The influence of trace elements on the formation of quenched-in vacancies in Al-alloys

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Strengthening of Al-Cu alloys is mainly controlled by the formation of copper-rich precipitates, so called Guinier-Preston zones (GPZ). Their size, distribution, and crystal structure plays a key role in defining the mechanical properties of these alloys (see Fig.1 right). It has been reported that the addition of trace elements such as In or Sn influences the formation of GPZs and, thus, the strength of the alloys by a strong binding of trace element atoms to quenched-in vacancies [1]. The presence of In or Sn influences the diffusion of Cu atoms and, thus, the formation of GPZs. Positron annihilation spectroscopy is used to study the interaction of trace element atoms with quenched-in vacancies. In pure Al-1.7 at% Cu alloys GPZs containing Cu monovacancies are formed after quenching into ice water. The GPZs evolve into the Θ'-phase during further heating. We performed theoretical calculations of positron lifetimes and found them to agree well with experimentally obtained values. While some trace elements (In or Sn) form thermally stable complexes and, thus, freeze out the mobility of vacancies, other trace elements such as Pb, Bi and Sb display nearly no effect in Al-Cu alloys: the average positron lifetime is very similar to that of the pure Al-Cu, indicating a small binding energy of vacancies to these elements. However, when binaray alloys were quenched to -110°C (163K), they showed a high average positron lifetime, and thus a high concentration of vacancies (see Fig. 1), corroborating that the binding energy of vacancies to trace elements like Pb, Bi, or Sb is small.

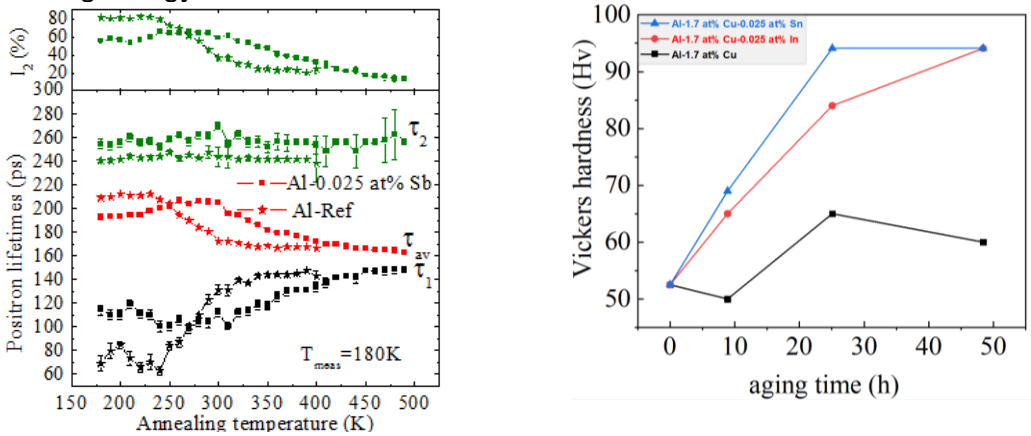

Figure 1 *Al reference and Al-0.025 at% Sb after rapid quenching from 620 to -110°C (163K): positron lifetime as a function of isochronal annealing temperature (left). The measurement is performed at 180 K. Vickers hardness of Al-1.7 at.% Cu with and without 250 ppm In or Sn aged at 150°C for different times [1] (right).*

References

[1] F. Lotter et al., *Phys. Status Solidi A* **215**, 1800038 (2018).

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