Applied Research Activities

Adhesive crystalline diamond coatings on steel sliding rings as high-performance tribo pairing under water lubrication or partial dry running

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Crystalline diamond coatings on ceramic rings made of silicon carbide have established themselves in special applications for high tribological requirements on plain bearings or mechanical seals. The diamond coatings, which are approx. 5 µm to 15 µm thick, are produced by chemical vapour deposition (CVD) at temperatures of around 800 °C. The crystalline structure of the diamond coating differs significantly from the largely amorphous DLC (Diamond Like Carbon) coatings produced at lower process temperatures by physical vapour deposition (PVD), which are used millions of times in oil-lubricated systems on steel parts.

Until now, it has not been possible to apply crystalline diamond coatings to steel because the iron in the steel promotes graphitic carbon deposition and the large difference in the coefficients of thermal expansion (800 °C to RT) of steel (approx. 11 µm/mK) compared to diamond (3.5 µm/mK) leads to extreme residual cooling stresses above 8 GPa and thus to coating delamination. In joint research work of the Friedrich-Alexander University Erlangen-Nürnberg with the Technical University Chemnitz, it has been possible to deposit well adhesive CVD diamond coatings on steel sliding rings (X46Cr13) with a thickness of up to 15 µm by means of a stable titanium nitride high-temperature intermediate layer and suitable mechanical pre-structuring of the steel surface. This article explains the way to produce the adhesive diamond coatings on steel with the highest possible evenness in order to achieve a sufficient contact surface in the subsequent Tribometer tests in water and/or in dry running. Furthermore, first industrial prototype applications are shown.

One goal of the research work is the development of a stable, corrosion-resistant tribosystem with steel substrates, e.g. also for seawater applications.