Study of the effect of cryogenic deformations by X-ray diffraction in situ and thermo-mechanical simulation (XTMS) in stainless steels AISI 430 and AISI 316L

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Two stainless steels (AISI430 ferritic and AISI316L austenitic) were analysed simultaneously by uniaxial tensile tests and X-ray diffraction in an advanced thermomechanical simulation (XTMS) system, at room and cryogenic temperatures, with controlled deformation rates for both metals. The Gleeble® Synchrotron system was used, able to perform X-ray diffraction measurements in situ, controlling the sample temperature, controlling the stress / strain condition, as well as the chamber atmosphere, and also allowing the injection of liquid nitrogen directly into the sample with excellent versatility and reproducibility. For this, linear or area X-ray detectors are assembled on a high-resolution goniometer for fast data acquisition, which allows real time measurements. The characterization was performed by means of SEM images and in situ XRD. The photomicrographs and the results of the tensile tests show that AISI 430 steel presents a ductile fracture at room temperature and fragile fracture at cryogenic temperature with resistance improvement. The results of the AISI 316 L steel show that the material has a ductile fracture in both conditions. For this same metal, the elongation at both temperatures was practically the same, but the tensile strength in the cryogenic environment was much higher. This behavior may be associated with the TRIP effect, which is in agreement with the XRD data, since peaks of α' martensite are evidenced.

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