

05.1-4 SHORT RANGE ORDER AND DECOMPOSITION IN NICKEL ALLOYS. By A. Cerri, F. Klaiber, G. Kostorz, L. Reinhard, B. Schönfeld, Institut für Angewandte Physik, ETH Zürich, CH-8093 Zürich, Switzerland.

Ordering and decomposition processes play an important role in controlling the mechanical properties of superalloys, i.e. nickel base alloys with a variety of alloying components. Single crystals of several relevant binary systems have been studied employing scattering techniques in order to analyse microstructural details.

Diffuse wide-angle scattering (x-rays and neutrons) has been used to determine the short-range order parameters  $\alpha_{lmn}$  and the first-order atomic displacement parameters  $\gamma_{lmn}^x$ . In Ni-Al with Al-concentrations close to the  $\gamma/\gamma'$  phase boundary, diffuse x-ray scattering maxima close to the  $L1_2$  superstructure positions were found. Modelled computer crystals consistent with the experimental results showed a preference for  $Ni_3Al$  structure elements. In Ni-19.4 at.% Cr, diffuse neutron scattering revealed maxima close to  $1/2$  0 positions. For this alloy, effective pair potentials  $V_{lmn}$  were obtained from experimental sets of  $\alpha_{lmn}$  for crystals with various ageing temperatures.

In Ni-11.5 at.% Ti, the decomposition process was monitored by small-angle neutron scattering at temperature (in-beam ageing), whereas the ordering was studied by x-ray measurements of the integrated intensity at  $L1_2$  superstructure positions. The results indicate a subtle interplay of ordering and phase separation.

05.1-5 EFFECT OF HYDROGENATION ON SOLID SOLUTIONS OF TRANSITION METALS. By V.F. Degtyareva, D.N. Mogilyansky and V.Sh. Shekhtman, Institute of Solid State Physics, Academy of Sciences of the USSR, Chernogolovka.

Metal hydrogenation is known to cause a change in the properties and crystal structure of metals. Structural transformations of the binary solid solutions by interstitial hydrogen have been studied in some transition metal alloys. The alloys were saturated by hydrogen at high pressure (10-50 kbar) and ambient temperature (200-300°C) to the ratio  $H/Me=0.5-1.0$ . The X-ray analysis was carried out under normal conditions (after partial hydrogen removing). Pd-Cu. Initial f.c.c.  $Pd_{50}Cu_{50}$  alloy was found to be ordered after hydrogenation with respect to the metal sublattice. The  $L1_0$ -CuAuI type of the ordered structure was formed by twinning. Pd-Ni. A single crystal equi-atomic (initial and hydrogenated) alloy was used to study decomposition of f.c.c. solid solution into two f.c.c. phases, enriched with Pd and Ni. The main crystallographic directions of crystals after decomposition were shown to retain the disarrangement of orientation of the two new f.c.c. sublattices which is about  $8^\circ$  off the  $\{100\}$  direction. Fe-Cr. It was found that the b.c.c. equi-atomic Fe-Cr alloy transformed to a h.c.p. structure by interstitial hydrogen. The latter structure was retained under normal conditions after removing hydrogen. These investigations show that interstitial hydrogen affects the interatomic interaction by changing essential factors such as:

- (i) diffusion of metal atoms
- (ii) interatomic distances
- (iii) electron concentration.

05.1-6 LATTICE EXPANSION AS A FUNCTION OF SELF-IRRADIATION FOR  $^{239}PuB_6$ . By R.B. Roof, Chemistry Division, Los Alamos National Laboratory, Los Alamos, New Mexico, U.S.A.

As a function of self-irradiation the expansion of the lattice constant of  $^{239}PuB_6$  has been followed for approximately five years. Expansion is caused primarily by the retention of He bubbles in the lattice. The X-ray diffraction line width remains quite narrow for rather extended periods of time indicating that the "crystal cage" is relatively insensitive to damage from the radioactive atom contained within the lattice.

After reaching a maximum value the lattice constant decreases as the accumulated He bubbles diffuse out of the lattice. The time required to reach a maximum is dependent on the fission strength of the included radioactive atom. Comparison with data from  $^{238}PuO_2$  (R.B. Roof, *Advances in X-ray Analysis*, 1974, 17, 348-353) and  $^{241}AmB_6$  (currently under investigation) indicates that the more intense the radiation the sooner the maximum value of the lattice constant is obtained.

05.1-7 EFFECT OF INTERNAL STRAINS ON X-RAY DIFFRACTION PATTERNS OF  $BaTiO_3$ . By K. Irie, H. Nakamura, N. Ohnishi and A. Okazaki, Department of Physics, Kyushu University, Fukuoka 812, Japan.

The cubic-to-tetragonal phase transition in  $BaTiO_3$  has been examined by means of the high-angle double-crystal X-ray diffractometry (HADOX). In a series of high-resolution diffraction patterns of a single-crystal specimen, a drastic change is observed in the peak profile around the transition temperature  $T_C \approx 393$  K. At and just below  $T_C$ , e.g. down to  $T_C - 0.3$  K, the diffraction pattern of the tetragonal phase consists of several small peaks. At the higher and lower temperatures, in contrast, the pattern contains only one large peak of 400 of the cubic phase and that of 004 of the tetragonal phase, respectively. An example of the pattern at  $T_C - 0.3$  K is shown in the figure below. The peaks marked by hatching are around the position of 004, while the others around that of 400. The peak height is about  $1/6$  of the original single peak. The splitting of these peaks can be attributed to the appearance of domains and grains resulting from internal strains. The effect of such strains have also been observed on the peak profile near room temperature, and on the peak position in the cubic phase.

