INVESTIGATION OF SURFACE LAYERS OF SOLIDS WITH ACCELERATED LIGHT ION AND FAST NEUTRON BEAMS

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In the modern analytic practice element composition depth profiling study of surface layers and element analysis assume paramount importance as many physical and chemical properties of a material depend on surface and near-surface regions. The analysis of material provides information on the element composition, the surface and depth element distribution. Detection of fine little quantities of element is actual too.

To solve these problems particle induced X-ray excitation (PIXE), Rutherford baskscattering spectrometry (RBS), nuclear reaction analysis (NRA), neutron activation analysis with fast neutron (NAA) are widely used. The techniques are express, understructive, high-sensitive and precise. They are mutually complementary and can give an opportunity to find out a full elementary composition with just one experiment. They are successfully put into practice in the spheres of fundamental and applied sciences, researching new materials and technologies, semiconductor and superconductor structures, ecology, medicine, geology, etc. For the purpose of usage the techniques at PNPI RAS electrostatic accelerator [1] and neutron generator [2] we designed experimental installations with computer complexes with the software worked out for storage and information processing [3, 4]. The analysis parameters of the installations are given in the Table.

In [5] the investigations of the concentration depth profiling of fluorine and other elements in optical fluorine-silicon glass materials having especially low optical density owing

to the presence of fluorine inside them were carried out by the RBS and NRA (reaction $^{19}F(p,\alpha\gamma)^{16}O$) techniques. The fluorine concentration influences optical density and the boundaries of the fluorine bedding define the boundaries of the optical density jump which can alter within numbers 1,41 and 1,74. The results obtained allow to draw the conclusion that the width of the fluorine-deficient zone depends on the change of the sort of glass and external conditions.

The investigations of the depth profiling by steps $\leq$100 A in high temperature superconductive structures $YBa_2Cu_3O_7$ and Y_2BaCuO_5 ("Green fase") by means of the nuclear reaction analysis (reaction $^{16}O(d,\alpha)^{14}N$) gave an opportunity to get the information on what is the difference between the interaction of superconductive layers and "Green fase" with substrates [6, 7].

Depth profiling and absolute concentration of all elements (oxygen and heavy elements) in thick superconductive films of $YBa_2Cu_3O_7$ on magnesium oxide superstrates are measured by combination of the NRA and RBS techniques.It is found that the surface ($\sim$1000 A) layers are impoverished with heavy elements (barium, copper) and enriched with oxygen [8].

Table

Analytical characteristics of nuclear physics technique for elementary analysis at PNPI RAS

Technique	Detection elements	Thickness of layer investigated [μ]	Resolution of deepness [A]	Sensibility %	Accuracy %
PIXE	$z > 10$	$1 \div 10$	—	$10^{-3} \div 10^{-5}$	$\sim$3
NRA	$z > 1$ $z < 15$	$1 \div 10$	$\leq$100 A	$10^{-1} \div 10^{-6}$	$3 \div 5$
RBS	$z > 1$	$1 \div 10$	300 A	$1 \div 10^{-3}$	$1 \div 2$
NAA	$z > 2$	volume distrib.	—	10^{-4} (oxygen)	$\sim$1 (oxygen)

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