ANALYSIS OF OXYGEN CONTENTS IN HiT_c MATERIALS

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When producing HiT_c materials it is very important to know a total value and distribution of oxygen contents due to technical reasons. Here-in the nuclear physical methods of oxygen analysis are briefly discussed. The methods were used in the ANSIN and the TOCHNOST projects of the HTSC Program.

The content of oxygen distributed throughout the material has been determined from the $^{16}O(n,p)\,^{16}N$ reaction at neutron energy E_n=14 *MeV*. The ^{16}N radionuclide activity has been determined using high-energy gamma-rays (E_γ = 6.1 and 7.1 *MeV*) with the short half-life $T_{1/2}$ = 7.14 *s*. Neutrons were produced by the neutron generator [1,2] with the yield $2 \cdot 10^{12}\ s^{-1}$. Due to rather high neutron yield some uncertainties in neutron activation analysis [2] were avoided. Finally the method of a reference material was used and reproducibility of results e.g. the uncertainty of measurements, is about 0.3% of oxygen weight, oxygen detection limit is 10 *mcg*. The size of the samples under investigation is $1 cm^3$.

The analysis of surface layers is based on the nuclear reaction $^{16}O(d,p)\,^{17}O$ and the electrostatic accelerator [3] was used. The reaction products (protons) give two groups with Q = 1.92 *MeV* and Q = =1.05 *MeV*. The yield of the two groups is a measure of oxygen content in a sample. Oxygen content was calculated as the ratio of the counting rate of the protons from the $^{16}O(d,p)\,^{17}O$ reaction to the counting rate of the deuterons which came to the sample during the measurement. Hence monitoring of the deuteron beam is of a great importance. Here the reference material method was also used [2,4]. The uncertainty of the Rutherford back scattering [2] is about 0.3%. The oxygen sensitivity was estimated to be $10^{15}\ atoms \cdot cm^2$ (thinner than one monolayer).

The experimental results of the oxygen x-value for three different but identical $YBa_2Cu_3O_x$ samples are listed in the table.

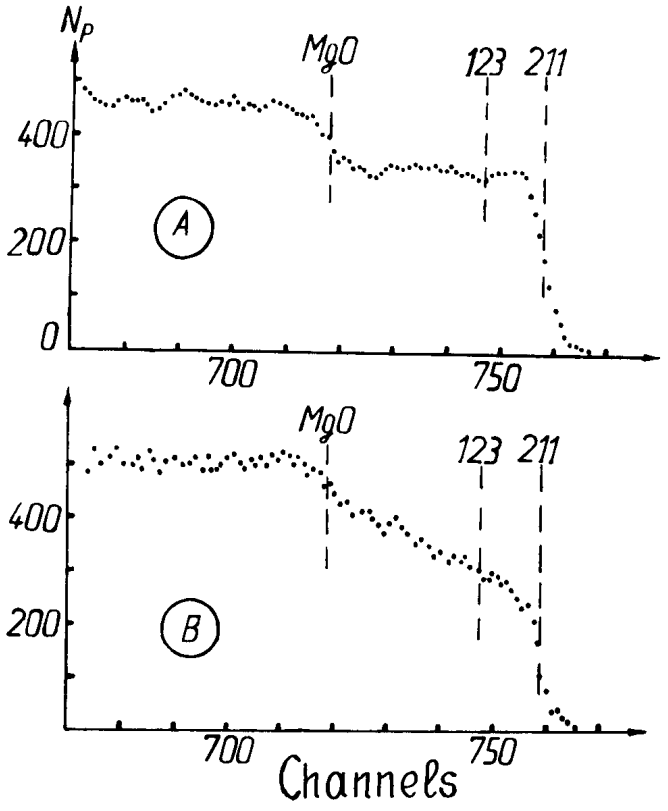

Fig.

Table

Sample	Oxygen content (relative units)	
	x (on surface)	x (in volume)
1	6.22 ± 0.02	6.22 ± 0.02
2	6.20 ± 0.02	6.21 ± 0.02
3	6.23 ± 0.02	6.21 ± 0.02

For the determination of oxygen distribution with depth in a HiT_c films (up-to 10000 Å) the $^{16}O(d,\alpha)\,^{14}N$ reaction was used [5]. Here an α-particle energy gives the information on the depth where the reaction occurs and the number of α-particles gives oxygen contents. The energy resolution of the α-detectors determines the depth resolution and they are 7 *keV* at $E_\alpha = 2.6$ *MeV* [6] and 100 Å correspondingly. The α-spectra from the (d,α) reaction at $E_d = 900$ *keV* for $YBa_2Cu_3O_{7-\delta}$ and Y_2BaCuO_5 on MgO backing with the thicknesses 1000 Å and 400 Å correspondingly are shown in fig. The cross-section of the $^{16}O(d,\alpha)\,^{14}N$ reaction in this energy region is constant and one can say that the oxygen distributions are different: it is constant in fig.A and goes down between the MgO backing and surface in fig. B correspondingly. The scale in the spectra: 1 channel = 60 Å.

The method described can be used for investigations of oxygen distributions in films, surface layers and in an adhesion region near a backing.

References

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