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# Solute nanostructures and their strengthening effects in Al–7Si–0.6Mg alloy F357

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## Abstract

The solute nanostructures formed in the primary α-Al grains of a semi-solid metal cast Al–7Si–0.6Mg alloy (F357) during ageing at 180 ℃, and the age-hardening resp onse of the alloy, have been systematically investigated by transmission electron microscopy, atom probe tomography and hardness testing. A 120 h natural pre-ageing led to the formation of solute clusters and Guinier–Preston (GP) zones. The natural pre-ageing slowed down the precipitation kinetics 6-fold during 1 h ageing at 180 ℃, but this effect diminished after 4 h when t he sample reached the same hardness as that without the pre-ageing treatment. It reduced the number density of β″ needles to approximately half of that formed in samples without the treatment, and postponed the peak hardness occurrence to 4 h, four times that of the as-quenched sample. A hardness plateau developed in the as-quenched sample between 1 and 4 h ageing corresponds to the growth of the β″ precipitates and a significant concurrent decrease of solute clusters and GP zones. The average Mg:Si ratio of early solute clusters is <0.7 while that of GP zones changes from 0.8 to 0.9 with increasing size, and that of β″ needles increases from 0.9 to 1.2. β″ needles, GP zones and solute clusters are important strengthening solute nanostructures of the alloy. The partitioning of solutes and precipitation kinetics of the alloy are discussed in detail.

**Keywords:** Solute nanostructure; Precipitation; Cast aluminium alloys; Atom probe tomography; TEM