3D-Characterization of AlCu4.5Mg0.3 and AlCu7 alloys after solution heat treatment and during in situ tensile tests

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Synchrotron microtomography can be used to describe three dimensionally the internal microstructure of materials ex situ as well as under the effect of external thermal/mechanical/thermo-mechanical loads. This technique is applied to study the microstructural evolution of A206 (AlCu4.5Mg0.3) and AlCu7 alloys as a function of solution treatment (ST) time: 0h, 1h, 4h and 16h at 530°C. The evolution of volume fraction (Vf), interconnectivity (volume of biggest aluminide/total aluminide volume) and morphology of interdendritic aluminides reveals a partial dissolution of these phases segregated during casting that stabilizes after < 4h ST, while the interconnectivity remains > 80% for both alloys. In situ synchrotron tomography is carried out during tensile deformation to characterize the damage mechanisms and their evolution. Damage initiation seems to be more likely in the aluminides with a large surface or eutectic areas perpendicular to the loading direction. Cracks propagate along the aluminides network, while shrinkage pores ~ $(100\ \mu m)^3$ play a minor role either for initiation or propagation. This confirms that the interconnectivity of the aluminides network plays a decisive role in the crack propagation process. The alloy after 4 h ST shows an ultimate tensile strength ~ 50 % higher than in as-cast (AC) condition as well as an increase of ductility by a factor of ~ 3.The Vf of voids created in the plastic region up to the UTS for the A206 (AC and 4h ST) is the same, although this is reached at a higher strain after 4 h of ST. This indicates that the microstructure is able to accommodate the same amount of damage in AC and 4 h ST conditions. The simultaneous increase of strength and ductility for the ST conditions is a result of the homogeneization of rigid phases that retards damage formation in the highly interconnected alumides network.

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