Acta Microscopica, Vol. 8 Supplement A October 1999
Proc. XVII Congress of the Brazilian Society for Microscopy and Microanalysis and X Congress of the Brazilian Society for Cell Biology

RAPIDLY SOLIDIFIED STRUCTURE OBSERVED BY TEM IN ALLOY 600 AFTER LASER WELDING PROCESS

[1]Buso, S.J.; [1]Monteiro, W.A.; [1]Calvo, W.A.P.
[1]Departamento de Engenharia de Materiais, Instituto de Pesquisas Energéticas e Nucleares

Comparing with conventionally processed solidified materials, rapidly solidified materials generates unusual microstructures associated to several improvements on its mechanical properties[1]. A rapidly solidified structure was observed by TEM on studies of a Brazilian superalloy EMVAC 600 welded by LASER YAG welding process (the material: flat pieces, without filler material, top unions and single pass, which was initially 91,2 % cold worked and then annealed at 1150 °C for 30 minutes).[2] During the weld process, was employed a heat dissipator of copper with dimensions like the samples. Microhardness measurements was made to verify mechanical improvements after the weld process.

EXPERIMENTAL PROCEDURES

With flat pieces of dimensions of 50x14x1,4 mm, which was initially 91,2% cold worked and then annealed at 1150 °C for 30 minutes of a Brazilian superalloy EMVAC 600 (76Ni-15Cr-8Fe base chemical composition), was prepared top unions, without filler material, weld with LASER YAG welding equipment[2]. For better results of metallurgical aspects, was decided to use a heat dissipator of copper, which was put in contact with the welding specimen.

The specimen preparation begin with preparation of samples to microhardness measurements and then analysed from the welded zone (WZ) center to base metal, with 0.25 mm spacement and 50 g of charge. After the measurements, samples was prepared to TEM analysis taking samples of welded zone and welded zone/base metal interface. Both processes of specimen preparation following the usual methods.

TEM analysis was made on a JEOL JEM 200C from Instituto de Pesquisas Energéticas e Nucleares and the microhardness measurements on a SHIMADZU type H microhardness equipment from Universidade de Mogi das Cruzes.

RESULTS AND DISCUSSION

The figure 1 shows a curve of microhardness obtained from the analysis of samples of the alloy EMVAC 600, welded by LASER YAG welding process. Some improvement of microhardness was observed in the center of welded zone comparing with the interface welded zone/base metal and base metal measurements. The structures observed by TEM in welded zone as well as in welded zone/base metal interface, shows formation of subgrains, fine precipitation at grain boundary as within the grains, crystalline defects like dislocations networks, most of these interacting with precipitates indicating that was occurred dislocations movements during the welding process (figure 2). These structures are common in rapidly solidified studies of alloy 600.[1]

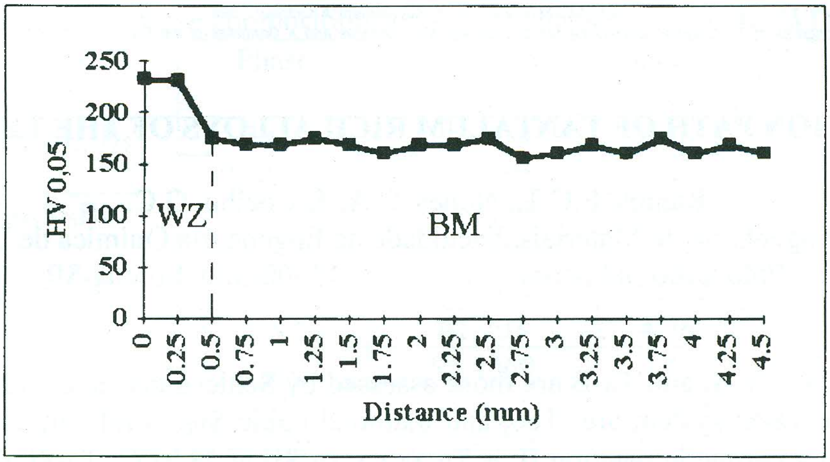

Figure 1. Microhardness curve of EMVAC 600 after welding process, from center of welded zone (WZ) to base metal (BM).

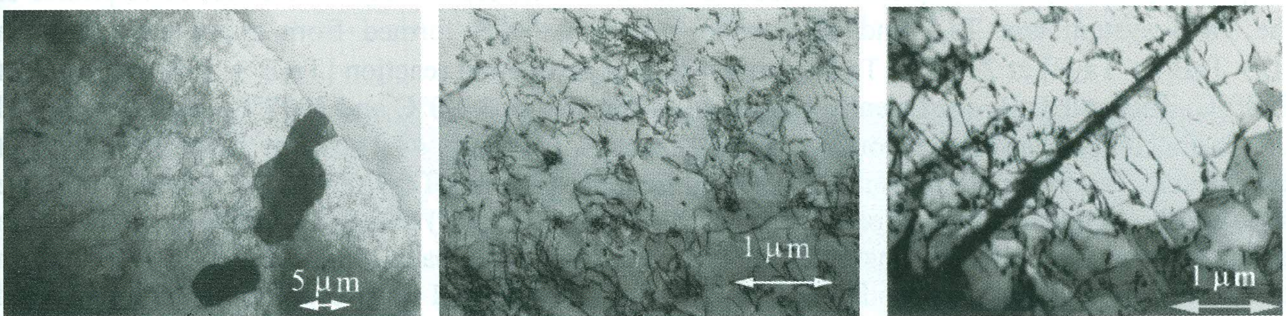

Figure 2. Micrographs obtained by TEM of EMVAC 600 welded by LASER welding process, showing: (a) subgrain formation in welded zone, Zone Axis ≈ (013); (b) dislocations interacting with fine precipitates within the grain in welded zone/base metal interface, Zone Axis ≈ (011); (c) dislocations elongated and precipitates on grain boundary in welded zone/base metal interface, Zone Axis (011).

CONCLUSIONS

In this work was observed clearly a rapidly solidified microstructure in the samples of EMVAC welded by LASER YAG welding process. These microstructures were formatted mainly due to the efficient heat dissipator and the relation of welding pool and the pieces dimensions. The improvement observed on microhardness measurements is due to the great quantity of crystalline defects associated to the observed subgrain formation.

REFERENCES

1. BUSO, S.J.; MONTEIRO, W.A.; CALVO, W.A.P. ***Microstructure in welded zone of Ni-Fe-Cr alloy after LASER welding***, Proceedings of the 6th Brazilian Conference on Microscopy of Materials - Micromat 98, pp 329-332, 1998.

2. DEY, G.K., SRIVASTAVA, D.; SUNDARARAMAN, M; MUKHOPADHYAY, P. ***Microstructural studies on rapidly solidified alloy 600***, Scripta Materialia, vol. 34, (4), pp 625-631, 1996.