MICROSTRUCTURE IN WELDED ZONE OF A NI-FE-CR ALLOY AFTER LASER WELDING

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ABSTRACT

Heat-resisting alloys are usually superalloys, particularly used when oxidation, creep or fatigue resistance is necessary. These alloys are developed from austenitic steels, increasing the amounts of alloying elements, which include chromium (up to 25%) and nickel (up to 30%)[1, 2].

Now efforts occurs in welding processes of these alloys to enhance and maintain good properties in service[3]. This work shows some aspects of microstructure on welded zone, of a Brazilian superalloy EMVAC 600, welded by LASER YAG welding process, using electron and optical microscopy, taking deep chemical etching (the material: flat pieces, without filler material, top unions and single pass, which was initially 91% cold worked and then annealed at 1150°C for 30 minutes).

Usually, in the study of welded unions, is necessary some type of etching to reveal the dendritic fine structure and some metallurgical defects that can happen in solidification process[4].

Experimental Procedures

With flat pieces, without filler material, top unions and single pass, which was initially 91% cold worked and then annealed at 1150°C for 30 minutes, and welded by LASER welding process, of a Brazilian superalloy EMVAC 600, 76% Ni, 15% Cr and 8% Fe (base chemical composition), we prepare specimens in order to reveal the microstructure of the welded zone (WZ), which was observed by electron and optical microscopy.

The work on the specimen preparation, both for the optical and electron microscopy, follow the usual methods[4, 6]. In the stage of chemical etching, in the specimen preparation for analysis by scan electron and optical microscopy, we prepare a solution which best reveals the dendritic fine structure founded in the welded zone. The solution includes 30 ml Hydrochloric acid and 10 ml Nitric acid. The time of etching was 7 minutes.

The specimen was observed by scan electron microscopy on microscope LEICA model STEREOSCAN 440, from the Laboratório de Caracterização Tecnológica of the Departamento de Engenharia de Minas Escola Politécnica da Universidade de São Paulo, by transmission electron microscopy on microscope JEOL JEM200C from the Laboratório de Microscopia Eletrônica de Transmissão of the Instituto de Pesquisas Energéticas e Nucleares, and by optical microscopy on microscope OLYMPUS RX60M, from the Laboratório de Metalurgia from the Universidade Presbiteriana Mackenzie.

RESULTS AND DISCUSSION

In the analysis by scan electron and optical microscopy of the alloy EMVAC 600, welded by LASER YAG welding process, in the welded zone (WZ), etched with the solution previous described, shows[5] fine dendritic formation, with interdendritic spacing of 3 μm and preferential directional growth (figures 1, 2 and 3). The transmission electron microscopy shows formation of subgrains; dislocation networks, fine carbide precipitates (figure 4).

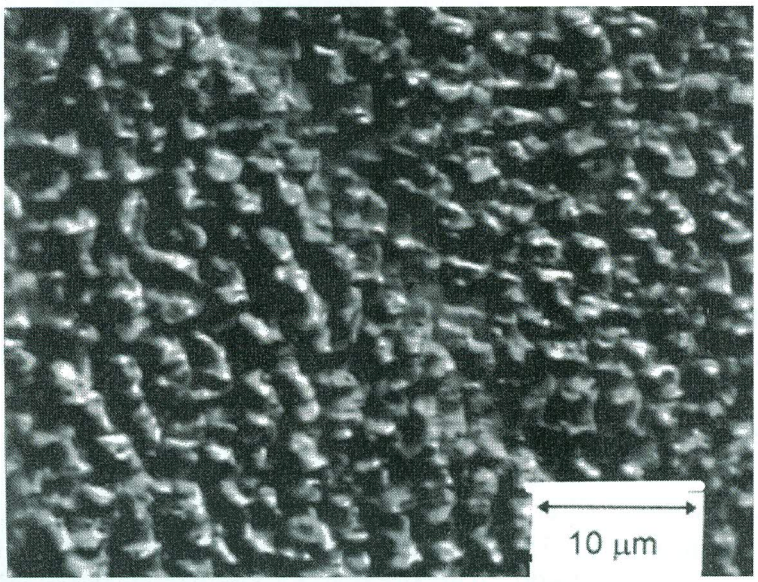

Figure 1 - Microstructure observed by optical microscopy of the alloy EMVAC 600, welded by LASER welding process in the welded zone, showing fine dendrites with preferential directional growth.

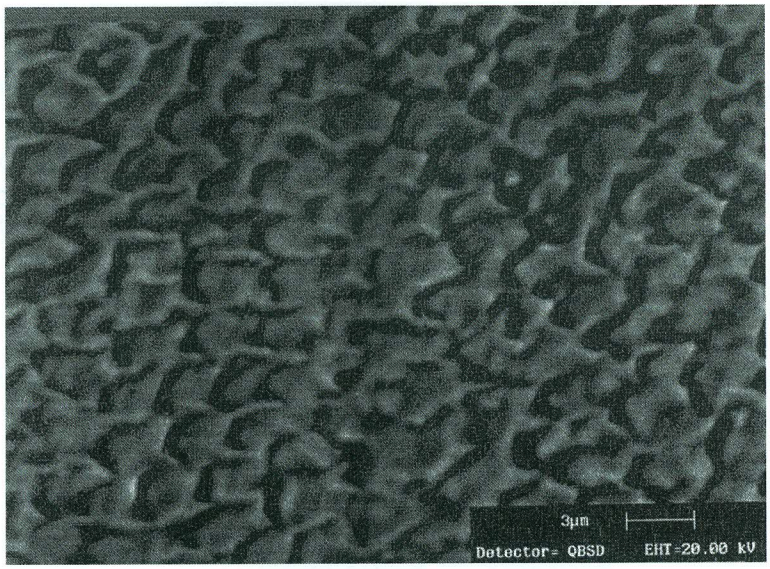

Figure 2 - Microstructure observed by scan electron microscopy of the alloy EMVAC 600, welded by LASER welding process in the welded zone, showing fine dendrites, interdendritic spacing of 3 µm, with preferential directional growth.

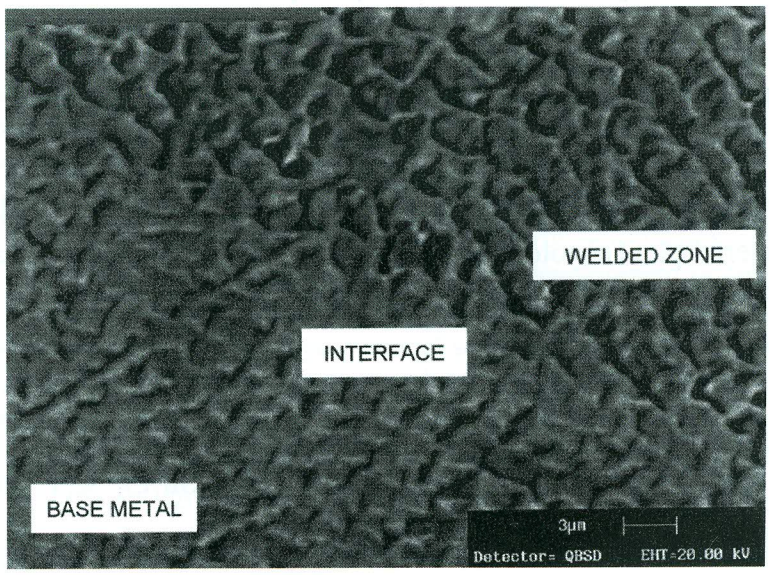

Figure 3 - Microstructure observed by scan electron microscopy of the alloy EMVAC 600, welded by LASER welding process in the interface welded zone/base metal, showing fine dendrites with preferential directional growth.

Figure 4 - Microstructure observed by transmission electron microscopy of the alloy EMVAC 600, welded by LASER welding process in the welded zone showing formation of subgrains; dislocations network interacting with fine carbide precipitates (Zone Axis ≈ 013, 200 kV, Bright Field)

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