EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office via the User Portal: *https://wwws.esrf.fr/misapps/SMISWebClient/protected/welcome.do*

Deadlines for submission of Experimental Reports

Experimental reports must be submitted within the period of 3 months after the end of the experiment.

Experiment Report supporting a new proposal ("relevant report")

If you are submitting a proposal for a new project, or to continue a project for which you have previously been allocated beam time, you must submit a report on each of your previous measurement(s):

- even on those carried out close to the proposal submission deadline (it can be a *"preliminary report")*,
- even for experiments whose scientific area is different form the scientific area of the new proposal,
- carried out on CRG beamlines.

You must then register the report(s) as "relevant report(s)" in the new application form for beam time.

Deadlines for submitting a report supporting a new proposal

- 1st March Proposal Round - **5th March**
- 10th September Proposal Round - **13th September**

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report in English.
- include the experiment number to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** Investigation by 3D nano-imaging of intermetallic growth kinetics in dissimilar metallic joint during heat treatment	**Experiment number**: **MA-4095**
Beamline: ID16B-NA	**Date of experiment**: from: 04 July 2018 to: 09 July 2018	**Date of report**: 09/09/2020
Shifts: 15	**Local contact(s)**: VILLANOVA Julie	*Received at ESRF:*

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Report:

Objective:

Intermetallic (IM) have been widely investigated over the past few decades. Within the iron aluminum IMs, particular attention has been given to Fe_3Al - β1 phase (< 50 at.% Al) which offers good resistance to sulfidation, oxidation at high temperature and mechanical wear, while having relatively high ductility among all the Fe/Al IMs and lower density than that of steel [1, 2]. Other Al-rich (≥ 50 at.% Al) Fe/Al IMs are FeAl - β2, $FeAl_2$ - ζ, Fe_2Al_5 -η, Fe_4Al_{13} – θ (also referred to as $FeAl_3$ in some early literature) and Fe_5Al_8 - ε (only stable at temperatures above 1095°C [3]). The β2 and ζ phases form via decomposition of ε phase resulting in lamellar microstructure [4-6]. However, their limitation of use and disadvantage come from a low ductility (at room temperature) involving very small capability to deform plastically before fracture. Presence of such IMs at the dissimilar welded joints results in premature failure due to stress concentration at the interfaces followed by a rapid and catastrophic propagation of crack through the welded joints. Hence, minimising the IM growth is a goal of many researchers to improve the mechanical performance of multi-metallic dissimilar joints [7]. Moreover, reducing the IM growth can help to minimize the residual stress induced by the IM and thus identifying the appropriate growth mechanism enable to apply appropriate measures to control the growth kinetics. Therefore, this experiment is carried out to develop a complete understanding of the IM growth kinetics using X-ray nano-holotomography techniques during thermal treatment.

Experimental method:

The friction melt bonding (FMB) techniques is used to fabricate Al/Steel bimetallic joints at UCLouvain. A schematic illustration of the sample geometry is given in Fig 1.

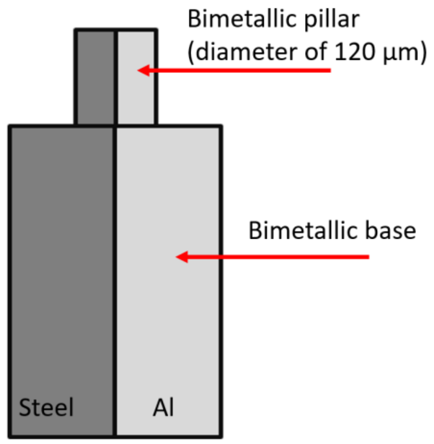

Fig. 1. Schematic illustration of the sample geometry

5 micro piller samples were treted to identify the IM growth kinetics, with different heating interval. Here the 1st sample results are explained below in Fig. 2.

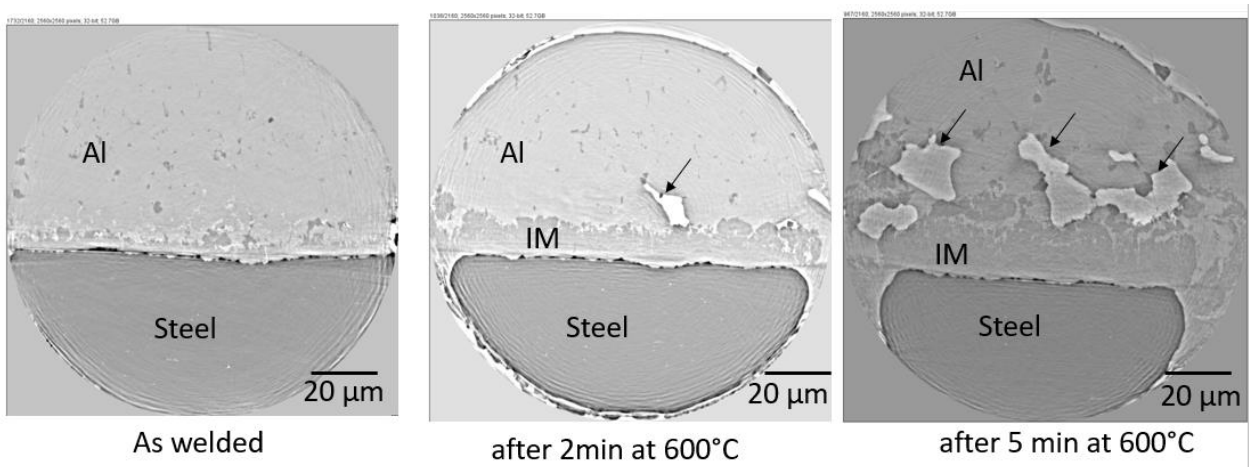

Fig. 2. IM growth with the anealing treatment

In situ heating reveled the growth of IM, growth and evalution of Kirkendall porosity (Porosity marked by black arrow). On the steel side the black and white region correspond to the heterogeneous interlocking at the interface. Further post treatment has been performed to understand the fundamental mechanisms in the growth kinetic of IM and porosity. It revealed that the grain boundary diffusion is not the competing mechanism during the IM growth, while the bulk diffusion is the leading mechanism during the IM growth. After that, further studies at lab scale were performed to develop a complete understanding on the IM growth. **One journal article will be submitted on these original findings of IM growth on Al/Steel joints.**

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