Microsc Microanal 15 (supp 3), 2009 79
Copyright 2009, LASPM doi:10.1017/S1431927609990857

Defect formation and microstructural changes in friction stir welds between pure copper and a brass alloy

Rui M. Leal [*, **], Carlos Leitão [*], Altino Loureiro[*] and Dulce M. Rodrigues [*]

[*] CEMUC – Department of Mechanical Engineering, University of Coimbra, Rua Luís Reis Santos, Pinhal de Marrocos, 3030-788 Coimbra, Portugal
[**] ESAD.CR-IPL Rua Isidoro Inácio Alves de Carvalho, 2500-321 Caldas da Rainha, Portugal
altino.loureiro@dem.uc.pt

Several attempts have been made in the last few years for joining similar pure copper [1, 2] and brass alloys [3, 4] using the solid state friction stir welding (FSW) process. For both material types, all the works performed reported that the production of defect free welds is largely dependent on the correct choice of process parameters. It was also observed that, despite grain refinement occurred in the centre of all the welds, the welds in copper showed a slight reduction in strength, when compared to that of the base material, as opposed to welds in brass alloys, for which an increase in strength was observed. Regardless of the encouraging results obtained in similar FWS of these materials, in the knowledge of the authors, few reports exist concerning dissimilar joints between them. In his work, dissimilar welds between Cu DHP cooper plates and Cu-Zn 37 brass plates, both of 1 mm thickness, with the brass plate positioned in the advancing side of the tool, were analysed. Welds were carried out with a solid tool made of high speed steel. Tool geometry was characterized by a tool shoulder of 10 mm in diameter, containing a conical cavity of 6 degrees, and a threaded probe of 3 mm in diameter. Welds were done in a milling machine, in position control, using the working parameters indicated in table 1.

Though the welds obtained displayed good surface appearance, see Fig. 1, optical microscopy revealed the existence of large voids in the stirred zone, close to the brass alloy side of the weld, as shown in Fig. 2. Fig. 2 illustrates a cross section of a weld selectively etched with convenient reagents, displaying cooper material on the right side and brass alloy on the left. Magnifications of the main zones of the weld are also depicted in the same figure. In this figure it is possible to observe a narrow zone where the grains suffered significant plastic deformation due to the action of the rotating tool. In fact, at the centre of the weld, copper and brass were submitted to large plastic deformations following complex strain paths. Copper was drawn from the retreating to the advancing side of the weld by the action of the tool shoulder but the combination of the effects of shoulder and probe was not enough to fill the groove created by the probe. A very fine "equiaxial" grain structure was observed in the central zone of the welds; this zone is currently named nugget. In order to verify if there is an effective mixture of both materials in this zone an electron probe micro analysis of copper and zinc was also done in the nugget, in the transition between booth materials, as shown in Fig. 3. This figure shows that there is not an effective mixture of both materials in the nugget. These results suggest that an insufficient plasticization of both materials happened during welding.

References:
[1] W.B. Lee, S.B. Jung, Materials Letters, 58 (2004) 10041.
[2] T. Sakthivel, J. Mukhopadhyay, J. Mater. Sci. 42 (2007) 8126.
[3] H. S. Park et al., Mat. Sci. and Eng. A 371 (2004) 160.
[4] G. Çam et al., Mat.-wiss. u. Werkstofftech, 39 (6) (2008) 394.

Table 1 – Welding parameters

rotation speed ω (rpm)	travel speed *v* (mm/min)	Tool tilt angle α (º)	Plunge depth (mm)
1140	300	2	0.8

Fig. 1 – Appearance of the crown of the welds

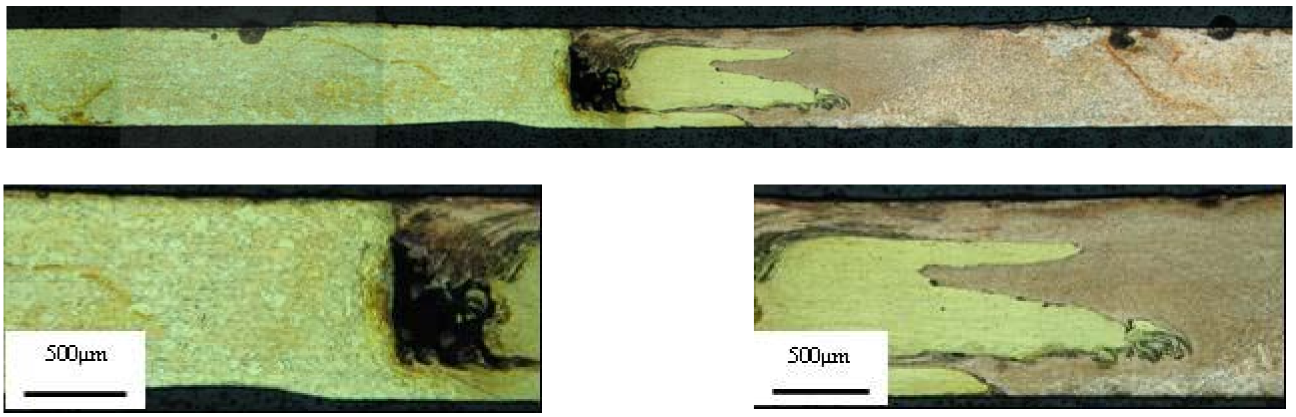

Fig. 2 Optical micrograph of a weld.

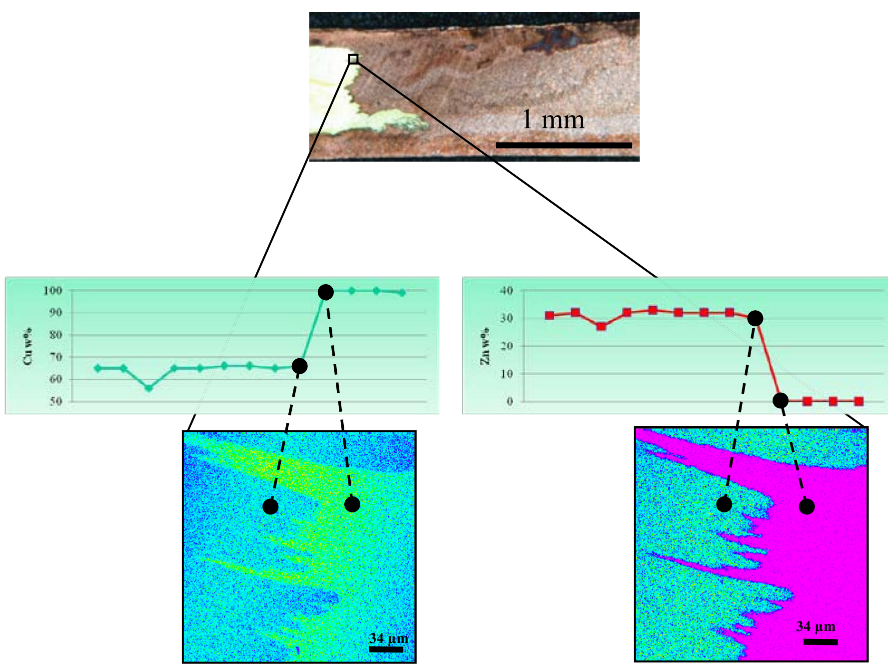

Fig. 3 – Qualitative and quantitative distribution of copper and zinc in the nugget.

https://doi.org/10.1017/S1431927609990857 Published online by Cambridge University Press