The long-term ageing process of alloy 2618A

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The aluminum alloy 2618A is an Al-Cu-Mg alloy with additions of Fe and Ni, which is designed for long-term operation at elevated temperature in transportation and aerospace industries. The alloy degrades due to coarsening and dissolution of GPB-zones and coarsening of S-Phase precipitates (Al_2CuMg) (Wang et al., 2006, Styles et al., 2015).
This work investigates the overageing process at the application relevant temperature of 190 °C for durations up to 25,000 h. The nm-sized precipitates were selectively imaged along the <001> direction of the Al matrix using dark-field transmission electron microscopy (DFTEM). A selection of DFTEM images is shown in Fig. 1 for the initial state (a) and samples aged for 1,000 h (b), and 8,760 h (c). The coarsening of the precipitates is qualitatively confirmed. The resulting images were then evaluated using a multi-step process recently established (Rockenhäuser et al., 2018) and allow the statistically relevant determination of radii distributions and the mean radius of the precipitates dependent on temperature and heat treatment duration. The radii distributions are well-described by a lognormal distribution and an example for an ageing time of 1,000 h at 190 °C is shown in Fig. 2a).
Ostwald ripening of the S-phase does not describe the ageing process adequately over the complete ageing. The evolution of GBP zones during the initial ageing regime had to be considered in addition to the coarsening process of the S-phase. This allows a quantitative description of the overageing process based on the average radii. However, Ostwald ripening requires several boundary conditions to be fulfilled. In order to ensure the validity of the TEM data, the radii distributions were converted to volume-weighted precipitate data (Fig. 2b)), which shifts the distribution to higher radii, and will be compared to small-angle X-ray scattering (SAXS) data.

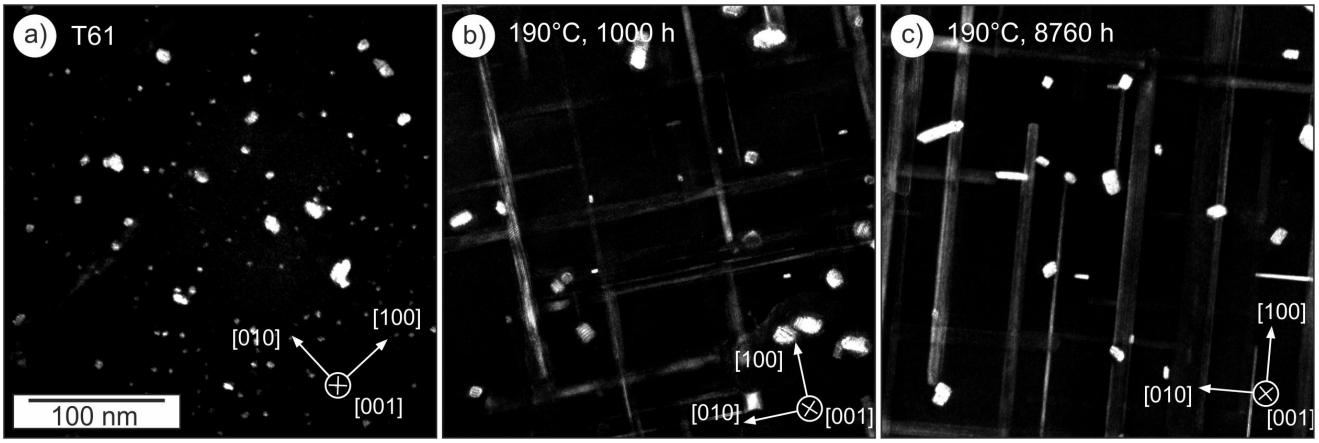

Fig. 1 DFTEM images of Al_2CuMg precipitates along the [001] zone axis of the aluminum matrix.

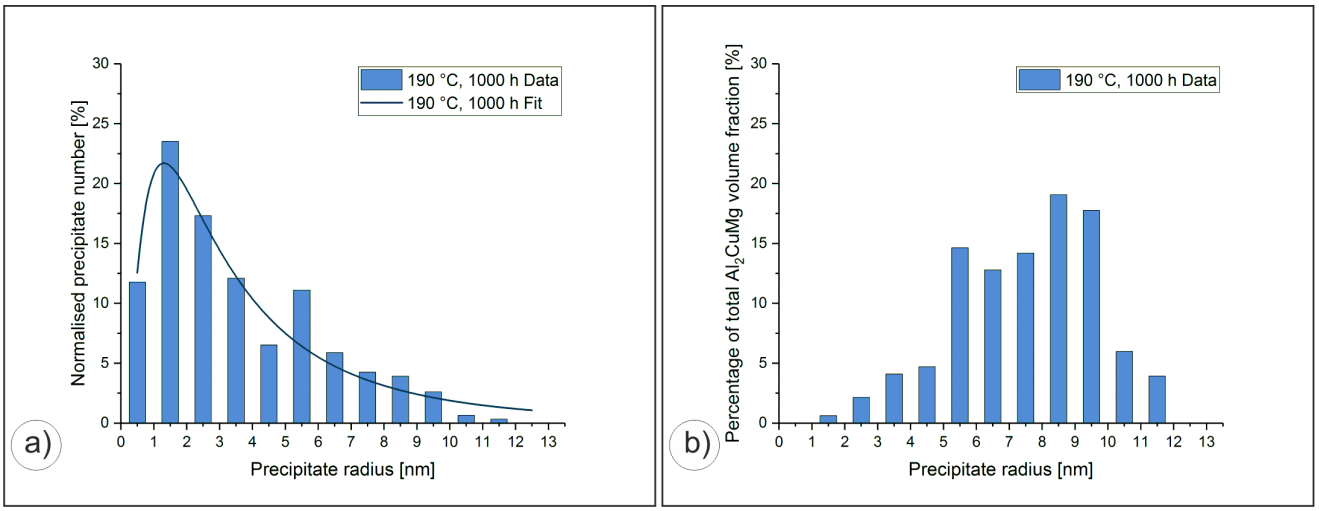

Fig. 2 a) Radii distribution and lognormal fit for an aged state (190 °C, 1,000 h), b) conversion of distribution of (a) in volume-weighted precipitate size data.

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