SMU Department of Mechanical Engineering

SEMINAR

"Nanoscale Properties of *In-Situ* formed Tribofilms"

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Abstract: In-Situ formed tribofilms are the first line of defense against wear in an internal combustion engine as well as in various other applications such as gears, bearings etc. In addition, fuel economy in an automobile is affected significantly by the frictional losses at various locations within the engine including bearings, piston and piston ring regions etc. The chemistry of the tribofilms that are typically 100-200 nm thick largely controls the friction and wear behavior. Over the last 70 years zinc dialkyl dithiophosphate (ZDDP) has been used as the exclusive additive to minimize wear and control oxidative degradation of lubricants due to their low cost and good wear performance. However, ZDDP suffers from some significant limitations, its volatility in the engine results in deposits on catalytic convertors resulting in higher tailpipe emissions, the tribofilms formed using ZDDP result in higher friction and lower fuel economy. In addition, the Zn present in the structure resulted in higher ash content and larger sludge formation resulting in increased viscosity of the oil over time and lower fuel economy.

In this study a new molecular chemistry formed by fluorinating ZDDP, an ashless fluoro-thiophosphate and an ashless thiophosphate are examined as possible replacement for ZDDP. Wear tests in base oil as well as in several different fully formulated oils indicate that the fluorinated chemistries provide significant improvements in wear protection over ZDDP and when blended with the appropriate friction modifying chemistry can significantly reduce friction. Controlled conditions were used to generate tribofilms on steel substrates and their properties examined to study the mechanism of formation of tribofilms on the surfaces and the influence of the starting chemistry on the structure an properties. Surface analytical techniques such as scanning electron microscopy, energy dispersive spectroscopy, Auger electron spectroscopy, X-ray absorption near edge spectroscopy, transmission electron microscopy, focused ion beam were used to characterize the structure and chemistry of the tribofilms. The mechanical properties of the tribofilms were examined using a nanoindenter. Information gathered using these techniques was used to develop phenomenological models of the tribofilms.

Bio: Dr. Aswath is the Associate Chair and Professor of Materials Science and Engineering and Mechanical and Aerospace Engineering at The University of Texas at Arlington. He got his B.S. (Phy. Chem. Math) from St. Joseph College, Bangalore University, B.E. (Metallurgy) from Indian Institute of Science, Bangalore, India. M.S. and Ph.D. from Brown University. Dr. Aswath has published over 80 journal and conference papers and has worked extensively in diverse research fields including fatigue and fracture, oxidation and degradation of materials, synthesis and properties of ceramics and ceramic composites, synthesis, characterization and applications of biomaterials for drug delivery, tissue engineering and structural application and lastly tribology and lubrication. He serves as a reviewer for Metallurgical Transactions, Acta Materialia, Journal of Materials Science, Tribology Transactions, Advances of Tribology, Journal of Biomedical Materials Research, Journal of Applied Physics, Annals of Thorasic Surgery, Journal of Polymer Research among others. He currently serves as the Chairman of the Lubrication Fundamentals Committee of STLE and as Program Session Chair for the last few years. He also serves on the National Action in Education Committee of ASM International.