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Annealing behavior of the AISI 430 ferritic stainless steel obtained by directional solidification

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Abstract – We report on the behavior of the AISI 430 stainless stell deformed by cold rolling (up to 85%) followed by annealing at 500, 700 and 900 °C. The principal results show that shear bands are present in deformed state and in the annealed state there are recrystallized grains in these bands. Microstructural characterization was performed using light optical microscopy (LOM), scanning electron microscopy (SEM) and Vickers hardness measurements.

Stainless steels are alloys with high amount of alloying element, mainly chromium. The main characteristic of those steels it is associated to the high resistance to corrosive processes and of oxidation, combined with good mechanical properties, especially the ductility.[1] Components of stainless steels can be obtained through different processing types, as casting, rolling, forging, extrusion etc, and can be used in the making of cutlery, for example.

Directional solidification (DS) it is used for the production of components where columnar structures are more interesting. In these cases being used in an appropriate way the current anisotropy of the mechanical properties, because in some important applications the most significant tensions are aligned in an only direction along an only axis, as in the case of the production of gas turbines blade for energy generation. Another interesting aspect of this solidification technique is its use with relationship the as-cast structure, in another words, is related with the primary and secondary spacings interdendritics with the composition of the alloy, the growth speed, the thermal gradient, the local time of solidification and with the cooling rate. [2]

In the present work we report the main results of the microstructural characterization of the AISI 430 ferritic stainless steel obtained by directional solidification, cold rolling to thickness reductions up to 78% thickness reduction and annealed at 500, 700 and 900°C. The starting material consists of longitudinal sections of a slab with 40 mm of diameter and 250 mm of length, obtained by directional solidification. The starting microstructure of these material is formed by columnar and equiaxial grains.

The principal results show that in the deformed material the presence of shear bands was verified (in prominence in the Figure 1). Those bands are preferential areas for the nucleation of the recrystallization, when the material is submitted to thermal treatment after deformation. In the annealed condition it was verified that the softening curves decrease monotonically with the time for each annealing temperature and there are important differences between samples with columnar and equiaxial structure (Figure 2 and 3). The obtained results can be useful in the investigation of the mechanisms that happen during the solidification process of the ferritic stainless steels and in the formation of the as-cast microstructure and also to help in the understanding of as the process of directional solidification and its influences in the deformation and annealing behavior of this material.

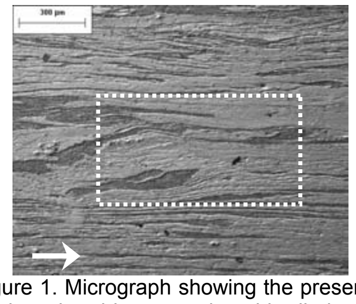

Figure 1. Micrograph showing the presence of shear band in a sample cold rolled up to 78% (LOM, Nomarski contrast). The arrow indicates the rolling direction.

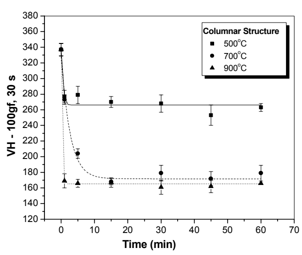

Figure 2. Softening kinetics for AISI 430 deformed by cold rolling and annealed, showing columnar structure.

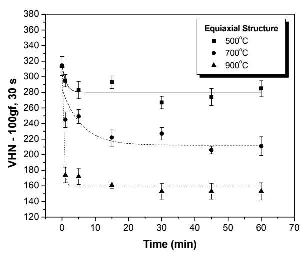

Figure 2. Softening kinetics for AISI 430 deformed by cold rolling and annealed, showing equiaxial structure.

References

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