



**Advanced Materials for Preventing Tribological Failures
in Submersible Pumps and Other Turbomachinery**

Due to harsh operational conditions of Electrical Submersible Pump (ESP) and other turbomachinery devices, their bearing surfaces are prone to high friction, wear and damage, such as scuffing, galling and seizures, leading to catastrophic failures of these devices. In terms of ESPs, state-of-the-art materials used include both hard materials and “soft” materials. Such interface material solutions have advanced the life of these devices significantly. However recent advances in subsea and deep exploration, require the development of the next generation of interface materials, under aggressive operating conditions, including higher temperatures, higher pressures and limited or the absence of effective liquid lubrication.

As far as materials are concerned, during the last few years, new material solutions have emerged, especially in thin film coating format. These include hard materials such as diamond-like-carbon, WC/C, HfB₂ and other nano composite material combinations (offering reduced friction and minimal wear), as well as advanced polymeric-based high bearing materials, such as polyether ether ketone (PEEK)-based, polytetrafluoroethylene (PTFE)-based and aromatic thermosetting polyester (ATSP)-based materials, including in thin film format.

We have developed collaborations with major coating manufacturers and procured advanced materials, including soft coatings and hard coatings, for turbomachinery bearing systems to reduce friction, reduce wear and prevent tribological failures (scuffing or galling). We use several specialized tribometers referred to as High Pressure Tribometer (HPT), High Temperature Tribometer (HTT), Ultra High Pressure Tribometer (UHPT) and a Falex four ball machine, that can test under specific operating conditions, simulating specific devices such as pumps and compressors. We have accomplished/present original work on the friction and wear behavior of three different advanced coatings: PTFE-based, PEEK-based and ATSP-based coatings tested against 4130 steel under boundary lubrication conditions, simulating extreme operating working status of hydrodynamic bearings. The coatings exhibited excellent performance compared to bare substrate materials without coatings. All three coatings exhibited improved scuffing resistance and all coatings exhibited relatively low coefficient of friction and low wear rate; among these three coatings, ATSP coatings exhibited the best wear resistance. This study is an important contribution for proving the application of thin coatings in hydrodynamic bearings. The work so far has been submitted to two journal publications, as follows:

Lan, P., Meyer, J.L., Economy, J., Polycarpou, A.A., “Unlubricated tribological performance of aromatic thermosetting polyester (ATSP) coatings under different temperature conditions,” Trib Let, in press.

Lan, P., Meyer, J.L., Polycarpou, A.A., “Advanced polymeric coatings for tilting pad bearings with application in the oil and gas industry, Wear, in review.