

Faculty of Engineering

Summer Research Program 2024-2025

Project Title: Dislocation analysis of engineering alloys by using x-ray diffraction and line profile analysis

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Objective

Work hardening of metals and their alloys is a fundamental aspect when considering ductility. It is also a driver for recrystallisation when material is processed. An important part of work hardening is the dislocation generation in the material because of plastic deformation. However, quantification of dislocation densities is challenging. For example, transmission electron microscopy interrogates only very small volumes of material while in engineering alloys plasticity tends to be highly heterogeneous, which means that large volumes need to be investigated in order to obtain meaningful data. It is also inherently difficult to visualise dislocations in alloys once they have been strained plastically by a few percentages.

X-ray diffraction is a tool that has been long used to estimate dislocation densities though it is still not widely used. More recent advancements in developing a concept of analysing the shape of diffraction peaks to determine dislocation densities have highlighted the importance of x-ray diffraction in this field

Project Details

The aim of the project is for the student to undertake some mechanical experiments and deform austenitic steels to different levels of plasticity though some samples will already be available. These samples will then be investigated using careful x-ray diffraction measurements utilising a recently acquired X-ray diffractometer by the Monash X-ray Platform and a freely available analysis tool called Convolutional Multiple Whole Profile fitting. This experimental approach can be used to quantify dislocation density as a function of plastic strain and compare different types of metals or alloys to relate the build-up of dislocation density to the work hardening behaviour.

Prerequisites

The student should have an interest in materials science, mechanical testing and dislocation structures. Some basic understanding of x-ray diffraction is desirable but not necessary if the student is interest in reading up on these things.