X-Ray Intensity Fluctuation Spectroscopy Studies of Ordering Kinetics in a Cu-Pd Alloy

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While a number of studies have used x-ray intensity fluctuation spectroscopy (XIFS) to examine fluctuation dynamics, fewer have attempted to use it to probe the kinetics of phase transitions. This is also an area in which there have been few, if any, analogous dynamic light scattering studies. Here we report a XIFS study of the coarsening kinetics in the classic long-period superlattice (LPS) Cu-Pd alloy using the ID10A Troika beamline at the ESRF. In particular, our measurements probed the evolution of the two-time correlation function $C(q,t_1,t_2)$ in the alloy on length scales of 10^1-10^3 nm and time scales of 10^2-10^4 sec. The 23 at.% Cu single crystal was annealed at 510 C in the disordered state and rapidly (10 sec) quenched to 435 C, in the region of equilibrium 1-d LPS structure. The evolution of the speckle intensity was examined with a direct illumination Princeton Instruments CCD area detector near the centers of both a superlattice peak (associated with local $L1_2$ order) and a satellite peak (associated with 1-d antiphase correlations). A careful analysis of the superlattice and satellite peak intensities and widths was used to determine the onset of late-stage domain coarsening. During the coarsening regime, the decay of $C(t_1,t_2,q)$ was independent of direction examined and was similar for the superlattice and satellite peaks. In agreement with published Langevin theory and simulations[1], the decay time τ of the two-time correlation function increases linearly with average time $t_m = (t_1 + t_2)/2$ and is relatively independent of wavevector near the peak centers. However, τ increases much more slowly with increasing t_m than is expected. During the coarsening process, the superlattice and satellite peak centers shift, though the speckles themselves remain relatively stationary. Fluerasu *et al.*[2] have observed similar shifts in the superlattice peak of Cu_3Au coarsening during coarsening and suggested that it may be due to inhomogeneous lattice distortion relaxation at domain walls.

References

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[2] - A. Fluerasu, M. Sutton and E.M. Dufresne, Phys. Rev. Lett. **94**, 055501 (2005).