Faculty of Engineering
Summer Research Program 2021-2022

Project Title: Atomic scale evolution of voids in aluminium
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Objectives
Scientific objective: To examine the factors responsible for the shrinkage and growth of voids in aluminium alloys.
Learning objectives: ⚫ Introduction to practical transmission electron microscopy and exposure to atomic-resolution imaging in one of MCEM’s flagship instruments.
⚫ How to perform simple structural analysis and modelling of nanoscale systems based on experimental TEM images.

Project Details
Voids are a significant problem in structural metal alloys and interconnects in electronic circuits (see Fig. 1). Yet the factors behind void stability and evolution remain poorly understood. A better knowledge of these factors would enable control of void evolution, with obvious practical implications. Such knowledge would also guide the design of void geometries for novel optoelectronic, plasmonic and metamaterials applications.

The project will image nanoscale voids in 1-2 simple aluminium alloys in a transmission electron microscope (TEM) using an in-situ heating sample holder. It will record, in real time and at the atomic scale, the temporal evolution of these voids as a function of temperature. Preliminary work performed in an older TEM (Fig. 2) shows the shrinkage of a void in pure aluminium via the peeling of single layers of vacancies. The project will use the Titan aberration-corrected TEM to make real-time image recordings at atomic resolution. From the obtained movies, void size and shape will be measured accurately as a function of time and temperature. A key aim will be to compare these observations of coated voids with our earlier work on voids in ultra-pure aluminium (Z. Zhang et al. J. Appl. Cryst. 49 (2016) 1459.) and extend our recent work on Sn-coated voids (X. Tan et al. Acta Mater. 206 (2021) 116594).

Prerequisites

Fig. 1: Voids in interconnect (Li et al. Microelectronics Rel. 44 (2003) 365.)
Fig. 2: Sequence of TEM images showing a void in pure Al shrinking by one atomic layer. Each dot corresponds to a single column of atoms normal to the page.

Fig. 2: Sequence of TEM images showing a void in pure Al shrinking by one atomic layer. Each dot corresponds to a single column of atoms normal to the page.
At least one of MTE2541, MTE2101 or MTE3547.