

Faculty of Engineering

Summer Research Program 2024-2025

Project Title: Building Advanced Analytical Pipelines for 3D Materials Science

Supervisor(s): Yuxiang Wu, Michael Preuss

Email: yuxiang.wu@monash.edu, michael.preuss@monash.edu

Website profile of project supervisor:

<https://www.monash.edu/engineering/departments/materials/about-us/our-people/academic-staff>

Objective

Materials characterisation is essential for humans to understand nature, optimise existing materials, and design new materials in a sustainable way. Monash University is a national leader in materials characterisation and materials science, which boasts one of the largest investments in characterisation infrastructure in Australia. Reliable interpretations depend on 3D analysis rather than traditional 2D approaches, which is critical for industries such as energy, transport, mining, health, and more.

In this project, we will explore the 3D analysis of materials characterisation data, particularly in collaboration with our pillar technology platform, the Monash Center for Electron Microscopy. We aim to develop an advanced analytical pipeline for 3D materials science based on electron microscopy data. We invite engineering students to join this initiative, integrating a data analytical pipeline into the materials characterisation workflow and exploring future possibilities together. Students will gain research experience in cutting-edge topics in materials science, materials characterisation, and software, preparing them for diverse career paths in engineering and academia.

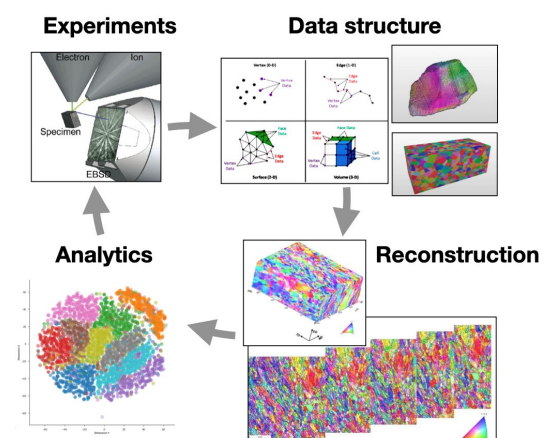


Figure 1 Analytical pipeline for 3D Materials Science

Students will gain research experience in cutting-edge topics in materials science, materials characterisation, and software, preparing them for diverse career paths in engineering and academia.

Project Details

The student will work with a pre-collected dataset from a series of two-dimensional electron microscopy scans, primarily focusing on electron backscatter diffraction data, along with other types (such as backscattered electron and chemistry data). This multidimensional dataset incorporates rich crystallographic orientation information about the microstructure. As shown in Fig.1, this dataset includes basic elements that are to be incorporated into grain features and eventually into a microstructure ensemble (e.g., a reconstructed grain orientation in 3D). The student will begin with the raw data and develop a complete analysis that extends to 3D reconstructions, using a combination of software tools including Dream3D, Dragonfly, Paraview, and customized Python scripts.

The outcome of this project is an in-house analytical pipeline that enhances our experimental data collection workflow. This pipeline will enable us to align, segment, and reconstruct data, and further develop a set of advanced microstructure analyses, including the incorporation of machine learning methods.

Prerequisites

We encourage all students motivated by this project description to apply. The ideal candidate should possess expertise in materials characterization and software development. Students familiar with SEM characterization and microstructure, who also have experience in Python or other object-oriented programming languages, will find it easier to begin this project.

Additional Information

Please email Dr. Yuxiang Wu/Prof. Michael Preuss (yuxiang.wu@monash.edu and michael.preuss@monash.edu) for more details before applying. In your email, please explain (within 200 words): Why this project interests you? Which past experiences/knowledge prepare you for success in this project? Describe a scenario where you solved a hard problem from scratch?