By employing various antifriction additions (graphite, sulfides, boron nitride), it is possible appreciably to lower the coefficients of friction of cermets. Because of the low oxidation resistance of such materials at elevated temperatures, however, cermets containing these additions are only used on a small scale. Synthetic mica employed as a filler enables nickel composites to be produced whose coefficients of friction are much lower than those of nickel–graphite materials [1]. The reason for this is that mica is chemically more stable than graphite under dry friction conditions. It has also been established that the addition of up to 25 vol.% of mica has no effect upon the oxidation resistance of nickel as long as the porosity of the resultant cermets is less than 10% [2].

In the present work, a study was made of the preparation and properties of cermets composed of nickel and synthetic mica. As starting materials, carbonyl nickel of <10 μ particle size and mica glass prepared by the water granulation of molten potassium fluorophlogopite, K(Mg₃Si₃AlO₁₀)F₂, were used. The mica glass contained up to 30 vol.% of crystallized mica, and its mean particle size varied from 7.5 to 30 μ.

The starting powders were thoroughly mixed by repeatedly passing them through a sieve. The resultant powder mixtures were pressed, under pressures of 1000 and 4000 kg/cm², into 15-mm-diameter × 15-mm high cylindrical specimens and 10-mm-square × 60-mm high rods. The compacts were calcined for 2 h in commercial hydrogen at 1170°C. After calcining, determinations were made of the volume shrinkage, porosity, transverse rupture strength, and Brinell hardness of the cermets; in addition, the structure of the composites was examined using microsections, and the effects of the nickel plating of the starting mica glass powder upon the properties listed above were investigated.

![Fig. 1](image1.png)

Fig. 1. Variation of transverse rupture strength (1, 2) and porosity (3, 4) with mica content. Mica glass: 1, 3) unplated; 2, 4) nickel-plated.

![Fig. 2](image2.png)

Fig. 2. Volume shrinkage of mica cermets, Mica glass: 1) unplated; 2) nickel-plated.
The nickel plating of the mica glass powder was performed by the method of electroless deposition of nickel from a nickel chloride solution with the aid of sodium hypophosphite [3, 4]. A batch of mica glass was treated at a temperature of 18-25°C with a solution containing 10 g SnCl₂·2H₂O, 40 ml HCl (conc.), and up to 1 liter H₂O and then dried at 90-100°C, after which the powder was treated with a palladium chloride solution and once again dried, at 120°C. Palladium chloride acts as a catalyst of the hypophosphite decomposition reaction, and, because of this, its concentration in the solution has a pronounced effect upon the rate of deposition of metallic nickel and hence on the quality of the resultant deposit. The optimum amount of the crystalline hydrate PdCl₂·2H₂O (for mica glass powder of the particle size mentioned above) was found to be about 0.15 g per 1 liter of solution acidified with hydrochloric acid to pH 3.5. The activated mica glass powder was placed in a solution containing 45 g/liter NiCl₂·6H₂O, 50 g/liter Na₂C₂H₃O₇·2H₂O, and sufficient 25% ammonia solution to reach pH 8-8.5. A sodium hypophosphite solution (50 g/liter NaH₂P₂O₅·H₂O) was added drop by drop with intense agitation of the powder in the solution and gradual raising of the reaction medium temperature to 80°C. The nickel-plated powder was washed with water and dried. The quality of plating was tested by examination under an MIM-8 microscope in transmitted light. The plating conditions chosen enabled nickel to be deposited on particles less than 5-7 µ in size. The density of the plated powder, determined pyknometrically, was of the order of 3.47 g/cm³ as against 2.70 g/cm³ for the starting mica glass, indicating a metallic nickel content of 22 wt.%. In diffractograms of the nickel-plated mica glass powder could be seen very diffuse reflections of metallic nickel, testifying to marked defectiveness of the nickel deposit.

During the heat treatment of the cermets, the mica glass crystallized, with the formation of potassium fluorophlogopite. This process was accompanied by no volume changes, and came to an end within 10-15 min at 1200°C. The total porosity of sintered specimens containing up to 30 vol.% of mica was about 3-5%, and was virtually the same for materials with plated and unplated mica. Over the mica glass content range 30-70 vol.%, the porosity of the cermets grew to 20-35%, cermets with plated mica glass showing increases in porosity at all the mica glass contents investigated (Fig. 1).

The variation of the volume shrinkage of the mica cermets was found to be in accord with the porosity data. The greatest shrinkage was characteristic of specimens of low porosity, containing less than 30 vol.% of mica. Raising the mica content to 70 vol.% (Fig. 2) had an adverse effect on the sintering behavior of the cermets, bringing about corresponding decreases in the volume changes, while at mica contents of more than 50 vol.% the specimen volume increased during sintering.

Metallographic examination was carried out in reflected light, using polished microsections. To bring out their microstructures, the microsections were etched for 15-25 min with concentrated hydrochloric acid at room temperature. The study revealed that, at mica contents of up to 40 vol.%, nickel plating had virtually no effect upon the shape and size of the nickel and mica particles. In Fig. 3a-f are shown some microstructures characteristic of this group. At low mica contents, the nickel grains were mainly of regular shape, and contained inclusions in the form of fine, closed pores or mica particles up