MODERN HIGH-SPEED SPINDLE BEARINGS WITH CERAMIC COATINGS: APPLICATION AND EFFECTIVENESS

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Modern high-speed spindles operating at speeds exceeding 100,000 RPM require optimization of the tribological characteristics of bearing assemblies to ensure long service life and operational stability. This research examines promising directions for using ceramic coatings on ball bearing components to improve their performance characteristics at extreme rotational speeds up to 120,000 RPM.

The subject of this study is the evaluation of the potential application of ceramic coatings on steel bearing rings when used with ceramic balls to create a "ceramic-ceramic" friction pair, which potentially provides further reduction in friction and heat generation. A rational solution is the use of a separate steel ring with an applied ceramic coating, which is mounted on the spindle shaft, allowing for reduced manufacturing and maintenance costs.

Analysis of research shows that ceramic coatings on raceways in combination with ceramic balls provide improvement in several key parameters of high-speed spindles: reduction of braking torque by 12-20%, decrease in bearing operating temperature by 20-25%, increase in service life by 1.5-2 times, and improved positioning accuracy due to minimized thermal expansion.

Technical challenges in implementing this solution include ensuring reliable adhesion of the ceramic coating to the steel substrate, optimizing coating thickness, and developing technology that prevents coating damage during installation and operation. To minimize these risks, the application of modern PVD/CVD technologies is recommended, as well as the development of specialized quality control methodologies.

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