

Faculty of Engineering

Summer Research Program 2022-2023

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 also is 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. 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 have again 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 to load certain types of alloys 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 the modern X-ray diffractometers on the Monash X-ray Platform and a freely available analysis tool called Convolutional Multiple Whole Profile fitting. Such experimental approach will enable to consider the 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 hardening behaviour.

In case the student is based overseas some existing samples will be made available and the diffraction analysis will be carried out by staff of the Monash X-ray Platform and the data will be send to the student for analysis. The data analysis is the most time-consuming aspect of the project and will require the student to gain a good understanding of x-ray diffraction analysis. The software tool required for the analysis can be downloaded from anywhere in the world but requires a computer that has a Linux operation system.

Prerequisites

The student should have an interest in metallurgy, 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.