EFFECT OF CADMIUM DOPING ON SOME PROPERTIES OF GLASS-INSULATED BISMUTH-BASED MICROWIRES

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According to the literature, semiconductor converters based on films and wire crystals are widely used in present-day microelectronics. However, the production of efficient semiconductor converters requires crystals of high structural perfection with a given composition and desired electrical and mechanical properties. In this work, we describe the study of the perfection of the microstructure and mechanical properties of glass-insulated microwires based on Bi doped with cadmium (Cd) and the technique of preparation of microresistors suitable for instrumentation applications.

Microscopic studies of ground, polished, and chemically etched microwires doped with cadmium showed that they have smooth cylindrical surfaces in the entire range of diameters. Sizes of defects in the form of micropores, microcracks, dislocations, and twins on their surface are much smaller than those of pure bismuth microwire. It is also found that the tendency to twinning and the number and size of surface defects decrease with decreasing diameters; at the same time, their homogeneity increases.

The tensile strength of the studied microwires with glass insulation is high for all tested diameters and ranges within 33.2–74.1 kg/mm with respect to internal diameters of 5.6 –21.2 μm; in addition, they withstand a breaking force up to 130 g and more, whereas the samples of pure bismuth microwires withstood a force up to 80 g. It is also found that the tensile strength of cadmium doped microwires is significantly higher than that of undoped samples.

The bending strength as a measure of elasticity was determined using a special installation according to the critical bending radius of the sample at which the sample integrity is violated. The results of bending tests showed that, with increasing diameter of the doped samples, the critical radius linearly increases; that is, in this case, the elasticity increases with decreasing diameter.

Metallographic analysis revealed that cadmium in the bismuth matrix appears in the form of insoluble microinclusions with sizes of 0.05 to 3 μm. The concentration of cadmium does not exceed 8%.

Note also that the introduction of Cd in bismuth has a positive effect not only on the degree of structural perfection and mechanical properties, but also on magnetoresistance. The measured magnetoresistance in a magnetic field H = 0.8 T at liquid nitrogen temperature significantly increases from 1358% for pure Bi to 1540% for Cd-doped samples.

These results show the possibility of using microwires of cadmium doped bismuth as a magnetic field sensor. The technique of preparation of microresistors using the studied microwires is proposed; these microresistors have small sizes and high mechanical and magnetic properties; they are reliable, vibration resistant, and stable in operation.