Tribology and Wear of Polycrystalline Diamond Bearings

Robust bearings for highly aggressive environments are a key requirement for reliable operation in many industries. One example is the thrust and radial bearings used in bottom hole assemblies for oil and gas borehole drilling, where bearing are required to operate in drilling mud at high pressure (e.g. 200 MPa) and high temperature (e.g. 300°C). Another example is aerospace turbine applications, where bearing failure can not only cause major repair costs but can also carry substantial safety implications. Polycrystalline diamond (PCD) compacts offer substantial benefits over other bearing materials in this type of application, providing a combination of robustness, low wear and toughness not found in any other material. Whilst the need for such bearings is clear, there remains substantial work to be completed in understanding the tribology and failure mechanisms of these materials in these challenging environments, to optimise their performance.

The PhD will combine experimental investigations with theoretical study and computer modelling in order to construct the best approach to:

(I) Development of an understanding of the in-service loading conditions which bearing assemblies are exposed to, and of suitable tribological testing protocols and field trials to enable characterisation of performance enhancement as the bearing materials and designs are developed. This work will need to consider the effects of lubricating medium, load, temperature and other operating conditions, and the reproducibility and relevance of the proxy testing conditions being developed.

(II) Development of a predictive computer model of bearing and tribological applications, with the support of the wider research team in which they are based. This modelling will include stress and lubricant film formation in bearings, and link micro-mechanical models to crack initiation and growth in the polycrystalline PCD materials. Capturing the mechanisms responsible for bearing failure will be the key objective of the modelling.

(III) Using links with other ongoing work (E6, Imperial, Oxford Physics etc.) looking at failure and wear mechanisms in PCD diamond, together with the new understanding developed of contact pressures, fluid flow and film formation, temperature pressure etc., develop a an understanding of the wear mechanisms of such bearings, and ultimately the lifetime performance of such bearings before catastrophic failure. Key contacts with other groups will be forged during the two mini projects preceding the PhD.

Whilst the end objective for the project is relatively well defined, the best route to achieve this has yet to be determined, and the PhD student will be able to substantially influence the direction of the project, contribute to real market applications, and quite possibly develop new Intellectual Property.

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