Two metal sheets of Titanium 21S have been stir welded at a rotation speed of 200 tr/min. and a linear speed of 50 mm/min. The microstructure was studied by EBSD. The particularity of this study is the very long duration of the EBSD acquisition experiment that was run over 9 days in continuous. To set this experiment a combine stage/beam acquisition was started up after having selected different areas including some large joined zones located at different positions over the sample. This type of experiment is only possible if the SEM can be stable enough over such a long period, which means that only a few schottky type FEG-SEM could be used. Figure 1 shows some typical areas (in blue) that were recorded. It shows also an orientation map acquired on an area of 15 mm x 4 mm at a step size of 2 microns although the blues areas (and others) were acquired at a step size of 0.2 micron (figure 2). The first one allowed a general overview of the microstructure evolution and the others the detail observations on specific parts. Doing some large areas combining stage en beam moves allow to be sure to get all the needed data in one go all over some interfacial zones (like area 4 and similar, by example).

At the initial state, the material is formed of an equiaxe grain size of about 35 microns. The microstructure is becoming very fine at the centre of the welding and evolve trough the thickness of the sheets. Orientation maps with the smallest step confirm the mean grain size in the area number 1 of about 1 micron and in zones 2 and 3 of about 2 microns. This important reduction is characteristic of a severe plastic deformation process. These small grains show a very small intragranular misorientation not more than 1°. In the contrary, in area number 4 grains show large intragranular misorientations (figure 3).

The analysis of the texture clearly indicates that the tool generates, during its rotation, a very strong shearing of the material.

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Fig. 1: Weld section of the whole sample with typical small step acquisition areas, in blue. Left side: the retreating side, right side: the advancing side.

Fig. 2: Grain sizes in zones 1, 2 and 3

Fig. 3: Variation of intragranular misorientation along an interface containing small and large grains.