for corrosion damage using SEM/EDX analysis. The corrosion product composition was determined using X-ray diffraction (XRD) and laser Raman spectroscopy.