4D Neutron Imaging on Textured Samples

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- PhD in physics from University of New South Wales (Australia)

- Postdoc in European Spallaton Source (ESS) on BEER diffraction beamline in cooperation between 15 EU country and Japan

- Worked in different countries and reactor/spallation sources (such as ANSTO – Australia, JPARC – Japan, HZB - Berlin, PSI - Switzerland, UJF - Czech Republic)

- Member in the national committee of crystallography (2023)
Some of the python codes used for the data analysis are found in [https://github.com/nancynaguib/imaging-python](https://github.com/nancynaguib/imaging-python)
Beamtime

Outline

- Neutron Imaging
- Experimental setup
- Computed Tomography and phase reconstruction
Beamtime

Experimental setup

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MCP detector

![Diagram showing stress vs deformation with markers for Stress 1 to Stress 6.]

- Tomography
- Radiography (strain)
- 46 projections over 360 degree for Stress 1 and Stress 6
- 25 min exposure time
Beamtime: Experimental setup

Flux: $1.3 \times 10^6 \text{ n/s/mm}^2$

Wavelength: 0.4 - 4.4 Å

Spatial resolution: 55 μm

Wavelength resolution: 0.2%
Stress 1

Stress 4

ROI-middle

BCC (211)

Transmission (%)

wavelength (Å)

Stress 1

Stress 4

Stress 6

Stress 1

Stress 4
Bragg edge transmission imaging

Background

- At certain hkl plane, the scattering angle increases with λ increases (red)
- Till θ

No more scattering from same hkl plane with increasing λ

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<th>Total cross Section (barn)</th>
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<th>λ &lt; 2d_{hkl}</th>
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<td>2d_{hkl} sinθ = λ</td>
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Total cross Section (barn) vs. wavelength (Å)

- Cu
- Fe (bcc)
- Fe (fcc)
- Al
- Zr
- Ni
- Pb
- The two angles (0° and 30°) look similar indicating no textured is observed in this sample.

Tomography at two angles show strongly textured structure sample.
Beamtime

Texture analysis

(a) Change in edge shape

(b) Change in edge height

(c) Transmission as a function of wavelength (Å)
- The texture for the three states at the three Bragg edge positions for austenite phase; (220), (200) and (111)
• Rietveld fitting for diffraction pattern for the virgin state confirms the austenite single phase
• The idea is to get the phases from the CT reconstruction, however we need to get the best quality CT slices.
The idea is to get the phases from the CT reconstruction.
- Stress 1 was all Austenite FCC and Stress 6 was mixed phase, some Martensite appear
- I choose to do CT around 4.15 Å (Austenite peak)
The Intensity is nearly uniform over all the sample.

The middle gauge has lower intensity as result of lower percentage of the FCC phase.
Beamtime SENJU  CT reconstruction
Take home message

X ray diffraction, neutron diffraction and neutron imaging are very powerful tools to study materials and correlate their structure with their properties
Acknowledgements
Some nice moments 😊
Thanks for your time