ESRF	**Experiment title:** Mechanical behavior of magnetic pulse welded samples	**Experiment number**: MA-5505
Beamline: ID19	**Date of experiment**: from: 31/08/2022 to: 01/09/2022	**Date of report**: 15/02/2023
Shifts: 3	**Local contact(s)**: Bratislav LUKIC	*Received at ESRF:*

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Report:

During the three shifts, impact tests using the Split-Hopkinson Pressure Bars (input and output bars are 1300 mm and 1100 mm long, respectively with a diameter of 12.7 mm) were successfully performed on Al/Cu welded samples. A set of 128 images was record during the impact, with an inter-frame time of 1930 ns. Before and after the impacts, samples were scanned by High resolution phase-contrast computed tomography to evaluate the evolution of the structures due to the mechanical tests. A voxel size of 1.43 µm was used for this experiment. During the shifts, the 16 bunch-filling mode was consiered.

Figure 1: Illustration of an Al/Cu assembly

From the initial Al/Cu assembly (figure 1), cubic samples were extracted from welded samples as presented in figure 2 (a-b) from Zielinski et al. [1]. A scheme of the experimental set-up of the samples with the SHPB, X-ray beam, and location of the ultra-high speed camera at ID19 is highlighted in figure 2 (c) from Zielinski et al. [1]. During the beamtime, two types of mechanical behaviors were identified thanks to the X-ray imaging available at ID19. The origin of such differences is related to initial cracks at the interface of the Copper and the Aluminium assembly. It was confirmed by initial tomography analysis on the samples performed also at ID19. Two orientations of the cubes were considered (0° and 90°):

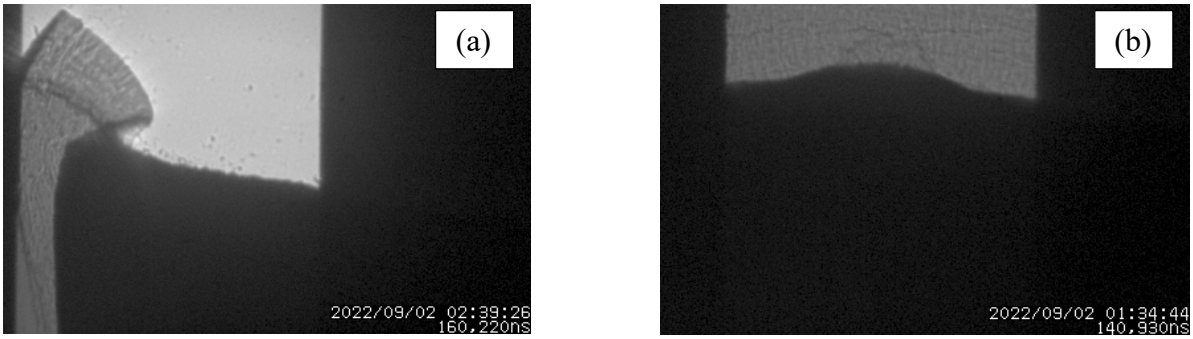

Figure 2: Ultra-fast X-ray radiographies of Al/Cu samples with two orientation. The welding joint is parallal to the bars (a) and perpendicular (b)

The figure 3 below illustrates an opening at the Al/Cu interface clearly visible thanks to the ultra-fast X-ray imaging :

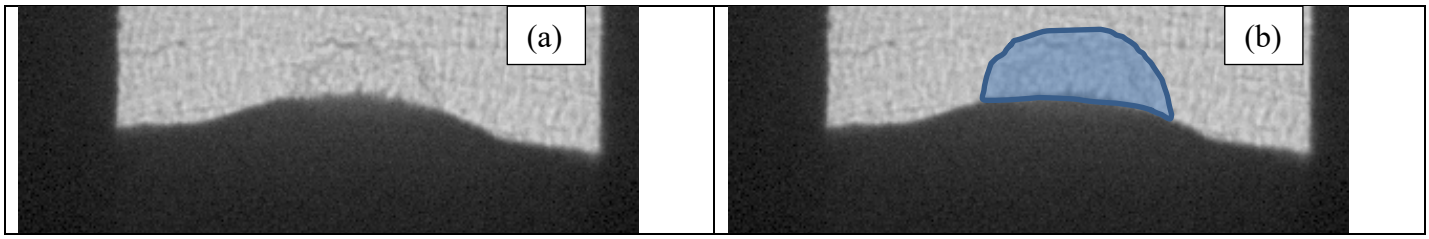

Figure 3: (a) Opening at the Al/Cu interface, (b) Illustration of the opening at the interface

Computed metrics were performed on the opening (surface, height and width).
Three domains of morphological evolutions of the opening at the interface during the impact (computed from the opening) were correlated with the applied force on the samples at high strain rates about 3250 s^{-1} and impact speed of 12 m/s.

A paper was accepeted based on this proposal [1]. Benjamin Zielinski presented this work at the ESRF-Users Meeting 2023 [2]. A talk will be done at the MecaDymat 2023 conference in Valenciennes regarding the results of this experiment.

Another article is actually under writing concerning the tomographic part of this experiment.

1. Zielinski, B.; Sadat, T.; Lukić, B.; Haugou, G.; Morvan, H.; Rack, A.; Markiewicz, E.; Dubar, L. Characterization of Local Mechanical Properties of Al/Cu Magnetic Pulse Welded Joints under High Strain Rates Using Synchrotron X-Ray Imaging. *Materials Letters* 2023, *337*, 133943, doi:10.1016/j.matlet.2023.133943.

2. Zielinski, B.; Sadat, T.; Lukić, B.; Haugou, G.; Morvan, H.; Rack, A.; Markiewicz, E.; Dubar, L. Local characterisation of Al/Cu weld interface produced by magnetic pulse welding under high strain rates and Synchrotron imaging. Esrf-Users Meeting 2023.