

Chemical and Nanomechanical Properties of Tribologically Formed Films on an Aluminum Alloy (Al383): Interactive Effects of ZDDP, a Molybdenum Friction Modifier and a Detergent

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The interactive effects of a friction modifier additive, and a calcium phenate detergent additive, with zinc dialkyl-dithiophosphates (ZDDPs) in the formation of antiwear films has been studied by synchrotron and nanoindentation techniques, independently. X-ray absorption near edge structure (XANES) spectroscopy has shown that films prepared from oils containing both ZDDP and detergent, and ZDDP and molybdenum dithiocarbamate (MoDTC), are chemically similar to, but thicker than those made from oils containing only ZDDP. In addition, wear was greatly reduced in the presence of the detergent which was correlated to the basicity and friction modifier. The phosphorus K- and L- edge XANES spectra show that the tribofilms are polyphosphate glasses of similar nature to those found on steel but characterized by a shorter chain length. The sulphur K-edge shows a MoS₂-like film and under certain conditions, presence of a sulphate is detected. Using various scanning probe techniques, in conjunction with an imaging nano-indenter, high resolution topographic images and mechanical properties can be extracted at the same length scale. The measurements of the indentation modulus of the films yielded very interesting results. The detergent yielded a similar mechanical response independent of conditions tested. The indentation modulus of the films on the Al matrix always appear much softer than the films formed on the Si grains whether or not the lubricant contains only ZDDP, or both ZDDP and MoDTC¹.

1. Gavin Pereira, Andreas Lachenwitzer , David Munoz-Paniagua, Masoud Kasrai, Peter R. Norton , T. Weston Capehart², Thomas A. Perry², Yang-Tse Cheng, Tribol. Lett, 2006, in press.