

# STRUCTURAL TRANSITIONS IN Y-Ba-Cu-O SYSTEM

**K.M. JAFAROV**

*Institute of Physics of Academy of Sciences of Azerbaijan  
370143, Baku, H. Javid av. 33*

High-temperature X-ray diffraction investigations of structural transitions in  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  high- $T_c$  have been carried out. The specimens come under two groups: a control (without Ag) and  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  with Ag-layer deposited specimens. It was established that in a control  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  specimen orthorhombic  $\rightarrow$  tetragonal phase transition takes place at 965 K.

Structural changes connected to transition from orthorhombic phase to tetragonal one, which take place at thermal processing (at  $T=873 \pm 1073$  K), have been studied in [1-3]. It was established that this transition depends on oxygen content in  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  superconductor. At  $y=0.1 \pm 0.8$  an orthorhombic phase is stable and with the decreasing oxygen content (at  $y \geq 0.8$ ) an orthorhombic phase is transformed to tetragonal one [3]. On the other hand a high mobility of Ag atoms and possibility of the chemical interaction Ag atoms with components of  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  can be accompanied by structural changes in  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$ -Ag system at thermal processing.

The aim of present work consists from X-ray high-temperature investigations of end influence Ag diffusion on the phase formation and structural changes in  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  superconductor.

The high-temperature X-ray diffraction investigations was carried out with a "DRON-3M"-type diffractometer with a "URVT-2000"-type high temperature attachment at 1,3 Pa and with  $\text{CuK}_\alpha$ -radiation. The angles of reflections were defined to a precision of 0.02°.

For the X-ray investigations were used two groups specimens: the  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  specimens with Ag layer deposited on surface and control  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  (without Ag). The temperature of specimens in Ag deposition process no exceed 373 K.

At 273 K in  $10 \leq 2\theta \leq 90^\circ$  angles interval from surface of control specimen fixed 15 sharp diffraction reflections, that indexed on the basis of an orthorhombic lattice with  $a=3.821$ ,  $b=3.883$  and  $c=11.679$  Å, that corresponds  $\text{YBa}_2\text{Cu}_3\text{O}_{6.97}$  compound (Table 1). After room temperature recording of diffraction reflections the heater is switched on and at 100 K-interval the control recording is carried out for observation of changes in diffraction pattern. At annealing of this specimen up to 965 K, as follows from diffraction pattern, the intensity and number of reflections don't undergo not essential changes and structural block of tetragonal phase is absent. At temperature above 965K sharp change of the number and intensity of reflections occur in a control specimen diffraction pattern (Fig.1,a), i.e. 10 reflections are fixed instead of 15 one (Table 1), with belong to the tetragonal phase with lattice parameters  $a=3.862$  and  $c=11.795$  Å. These values of the lattice parameters agree with data [4,5]. The temperature phase transition established in this work equals 965 K.

At the same time it was carried out X-ray investigation of the  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  specimen with Ag layer on surface. Interplanar spacings, calculated from room temperature diffraction pattern of this specimen are indexed on the basis of the orthorhombic lattice with  $a = 3.885$ ,  $b = 3.878$  and

Table 1  
Interplanar spacings of  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$

№	$d_{exp}$ , Å	$I$ , imp/S	Orthorhombic		$T$ , K
			$d_{cal}$ , Å	$hkl$	
1	2.728	270	2.7260	013	293
2	2.723	783	2.7223	110	
3	2.468	62	2.4674	112	
4	2.321	128	2.3195	014	
5	2.233	181	2.2311	113	
6	1.941	188	1.9414	200	
7	1.911	178	1.9090	020	
8	1.771	70	1.7729	115	
9	1.734	74	1.7343	016	
10	1.712	55	1.7118	211	
11	1.580	294	1.5814	213	
12	1.566	163	1.5680	123	
13	1.491	70	1.4887	214	
14	1.372	87	1.3747	206	
15	1.362	140	1.3630	026	
1	2.755	498	2.7565	103	973
2	2.731	846	2.7294	110	
3	2.475	282	2.4777	112	
4	2.344	252	2.3455	014	
5	2.243	280	2.2432	113	
6	1.939	229	1.9300	200	
7	1.926	233	1.9047	021	
8	1.782	250	1.7863	115	
9	1.597	334	1.5968	116	
10	1.589	397	1.5852	213	
			Tetragonal		

Table 2  
Interplanar spacings of  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$ -Ag

№	$d_{exp}$ , Å	$I$ , imp/S	Orthorhombic		$T$ , K
			$d_{cal}$ , Å	$hkl$	
1	2.755	765	2.7546	013	293
2	2.746	1919	2.7390	103	
3	2.475	160	2.4730	112	
4	2.340	282	2.3403	014	
5	2.238	385	2.2373	113	
6	1.957	312	1.9567	006	
7	1.920	204	1.9175	200	
8	1.778	101	1.7793	115	
9	1.744	141	1.7469	016	
10	1.722	106	1.7139	210	
11	1.589	538	1.5897	116	
12	1.575	237	1.5737	213	

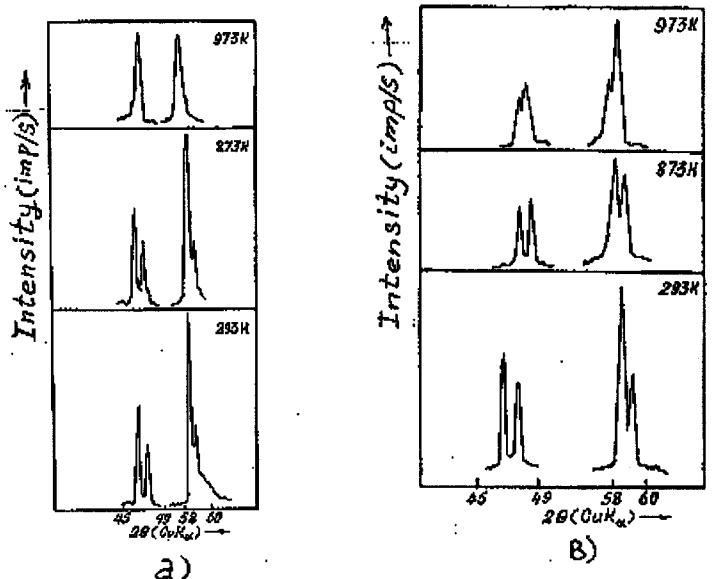


Fig. 1. Fragments of diffraction patterns of  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  specimens: a) control specimen (without Ag); b) Ag deposited  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  specimen.

$c = 11.740 \text{ \AA}$ , that correspond to  $\text{YBa}_2\text{Cu}_3\text{O}_{6.59}$  compound (Table 2). The sharp decreasing of oxygen content in this case can be connected by Ag diffusion. Those diffusion coefficient in  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  is anomaly higher even at room temperature [6]. The other possible reason-the oxygen removal from specimen during Ag deposited on it. With increasing temperature up to 973 K an orthorhombic phase is remained in spite of the formation of  $\text{YBa}_2\text{CuO}_5$  structural block, which relative a mount is minimum. It is clear that an annealing

$\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  specimen with Ag in 293-973 K temperature interval doesn't lead to structural transition (orthorhombic  $\rightarrow$  tetragonal) (Fig.1,b), which take place in case a control specimen.

Thus in this work established that a Ag diffusion alloyed of  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  and annealing at 293-973K temperature leads to stabilization of high- $T_c$  orthorhombic phase while in a control  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  (without Ag) is observed transition of an orthorhombic phase to a tetragonal one.

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Q.M. Cəfərov

### Y-Ba-Cu-O SİSTEMİNDE QURULUŞ FAZA KEÇİDLƏRİ

Y-Ba-Cu-O sistemində quruluş faza keçidləri rentgendifraktometrik metodla tədqiq olunmuşdur. Tədqiqat iki qrup nümunələrdə aparılmışdır: üzərinə Ag çökddürülmüşdür  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  və control  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  nümunələri. Müəyyən edilmişdir ki, gümüşün difuziyası ilə əlaqədar üzərinə Ag çökddürülmüş  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  nümunələrində ifratkeçirici rombik faza stabillaşır, öksinə control nümunələrdə rombik  $\rightarrow$  tetraqonal faza keçidi müşahidə olunur ( $T=965 \text{ K}$ ).

К.М. Джапаров

### СТРУКТУРНЫЕ ФАЗОВЫЕ ПЕРЕХОДЫ В СИСТЕМЕ Y-Ba-Cu-O

Проведены высокотемпературные рентгendifрактометрические исследования влияния диффузии серебра на фазообразование и структурные изменения сверхпроводящих керамических образцов  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$ , полученных стандартным методом твердофазового синтеза. Установлено, что в образцах, диффузионно легированных серебром при температурах 293-973 К, ромбическая (сверхпроводящая) фаза  $\text{YBa}_2\text{Cu}_3\text{O}_{7-y}$  сохраняется, тогда как в контрольных образцах (без серебра) при  $T=965 \text{ K}$  происходит фазовый переход (ромбическая  $\rightarrow$  тетрагональная структура).

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