Solute clustering in multi-component aluminium alloys

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Abstract: Decomposition of super saturated solid solutions of Al-Cu-(Li,Mg) alloys pose theoretical and experimental challenges. The formation of chemical fluctuations at room temperature is critically analysed using a combination of in-situ small angle scattering (SAS), differential scanning calorimetry (DSC), atom probe tomography (APT), and micro-hardness. A methodology for combined interpretation of SAS data from experiments using neutron and X-ray radiation is proposed and allows for comparison APT data. The results effectively capture the chemistry and sub-nanometer dimensions of clusters. The effect of Mg on the natural ageing kinetics is discussed with respect to its interaction with excess vacancies available for diffusion. Short isothermal treatments at relatively low temperatures are used to dissolve naturally aged clusters and obtain a solid solution with reduced vacancies. When Mg is present in the Al-Cu-Li system, released solute after dissolution exhibits clustering behaviour with kinetics comparable to those immediately after quench from solution treatment. The immediate increase of clustering kinetics when any concentration of Mg is present in Al-Cu-(Li,Mg) alloys is revealed through a composition graded sample.