INDUSTRIAL PILOT PROJECT

3D investigation of grain orientation induced braze alloy wetting

THE INDUSTRIAL CHALLENGE

Braze clad on aluminium sheets enables fast and convenient brazing assembly of complex heat exchangers. A well-known, but poorly understood, application problem is that the braze alloy may penetrate into the bulk of the sheet material, which reduces the corrosion resistance.

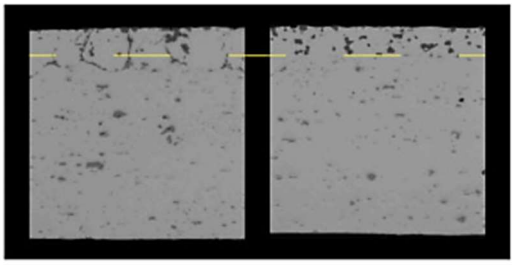

Figure 1. Aluminium sheet with a braze clad before brazing (right) and after brazing (left). The dashed yellow line highlights the original boundary between the aluminium core and the braze clad.

WHY USING A LARGE SCALE FACILITY

Recent studies indicate that the relative orientations of neighbouring grains might play a key role for braze alloy grain wetting. The results indicate that the effect may be critically dependent on the grain orientation mismatch. Obtaining the grain orientation is difficult and time consuming when using conventional techniques. Convenient synchrotron radiation-based methods, on the other hand, can provide 3D images that show orientations, shapes and locations of all grains in a sample.

HOW THE WORK WAS DONE

To obtain detailed 3D images the work has included three synchrotron radiation-based 3D imaging techniques: 1) Phase-contrast X-ray tomography (PCXCT), 2) 3D X-ray diffraction (3DXRD) and 3) X-ray diffraction contrast tomography (DCT). Studies have been performed at BL14B2 at SPring-8 in Japan and at the Swedish beamline (P21-2) at PETRA III in Hamburg, Germany. The SPring-8 session focused on the DCT in combination with PCXCT while the PETRA III session focused on 3DXRD in combination with PCXCT. These studies were complemented by additional X-ray tomography at the 4D Imaging Lab at Lund University. Project participants were representatives from Gränges R&I, Uppsala Synchrotronix AB and Lund University, together with the 3D imaging experts Dr. Daiki Shiozawa (Kobe University) for the SPring-8 session and Dr. Johan Hektor (DESY) for the PETRA-III session.

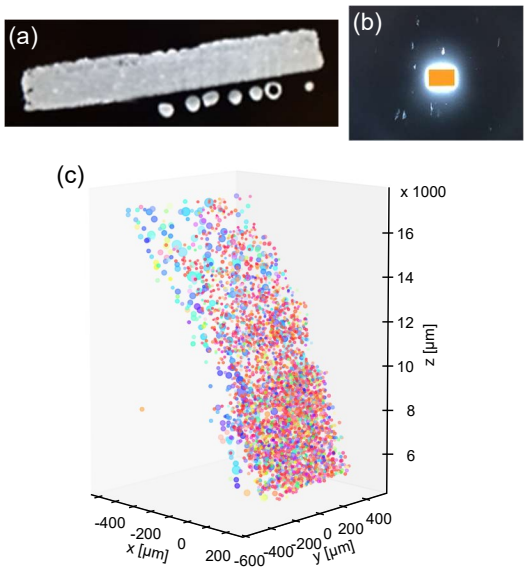

Figure 2. (a) a slice from the tomography imaging at SPring-8. The balls under the aluminium sample are glass beads that make it easier to identify positions in the samples. (b) the DCT data where every bright spot around the centre is a diffraction-projected grain image with a certain orientation. (c) the 3DXRD result image where every circle represents a grain. The diameter and colour of the circles corresponds to the grain size and orientation, respectively.

THE RESULTS AND EXPECTED IMPACT

The acquired data have provided 3D images of aluminium sheet materials showing characteristic signs of different stages of braze alloy penetration. The project has provided new perspectives on the braze alloy penetration process and valuable inputs for new approaches towards reducing this unwanted phenomenon.

"With the knowledge we have acquired we are now at the forefront in this field"
/ Torkel Stenqvist, Gränges R&I

GRÄNGES LUND UNIVERSITY Uppsala Synchrotronix AB

Contacts: Linda Ahl – Gränges Sweden AB, linda.ahl@granges.com
Stephen Hall – Lund University, stephen.hall@solid.lth.se
Mårten Edwards – Uppsala Synchrotronix AB, marten@synchrotronix.se

Vinnova's project No: 2018-03268 **Duration:** Oktober 2018 -- Oktober 2019

Funded by Sweden's Innovation Agency, Vinnova, in order to build competence and capacity regarding industrial utilisation of large-scale research infrastructures such as MAX IV and ESS.