FEATURES OF THE TEMPERATURE-INDUCED AND DEFORMATION-INDUCED ORDER-DISORDER PHASE TRANSITION

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1. Introduction

Phase transformations of different types are important way to be in control of properties of materials. The order-disorder transformation is one of them. It is able to change parameters of alloys changing a long-range order degree. A variation of antiphase domains sizes effects on properties of alloys as well. Despite a fact that atomic ordering has been studied many decades it will pay attention long time due to a great number problems demanding their decision.

2. Experimental procedure

Experimental results of the X-ray study are presented in this work. Binary alloys based on ffc lattice with superstructures $L1_2$, $L1_2$(M), $L1_2$(MM), $D1_a$ have been used for research. The alloys were obtained by inductional melting in an argon atmosphere. The ingots were homogenized at high temperatures. The samples were annealed near T_{melt} and quenched into ice water. The specimens of different alloys were annealed for ordering at various temperatures for different periods of time. X-ray diffraction was performed with DRON-1,5 and DRON-3 diffractometers using CuK_α - radiation.

The temperature-induced order-disorder phase transition has been studied in the alloys shown in the table 1. The lattice parameter, the antiphase period M, the degree of tetragonal or orthorhombical distortions, average long range order parameter, the long range order parameter far from and near the antiphase boundary were obtained to study the temperature-induced order-disorder phase transition.

The deformation-induced order-disorder phase transition has been researched in the alloys presented in the table 2. The well-ordered samples were deformed by cold rolling in this case. The long-range order parameter, the average size of the antiphase domains, the average size of the areas of coherent dispersion, microstresses and parameters of a crystal lattice are measured.

Table 1.

Studied alloys and their characteristics.

	Alloy	Superstructure	$T_к$,°C	η_{max}	$\eta_{Tк}$	<D>, nm
1	Au_3Cu I (polycrystal)	$L1_2$	208	0.95-1.0	0,6	15-20
2	Au_3Cu II (polycrystal)	$L1_2$(MM)	204	0.9-1.0	0,1	10
3	Au_3Cd polycrystal	DO_{23} - $L1_2$(M=2)	422	1,0	0,7 0,65	45
4	Au_4Zn(polycrystal)	$L1_2$ (MM)	305	1,0	0,5	60-80
5	Au_4Cr (polycrystal)	$D1_a$	360	0,82	0,66	33
6	Au_4V (polycrystal)	$D1_a$	565	0,94	0,9	85

Table 2.

Studied alloys and their characteristics.

	Alloy	Superstructure	$T_к$,°C	η_{max}	$\eta_{Tк}$	<D>, nm
1	Au_3Cu (polycrystal)	$L1_2$	208	0.95-1.0	0,6	15-20
2	Cu-22%Pt (polycrystal)	$L1_2$	685	0,8	0,6	80-130
3	Ni_3Fe (single crystal)	$L1_2$	535	1,0	0,44	13
4	Ni_3Al (polycrystal)	$L1_2$		1,0	1,0	>>100
5	Au_4Zn (polycrystal)	$L1_2$ (MM)	305	1,0	0,5	60-80
6	Cu_3Pd (polycrystal)	$L1_2$ (M)	468	0,8	0,54	50-150

3. Results and discussion

Studying of the temperature-induced and the deformation-induced order-disorder phase transformation has given possibility of establishing of their mechanisms, and has pointed at the role of antiphase boundaries, finding of their generality and difference. Some results of this study are presented in [1-4]. Increasing of the degree of the temperature or the deformation influence has brought on increasing amount of the defects in the alloys. The accumulation of defects has led up to the destruction of the long-range order in alloys. The antiphase boundaries play a particular role in the order-disorder transformation. Different nature of driving-forces of the order-disorder transformation determines differential peculiarity of every type of transformation. Essential disagreement of driving-forces defines the difference of mechanisms of the antiphase boundaries accumulation. The main features of the temperature-induced and the deformation-induced order-disorder phase transformation are shown in the table 3.

Table 3.

The features of the temperature-induced and the deformation-induced order-disorder phase transformation

	T- transformation	ε-transformation
1.	a) homogeneous disordering (LRO) at $T< T_K$. b) heterogeneous disordering (LRO+SRO) at $T\leq T_K$.	heterogeneous disordering - (LRO+SRO) at $\varepsilon>0$.
2.	a) SRO-phase is absent at $T< T_K$. b) SRO-phase appears at $T\leq T_K$.	SRO-phase appears at $\varepsilon>0$.
3.	a) <D> = const at $T< T_K$. b) <D> decreases at $T\leq T_K$.	<D> decreases monotonically at $\varepsilon>0$.

4. References

[1] S.V. Starenchenko., E.V. Kozlov. (1999).The order-disorder transition in alloys with long period. *Mat. Science Forum*. V.321-324. P. 641-646.

[2] S.V.Starenchenko, E.V. Kozlov (1999).X-ray study of the order-disorder transition in alloys with long period. *Proceedings of International Conference on Solid- Solid Phase Transformation'99, (JIMIC-3).* The Jap. Institute of Metals - Ed. M. Koiwa, K.Otsuka and T.Miyazaki, P. 45-48.

[3] S.V.Starenchenko, E.V.Kozlov, V.A.Starenchenko (2000). X-ray study of the order – disorder transformation by the plastic deformation, *42 Advances in Structure Analysis*. Ed. R. Kuzel, J. Hasek. CSCA. Praha, ISBN: 80 – 901748 – 5 – x, P. 449 – 455.

[4] V.A. Starenchenko, O.D. Pantyukhova and S.V. Starenchenko (2002). Simulation of the process of deformation–induced destruction of long-range order in alloys with an $L1_2$ superstructures, *Physics of the Solid State (Russian)*, **44**, No 5, 994–1002.