BIFILAR MICROWIRES BASED ON BISMUTH AND TIN

D. Meglei and M. Dyntu
Institute of Electronic Engineering and Nanotechnologies "D Ghitu"
Academy of Sciences of Moldova , Academiei str. 3/3, Chisinau, MD–2028 Republic of Moldova
e-mail: meglei@iieti.asm.md

The development of semiconductor technology and microelectronics is indissolubly related to decreasing the characteristic sizes of sensing elements and to high and stable physical and mechanical parameters. The practice of using microwires in glass insulation in measuring technology has induced the problem of searching and studying new materials with small dimensions and improved electrical and mechanical properties.

In this work, we describe the results on the technique of preparation of glass-insulated bifilar microwires (BMs) based on bismuth and tin and study the perfection of their microstructure and basic mechanical characteristics, i.e., tensile strength (σ, kg/mm^2) and critical bending radius (r_{cr}, mm) as a measure of elasticity.

Microscopic studies of transverse and longitudinal sections of samples prepared via mechanical and chemical polishing showed that the BMs based on bismuth and tin are homogeneous and have a clean and smooth cylindrical surface. Sizes of defects in the form of pores, microcracks, dislocations, and twins on their surface are much smaller than those of microwires of pure bismuth and pure tin. The high structural perfection of the BMs is also evidenced by the low dislocation density 10^4–10^6 cm^{-2}, while for a microwire of pure bismuth, it is in a range of 10^5– 10^7 cm^{-2}.

Mechanical studies revealed that the BMs exhibit higher bending elasticity and tensile strength than single-core microwires of pure bismuth and pure tin. For example, the critical bending radius of the BMs is in a range of 0.37–1.40 mm with respect to outer diameters of 30.2–234 μm, and r_{cr} of microwires of pure tin takes on values of 0.52–2.52 mm with respect to diameters of 21.9–74.3 μm.

The tensile strength σ of a BM per unit cross-section of the sample with the glass is much higher than σ of a single-core microwire of pure bismuth or tin and ranges within 62.8–10.9 kg/mm^2 with respect to outer diameters of 38.4–135.3 μm; the BM withstands a breaking strength up to 200 g and more.

We have found the following pattern: despite the fact that BMs have relatively large outer diameters (30–234 μm), the tensile strength increases and the critical bending radius decreases with decreasing diameters.

These studies and analysis of the literature data showed that these BMs can be used for the manufacture of sensing devices. In this work, we propose a technique of preparation of transducers using the studied BMs suitable for instrumentation applications. It is found that the use of BMs based on bismuth and tin as sensing elements greatly simplifies the technique of production of the elements and increases their reliability owning to lower rigidity and higher strength.