INVESTIGATIONS OF NEW MATERIALS BASED ON SILVER AND SYNTHETIC MICAS


A method of the preparation of new composite materials based on silver and synthetic mica was developed. An experimental study of the physomechanical and antifriction properties of these materials under dry friction conditions was carried out. Increasing the mica content in materials of this kind produces a reduction in their specific gravity and volume shrinkage, a deterioration in their mechanical properties and an increase in their electrical resistance. Introducing the optimum proportion of mica (5-15%) leads to a reduction in the friction coefficient of the composite material and increases its load-carrying capacity.

The development of new branches of technology creates a demand for new materials capable of working in applications in which the use of liquid lubricants is inadmissible. Special difficulties arise in the case of friction pairs working in vacuum when conventional lubricants tend to volatilize and undergo various chemical changes. Moreover, there are many devices working in air (or in other atmospheres), in which liquid lubricants cannot be used.

From this point of view, especially important are antifriction materials which are nonmagnetic, being at the same time good conductors of heat and electricity. Powder metallurgy methods make it possible to produce materials with properties that could not be obtained in materials made by other methods. One of the promising materials of this kind is a silver-base composite containing various proportions of synthetic mica [1]. Pure silver has inferior antifriction properties: it has a high friction coefficient and is prone to seizing. The introduction of mica reduces the plasticity of silver and makes it more brittle, thereby improving its antifriction characteristics. The results of an experimental study of the mechanical and antifriction properties of sintered silver-mica composites are described below.

As the starting materials we used KLiMg₂[Si₄O₁₀]F₃ ~ synthetic mica and grade PS-1 silver powder. Finely granular mica contained about 15% impurities in the form of glass and so-called fluoride phase KMgF₃. The mica was ground for 100 h in a ball mill, after which its particle size did not exceed 50-60 μ. The mica content in the composites studied ranged from 5-50 vol.%. The specimens were made by a method based on previous experiments [1].

Measurements before and after sintering showed that sintering produces shrinkage, the magnitude of which increases with decreasing mica content in the composite. Thus, the volume shrinkage was 1.6-1.8% for the material with 50% mica. After coining and repeated sintering, the volume shrinkage of specimens with 30% mica was only 0.5%; no shrinkage of specimens containing 50% mica was detected.

The electrical conductivity of experimental materials was determined by a method using a compensating bridge. Data for the dependence of composite electrical conductivity on mica content are reproduced in Fig. 1. When the mica content does not exceed 30 vol.%, the electrical conductivity of the materials changes only slightly. At higher mica concentrations, the cross-sectional area of the silver skeleton is sharply reduced and the electrical resistance of the composite material increases.

The mechanical properties of the composite materials were also determined. The effect of the mica content on their hardness and on their bending and compressive strength is shown graphically in Fig. 2.

Analysis of the results of determination of the relative deformation in compression showed that increasing the mica content in composite materials produces a reduction in ductility. Especially characteristic are the changes in the specimen shape and in the nature of fracture in compression. While, in the case of materials containing 10 and 20% mica, the specimens deformed under load to form flat buttons before the appearance of cracks, the reduction in height of specimens with 30 and 40% mica was, respectively, 30-35% and 9.8%, while specimens with 50% mica broke in such a way that it was impossible to determine their deformation.

The antifriction properties of silver-mica composites were determined in dry friction on a MT-62M friction machine by a method developed at the Institute for Problems of Materials Science AS UkrSSR [2]. The machine is designed to accurately measure and record linear wear and the friction force during tests, without removing the specimen from the machine. For measuring the friction force and linear wear we used BV-844 induction pickups, electrically connected to BV-662 automatic recorders.

A St.45 steel ring (96 mm in diameter) quench-hardened and tempered to the hardness HRC = 56-58 was used as the counterbody; its working surface finish corresponded to class 8 of GOST 2789-59 specifications. A new counterbody was used in each test. Cylindrical specimens (10 mm in diameter and 15 mm high) were compacted with the aid of a special punch whose end face had the same curvature as the counterbody.