Towards 3DXRD visualization of in-situ measurements of grain orientation induced braze alloy wetting

TOOLS FOR ENHANCED DATA-ANALYSIS

THE INDUSTRIAL CHALLENGE

Braze clad on aluminium sheets enables fast and convenient brazing assembly of complex heat exchangers. However, there are processes in the brazing process that are poorly understood. One serious problem is if braze alloy penetrates into the bulk of the sheet material, which can lead to reduced corrosion resistance.

WHY USING A LARGE SCALE FACILITY

Standard tools to analyse material microstructures are light microscopy, Scanning Electron Microscopy (SEM) and Electron Back-Scatter Diffraction (EBSD). However, these techniques provide 2D data on cut surfaces and thus suffer from poor statistical sampling and restricted detail, plus require long sample preparation times. On the other hand, 3D techniques available at synchrotron radiation facilities allow analysis of the material microstructure over representative volumes and can yield details on the braze structure and penetration, as well as the related orientations and juxtaposition of all the grains in the material.

NEED FOR IMPROVED ANALYSIS

This project worked primarily with 3D X-ray diffraction (3DXRD) data obtained at the Swedish Material Science beamline P21-2 at Petra III, Hamburg, led by Dr. Ulrich Lienert. These data were supported by x-ray tomography data acquired on the same samples at the 4D Imaging Lab at Lund University. However, no easy-to-use tools exist to visualise and explore 3DXRD data or to integrate them with 3D X-ray tomography.

THE RESULTS AND EXPECTED IMPACT

Python-based software tools developed in the project enable visualisation and analysis of output from 3DXRD experiments. Key components are facilitating the merging of multiple 3DXRD scans that cover the length of long samples, as well as providing visualisations of the grain centre positions and distributions with their crystallographic orientations and relative volumes (see Figure). These visualisation tools provide an accessible representation of the data for non-experts. These tools have been tested on the braze-clad aluminium data from Petra III, as well as similar data for ductile cast iron from ESRF. Subsequently the software has been added to the DDDXRD tools collection. The analysis and visualisation enabled by the new software permitted the project team to better analyse the available data to gain new insight into the brazing process and the braze alloy penetration problem. First results have been submitted for publication in the journal "Advanced Engineering Materials". Approaches for analysing associated x-ray tomography data and their combination with the 3DXRD output were also developed. However, application of the latter was hampered by quality issues in the braze-clad aluminium data set.
Overall, the project has helped Gränges to understand the possibilities with these advanced analysis methods.

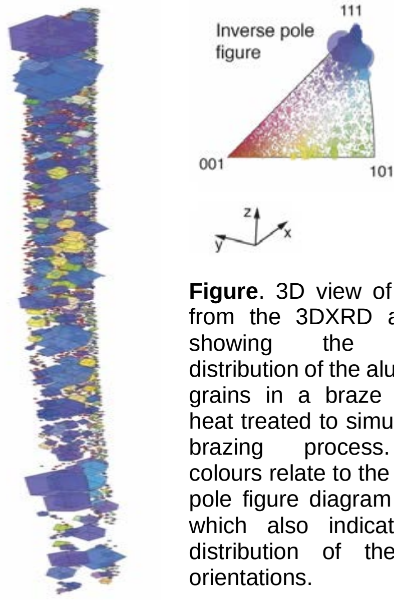

Figure. 3D view of results from the 3DXRD analysis showing the spatial distribution of the aluminium grains in a braze sample heat treated to simulate the brazing process. The colours relate to the inverse pole figure diagram above, which also indicates the distribution of the grain orientations.

"Gränges will definitely continue to use synchrotrons" ***/Linda Ahl, Gränges Sweden AB***

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