Quenched-in vacancies and hardening of Fe-Al intermetallics

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Physical properties of Fe–Al intermetallics are strongly influenced by the atomic ordering and point defects. During cooling from high temperatures Fe–Al alloys with Al content in the range 30–50 at.% undergo ordering from the disordered A2 phase to the partially ordered B2 structure. Fe–Al alloys with lower Al content 22.7–30 at.% undergo also a phase transition from the disordered A2 phase to the partially ordered B2 phase, but ordering continues with decreasing temperature and the B2 structure is transformed into the ordered $D0_3$ phase. As shown in Fig. 1b hardness of Fe-Al alloys shows a non-trivial dependence on chemical composition and cannot be fully explained by consideration of intermetallic phases formed. This is due to additional hardening effect by quenched-in vacancies. The concentration of vacancies was estimated from positron back-diffusion measurement on a slow positron beam (see Fig. 1a) and was found to strongly increase with increasing Al content. Comparison of vacancy concentration and hardness revealed that hardening of alloys with low Al content (< 30 at.%) is caused predominatly by anti-phase boundaries while vacancy hardening dominates for alloys with higher Al content (above 30 at.%)

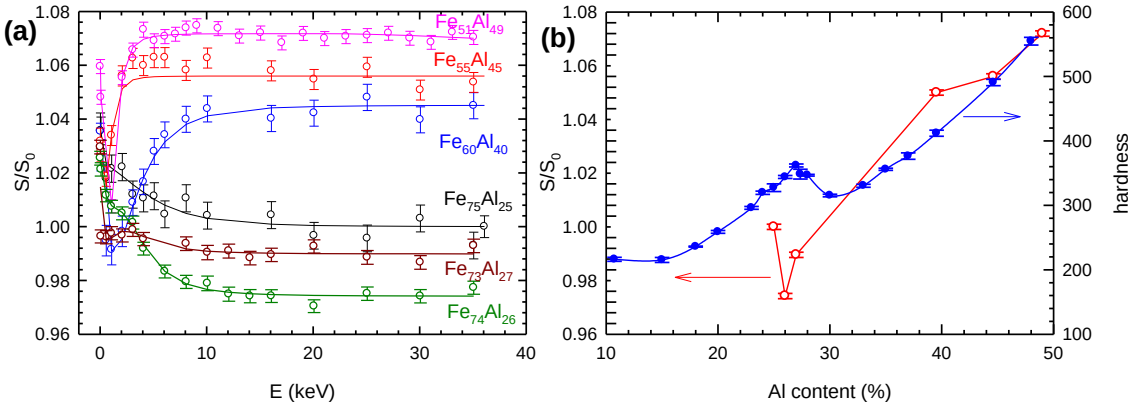

Figure 1 *(a) S(E) curves for Fe_xAl_{1-x} samples quenched from 1000°C, (b) comparison of the development of bulk S parameter and hardness with Al content.*

References

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