coefficient of thermodynamic friction losses may be used in engineering and technological
calculations as a reference parameter.

4. It is necessary to develop a procedure for using the coefficient of thermodynamic
friction losses in engineering calculations under arbitrary friction conditions.

5. The coefficient of thermodynamic friction losses may be used as a generalized cri-
teron of the technical state of bearings, friction units in machines, mechanisms, and vehi-
cles, such as automobiles, under operating conditions.

LITERATURE CITED

DEFORMATION PROCESSES IN TUNGSTEN CARBIDE POWDER GROUND IN A BALL MILL

A. V. Paul', S. F. Gnyusov, Yu. F. Ivanov, S. N. Kul'kov, and È. V. Kozlov

Electron diffraction microscopy and x-ray structural analysis are used to
study the evolution of particle size and defect structure in tungsten carbide powder during deformation by grinding in a ball mill. Correlations
are obtained between grinding time, particle size, and defect structure para-
eters (scalar dislocation density and azimuthal component of the full dis-
orientation angle).

One of the methods used for producing powders used in pressing of ceramic parts is
mechanical grinding. Variations in the grinding methods and device parameters (rate of rotation, grinding time, etc.) have a marked effect on the dispersion of the particles pro-
duced, their morphology, defect structure, etc. [1].

In the present study electron diffraction microscopy and x-ray structural analysis
will be used to study the evolution of defect structure in tungsten carbide powder ground in a ball mill for periods of 12, 24, 36, 48, and 65 h. The materials studied were tung-
sten carbide powders (TU-48-19-265-77), produced by reduction of tungsten oxide [2]. The
specimens for electron microscope studies were prepared by depositing powder particles on a carbon substrate prepared in a VUP-4 vacuum station. Granulometric analysis of the powder was performed by stereometric methods [3]; dislocation density and value of the disorienta-
tion angle were determined by the methods described in [4].

RESULTS

X-Ray structural and electron microscope analysis of the phase composition of the tung-
sten carbide powder showed that the main fraction of the material was tungsten carbide with composition WC (spatial symmetry group P6m2). Only rare in the original state, and somewhat
more often in the deformed were particles of the carbide W₂C (spatial symmetry group P6₃/mmc) observed in the WC powder. The cause of the appearance of W₂C in the WC structure may be decarbonization of the latter, which intensifies with grinding.

Together with the carbide, oxides of the type WO₂ (spatial symmetry group P4₂/mbm) were observed in the powder. Oxide particles were found both as independent particles and within the composition of tungsten carbide grains. It should be noted that in the grinding process one often finds cracks in such grains, occurring at the boundary between carbide and oxide phases. The defect structure of the tungsten carbide powder in the initial state shows individual dislocations chaotically distributed within the particle body (Fig. 1a). Analysis of microdiffraction patterns (Fig. 1a') gives reason to conclude that the particles are single-crystals. Grinding of the tungsten carbide particles leads to an increased defect rate (Fig. 1b, c), with both baseline and prismatic slippage. As follows from [5, 6], slippage along the base plane is accompanied by the appearance of long dislocations and dipole