ESRF	Nucleation in Ti-V	**number:** HS2203
Beamline: ID15A	**Date of experiment:** from: 27.10.03 to: 04.11.03	**Date of report:** 29.01.03
Shifts: 21	**Local contact(s):** Veijo Honkimäki	*Received at ESRF:*

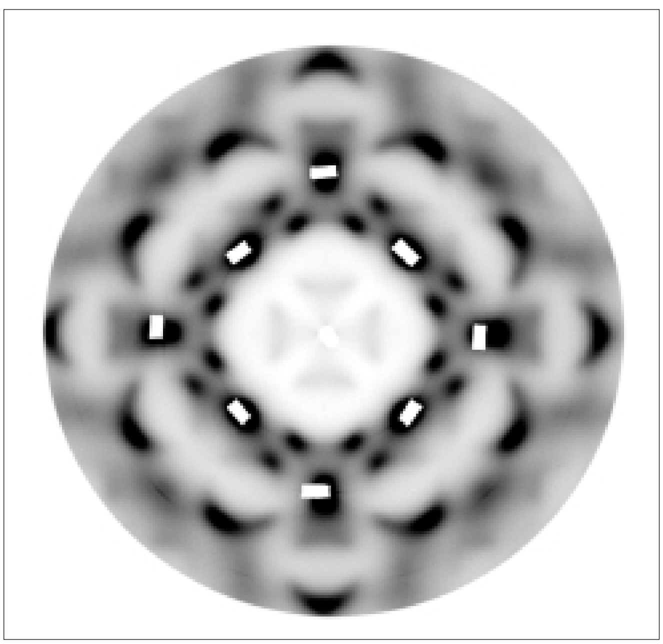
Names and affiliations of applicants (* indicates experimentalists):
Harald Reichert*, Ingo Ramsteiner*, Markus Mezger*, Sebastian Schöder*, Andreas Schöps, Helmut Dosch
MPI für Metallforschung, D-70569 Stuttgart, Germany

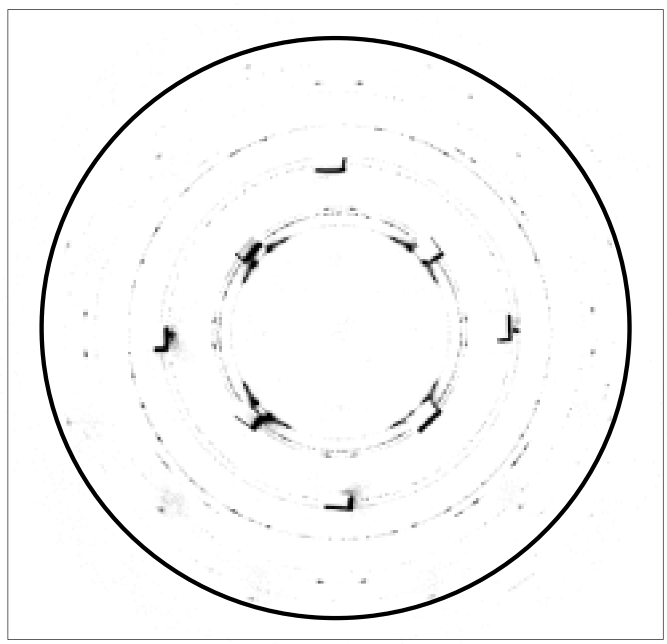
Report:

The configurational short range order (SRO) of a disordered alloy is governed by the atomic interaction parameters. Therefore the diffuse SRO scattering, which yields the Fourier components of the pair correlation function, is directly related to the effective pair interaction potentials of the system. We focus on various model binary alloys like Cu-Au, Cu-Pd, Au-Ni, Ni-Pd, Cu-Mn, Ti-V and others, representing a wide array of alloying properties. Working in collaboration with a theory group, which is developing novel methods to implement many-body and strain interactions into the formalism [1], we use a special setup to collect high quality diffuse scattering data in situ within very short aquisition times. A high energy X-ray beam (70-95 keV) enters our custom made in-vacuum diffractometer, illuminating the sample (1-2mm thickness) in transmission geometry. The single crystalline samples are mounted on a special heater featuring a hole. The transmitted primary beam is absorbed by a tungsten beamstop, the scattered intensity recorded by a mar-CCD. Due to the high X-ray energy, the Ewald sphere is almost flat within the solid angle covered by the detector, thus, a nearly plane cut through reciprocal space is recorded. In addition to the diffuse scattering, which yields information about the atomic interactions, we expect to observe the formation of Bragg peaks during the precipitation in phase separating alloys. This is particularly interesting, since the nuclei of a new phase are developing from the configurational fluctuations, which in turn depend strongly on the interaction parameters investigated simultaeously.

The system Ti-V is a model case of a phase separating binary alloy, the miscibility gap spanning almost the whole concentration range. Theoretical works propose in addition a transient ordered phase appearing during decomposition [2].

Fig. 1 shows the diffuse scattering of the disordered (homogeneous) Ti_3V_2 crystal, which is stable above 850°C, quenched to room temperature. The positions of the bcc Bragg peaks are covered with small lead shields to protect the CCD (in the center the shadow of the beam stop is visible). Aging the sample at temperatures between 300 and 800°C produced additional peaks, which we attribute to the formation of precipitates. Fig. 2 shows an example for this behavior. Due to the existence of misaligned powder grains in this particular sample, we observe not only the strong peaks of precipitates embedded in the bcc crystal matrix, but also precipitation powder rings (the diffuse scattering from the disordered high temperature phase has been subtracted from the image). Raising T above the miscibility gap within a sufficiently short time, the precipitates dissolve in the bcc matrix. Systematic quenches to many different temperatures revealed, that not only the growth velocity, but also the type and orientation of the nuclei are dependent on the aging temperature. In the low temperature regime (300-600°C) the precipitation is influenced strongly by the topology of the interaction potentials in k-space, with the Bragg peaks of the precipitates nesting in the diffuse scattering maxima. In addition we observed superstructure peaks. At high temperatures (600-800°C), where the potentials are almost featureless, a different nucleation scheme giving rise to the diffraction patterm shown in Fig. 2 takes over, which seems to be less influenced by atomic interactions. Appearance and growth of the different precipitates were monitored by time-resolved image series using the CCD. The short readout cycles of a few seconds enabled us to resolve the the precipitation process.





References

[1] V. N. Bugaev, H. Reichert, O. Shchyglo, A. Udyansky, Y. Sikula and H. Dosch; Phys. Rev. B **65**, 180203 (2002)

[2] L. Reinhard, P. E. A. Turchi; Phys. Rev. Lett. **72**, 120-123 (1994)