The Canadian Centre for Electron Microscopy provides world-class electron microscopy capabilities and expertise. We are the go-to provider of electron microscopy services to Canadian industry and researchers working in a broad range of fields. Located at McMaster University and operated by the Brockhouse Institute for Materials Research, the CCEM features state-of-the-art instrumentation and experienced, dedicated staff who are happy to work with you to find solutions to your materials research and development questions.

Metallurgy

Electron microscopy is the leading technique for microstructural investigations at essentially all length scales of interest, from grain structure and texture analysis to atomic resolution imaging of defects and segregation. At the CCEM we have available techniques to study materials across the whole length-scale range, not only providing structural data but also information on composition and chemical state.

We can provide

- grain and phase identification, size/volume analysis
- identification and analysis of oxides, corrosion products
- crack measurement and analysis
- texture, orientation, misorientation
- dislocation imaging and deformation mechanism determination

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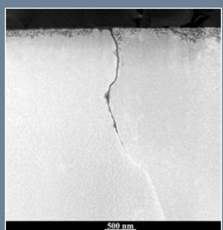
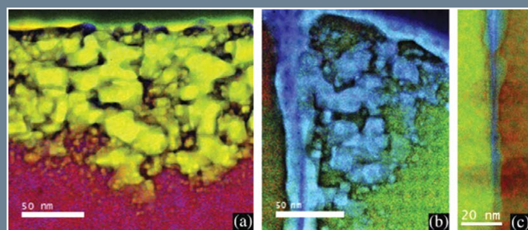
Investigation of the protective properties of Mg surface films

A major factor of concern for extending reactor life is the occurrence of primary water stress corrosion cracking. Alloy 600, a relevant material in CANDU reactors, was studied to determine its oxidation behaviour under simulated primary water conditions. Focused ion beam (FIB) cross-sections of specific sample regions were extracted and high resolution analytical electron microscopy provided images and chemical maps of cracked regions and specific crack features. It was determined that intergranular oxidation of solution annealed Alloy 600 occurred, resulting in embrittlement, but that heat treated Alloy600 underwent a slightly different oxidation process, with the end result being less embrittlement.

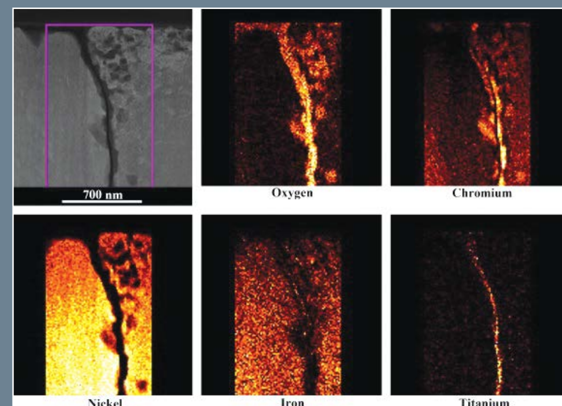


STEM image of a grain boundary micro-crack revealed after extracting a FIB cross-section from Alloy 600 previously exposed to hydrogenated steam.



Fe (red), Cr (green), and oxygen (blue) maps obtained, away from the crack (a), at the top of the micro-crack (b) and at the crack tip (c).

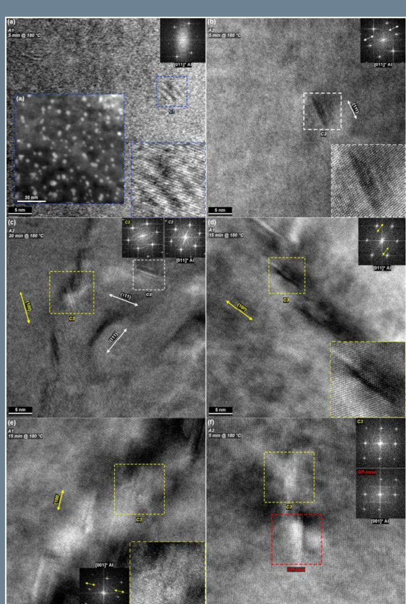
REFERENCE Internal oxidation of Alloy 600 exposed to hydrogenated steam and the beneficial effects of thermal treatment, S.Y. Persaud, A. Korinek, J. Huang, G.A. Botton, R.C. Newman, Corrosion Science 86 (2014) 108-122

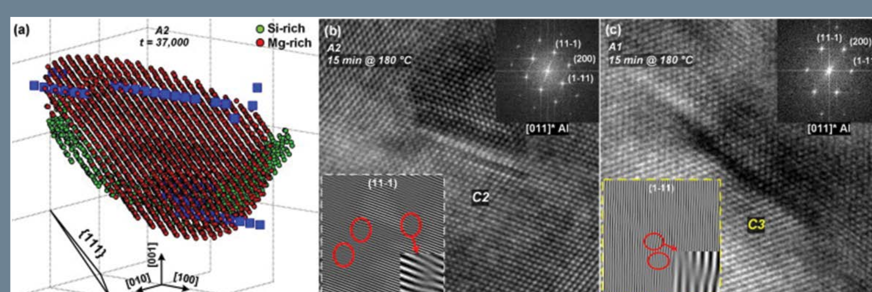


STEM image and elemental maps of the top of the intergranular crack from Alloy 600. Bright areas indicate enrichment. There is enrichment of O, Cr, and Ti while Ni and Fe are depleted.

Age hardening in aluminum (Al-Mg-Si) alloys

These alloys are strengthened by the inclusion of nano-scale precipitates with complex formation pathways. To optimize the strengthening effect of the precipitates their size, aspect ratio and orientation must be controlled, thus their formation and growth must be understood. HRTEM has the high resolution required to image the earliest stages of precipitation, giving unprecedented information on the initial microstructure; examination during aging (ex-situ) allows an understanding of the microstructural evolution, which can be used to design material processing routes for improved properties.





Above: Images showing association of clusters with dislocations. (a) A simulated cluster and (b, c) observed clusters. The inset Fourier-masked micrographs reveal dislocations marked with circles.

Left: HRTEM micrographs showing the evolution of clusters/precipitates.

REFERENCE Atomic-scale pathway of early-stage precipitation in Al–Mg–Si alloys, V. Fallah, A. Korinek, N. Ofori-Opoku, B. Raeisinia, M. Gallerneault, N. Provatas, S. Esmaeili, Acta Materialia 82 (2015) 457-467