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FSW and subsequent creep forming on Al5028 alloy designed for aircraft application.

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Weight reduction is of prime interest for aircraft manufacturers both economically and ecologically. It is part of the solution to reduce the CO_2 emission in aviation as it is imposed by the European union. To achieve that goal, research on friction stir welding (FSW) of an Al5028 developed and patented by Novelis has been performed in collaboration with Sonaca aerospace company. FSW followed by creep forming opens the door to the design of integral structures, which allows drastically simplifying the assembly operations, getting some significant weight reduction and showing some better mechanical performances than the current riveted assembly.

Al5028 alloy is a 5xxx series aluminium alloy containing a small amount of Sc and Zr that provide a non-recrystallised microstructure after hot and cold rolling. The effect of the FSW parameters on the grain structure and on the static mechanical properties of this alloy have been analysed. Hardness mappings, tensile tests as well as bending tests were performed. Significant loss of strength in the weld can be avoided by a good selection of the welding parameters. For the best welding conditions, a FSW joint efficiency of more than 90% was obtained. Digital image correlation was used to track strain localisation in the welded zone, which varies with the welding parameters. An example of the analysis performed is provided in Figure 1. Finally, the effect of hot creep forming on the welds was investigated. To this aim, a heat treatment mimicking this forming operation was applied to the FSW samples. The impact on their microstructure as well as their static mechanical performances was analysed. It was concluded that this treatment had no major impact, neither on the grain size, nor on the precipitates observed by SEM. TEM analyses will be needed to quantify its impact the smallest precipitates. Regarding the mechanical properties, they were only slightly influenced. It demonstrates that 5028 aluminium alloy is well suited to be welded by FSW and subsequently creep formed.

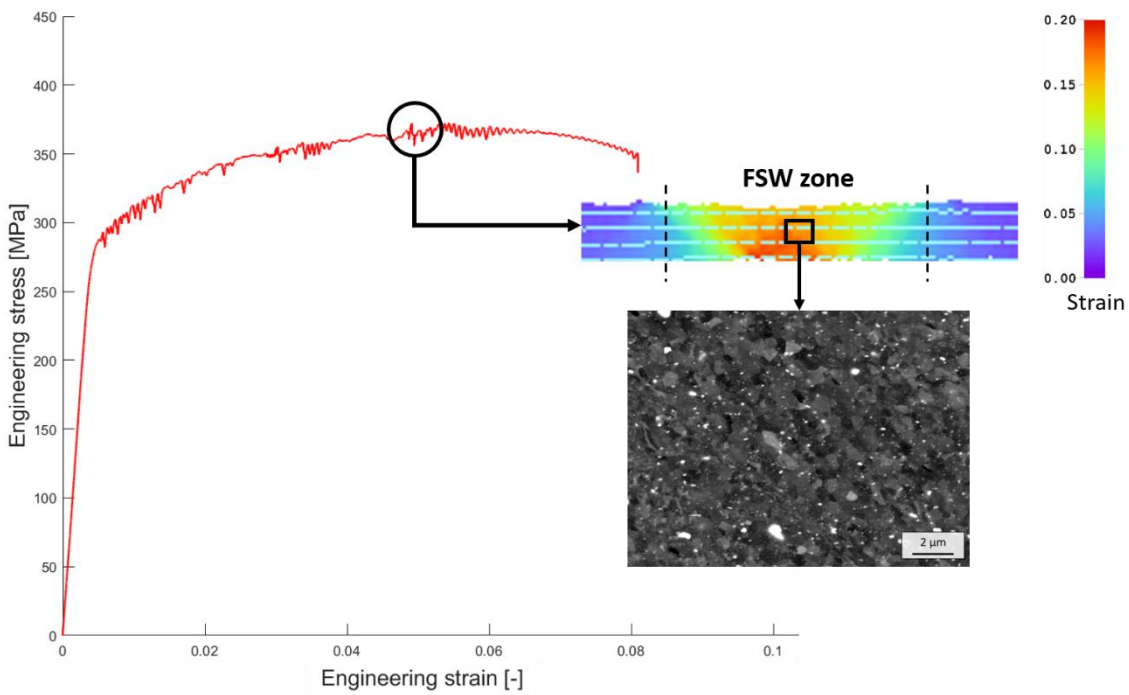

Figure 1: Engineering tensile curve of FSW Al5028 with DIC results showing the local strain as well as a SEM microstructure showing the fine equiaxed grains present in the nugget.