Neutron/ X-ray diffraction study of crystalline texture and residual stresses of directional solidified Al-Si alloys at different cooling rates

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Aluminum-Silicon (Al-Si) alloys are characterized by being versatile, economical, and attractive in a wide range of uses and applications; because they have good mechanical properties and good corrosion resistance, in addition to high performance and versatility when they are subjected to forming and machining processes to obtain parts with complex geometries [1].

In general, the solidification of metallic alloys is expected that the structure obtained in solidification is completely columnar, or completely equiaxial. However, under certain solidification circumstances (different cooling rates and thermal gradients), there is a zone where both columnar (Col.) and equiaxial (Eq.) grains are simultaneously present; this zone where both types of grains coexist is called the columnar-to-equiaxed transition zone (CET) [2, 3].

In this type of solidification, there are cooling differences at different distances from the cooling zone. The cooling rate decreases as we move away from the base of the specimen, on the other hand, different temperature gradients are also generated along the specimen resulting in different types of grains and sizes. These can cause the presence of residual stresses, crystallographic textures thus generating elastic, and plastic anisotropy that are characteristic of the solidification process.

Although no studies of these stresses were carried out, it is considered that they can be macroscopic or intergranular and will depend on the crystallographic texture that the material adopts in the solidification process and can generate defects in its subsequent handling such as deformation, for example. The texture and stresses that develop during the manufacturing process affect both the quality of the process and the properties of the final product.