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Color Etching of a MIG Welded Steel Joint

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Mild steels can be found in a multitude of applications that derive from their versatility and low production cost compared to higher content carbon steels. Its applications range from machinery manufacturing to the production of structures for various industries. Its carbon content does not exceed 0.25% wt.%, as is the case of 1011 steel, whose carbon content is equivalent to 0.11% wt.%, which allows its excellent weldabillity for the manufacture of structures with clean and smooth surfaces, where different joining technologies such as MIG welding are considered.

The 1011 steel is a very interesting material because of its low carbon content produces low-complex microstructures characterized mainly by the presence of ferrite. Even so, the metallographic preparation and the correct identification of the characteristic phases of a material often represents a difficult problem. The problem is further complicated when there is a change in the microstructure caused by chemical alteration of the material or exposure to high temperatures, as in the case of welding processes. In few occasions, a complete examination also requires techniques based on optical microscopy, such as color etching [1], which allows the microstructure of some materials to be studied in greater detail. Color etching takes advantage of the interference of light with reflections from the metal surface where the reactive agent has been deposited [2,3].

Due that this technique is sensitive to the crystallographic orientation, its applications are highly valuable in the analysis of ferrous materials, which previous chemical etching favors microstructure revealing of the material that is being studied. In the case of steels, a solution based on nitric acid and methanol contributes to this purpose [4].

In this work, sections of 1011 low-carbon steel alloy MIG welded (ER70S-6) in a transverse array and subsequently prepared by conventional metallographic techniques, which involve grinding with SiC abrasive papers followed by polishing to a mirror-like finish. The samples were chemically etched with Nital etchant, 10% Nitric Acid Volumetric. Color etching of the samples was carried out by immersion of the samples in aqua regia (HNO_3+HCl) mixed with potasium metasulfite ($K_2S_2O_5$) at 60°C for 2 minutes.

Fig. 1 shows bright field optical micrographs of the etched samples. Two different zones were characterized. The Fig. 1a, display the free-welding zone of the array shown in the inset, which display uniform grain size distribution with ferritic (colored grains) and perlitic (black grains), whilst the Fig. 1b shows a microstructure observed in the welded zone characterized by a lamellar structure. It is observed a noticeable difference in grain size and a visible presence of the colored effect in both samples related with different crystallographic orientation which effect is highly noticeable in the welded zone.

The comparative analysis of the microstructures allows us to conclude that the color etching technique is an effective method for analyzing the constituent elements of microstructures where the crystallographic orientation in low carbon steels can be visualized through different colors.

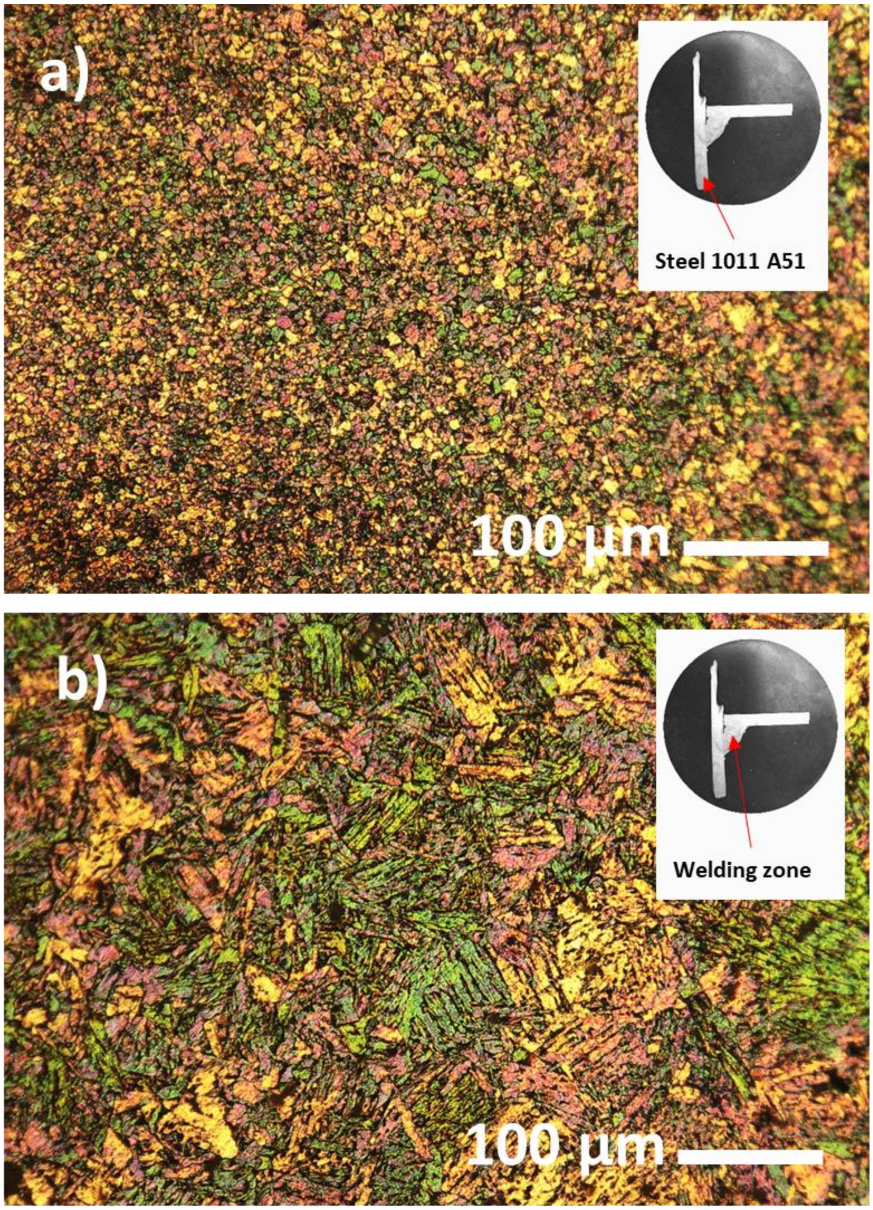

Figure 1. Colored etched samples. (a) 1011 A52 steel, (b) welding zone.

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