CHANGE IN THE STRUCTURAL PROPERTIES OF BISMUTH AND ITS ALLOYS AS A RESULT OF IRRADIATION

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It is shown that the intensities of certain diffraction lines characterizing bismuth and bismuth–lead alloy single crystals and polycrystalline aggregates change after these materials have been irradiated with electrons or protons.

The question as to the effect of irradiation on the structure of semimetals cannot be regarded as particularly well studied. It is accordingly interesting to study the effect of irradiation on the intensity of the diffraction lines of bismuth and bismuth–lead alloys.

We examined polycrystalline samples prepared from bismuth of the Bi000 type and a Bi–1 at.% Pb alloy, and also single-crystal samples of two crystallographic orientations (types A and B). In samples of type A the trigonal axis was oriented perpendicularly to the beam and in samples of type B parallel to the beam. The single crystals were made from Bi000 bismuth and bismuth alloys containing 0.2, 0.6, and 1 at.% Pb. The samples were irradiated with 6.8 MeV electrons and protons. The integrated doses were $7.4 \cdot 10^{16}$ and $6.6 \cdot 10^{14}$ cm^{-2} for electrons and protons respectively. The sample thickness was chosen so

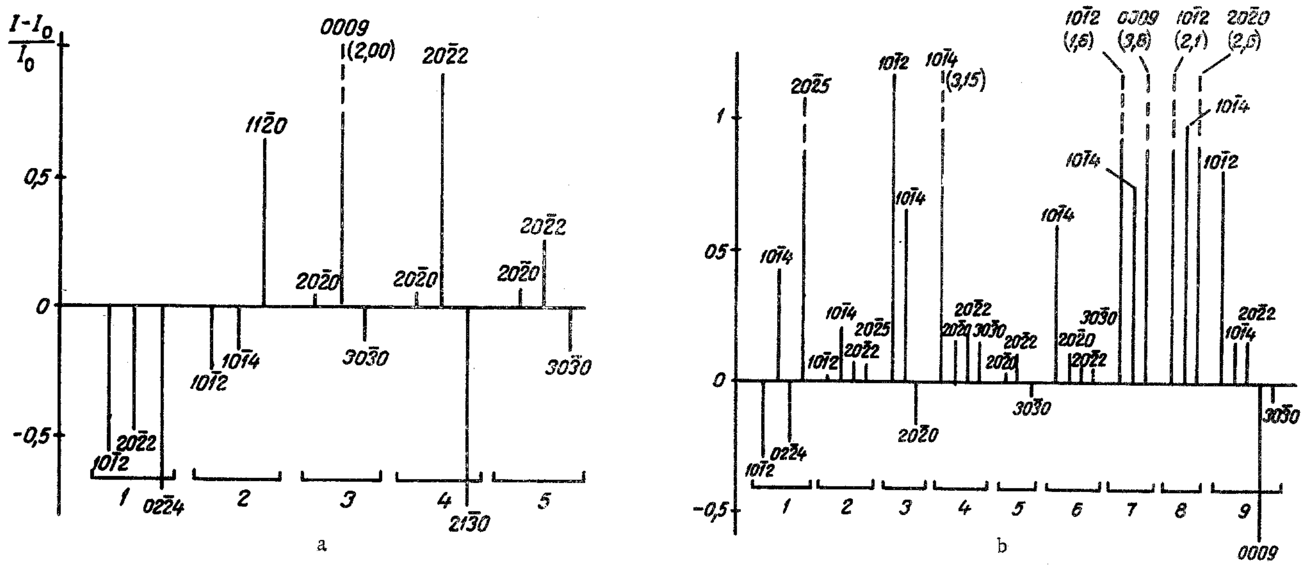

Fig. 1. Relative change in the intensity of certain diffraction lines in the x-ray diffraction pattern of bismuth and Bi–Pb alloys after: a) electron irradiation, polycrystalline aggregates: 1) Bi000; 2) Bi–1 at.% Pb, single crystals type Pb; 3) Bi000; 4) Bi + 0.2% (at) Pb; 5) Bi + 0.6% (at) Pb; b) proton irradiation, polycrystalline aggregates: 1) Bi000; 2) Bi–1 at.% Pb; single crystals type B: 3) Bi000; 4) Bi + 0.2% (at) Pb; 5) Bi + 0.06% (at) Pb; 6) Bi + 1% (at) Pb; type A: 7) Bi + 0.2% (at) Pb; 8) Bi + 0.06% (at) Pb; 9) Bi + 1% (at) Pb.

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as to ensure uniform irradiation of the whole volume of the crystal. The samples were irradiated at temperatures no higher than 100°K. The measurements were carried out in an URS-50IM diffractometer.

In Fig. 1a we illustrate the relative change in the intensities of certain diffraction lines of the test samples after subjection to electron irradiation.

It should be noted that after irradiation there is a certain fall in the line intensities of the polycrystalline aggregates; this may be associated with the formation of defect complexes and the pinning of these at grain boundaries [1]. The effect is stronger for proton irradiation owing to the greater defect density (Fig. 1b). The considerable increase in background furthermore supports this fact [2]. The unit in Fig. 1 is taken as the line intensity of the samples before irradiation I_0. In the case of the single crystals the change in intensity diminishes as the impurity content increases. The principal change in the intensity occurs for the lines of the family of planes which have predominantly covalent bonds. Similar effects were observed when studying the effect of plastic deformation on the structure of bismuth alloys.

Further investigations are required in order to explain these phenomena.

LITERATURE CITED

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