# Differences in Tribofilms Formed by ZDDP and Phosphonium-based Ionic Liquids

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**Abstract.** To achieve a stable tribological system for lubricated contacts under mild wear conditions, the formation of a tribofilm is desirable. The lubricants' additives have a major influence on the formation of a boundary layer. A typical additive is Zinc dialkyldithiophosphate (ZDDP), which forms a smooth film with low roughness on the surface. Such a film consists of glassy Fe/Zn polyphosphates with a height of up to 150 nm. The layer formation is favored by high shear stresses under high contact pressures and is additionally influenced by the temperature. A relatively new variant for additives are Ionic liquids (ILs). The tribofilm formation of two phosphonium-based ILs (Trihexyltetradecylphosphonium bis(2,4,4-trimethylpentyl)phosphinate and Trihexyltetradecylphosphonium bis(2-ethylhexyl)phosphate) is compared to a ZDDP-based tribofilm. Doing so, the formation of phosphate containing layers under tribological contact were investigated on samples of 100Cr6 rolling bearing steel in an oscillating milli-tribometer (Fig. 1). Ionic liquids (in mineral based oil), ZDDP-additivated oil and pure mineral based oil was compared. With a defined normal force, either a rolling ball with a diameter of 5 mm or a stationary ball with a diameter of 6 mm as a counter friction partner is moved over a lubricated 100Cr6 bearing steel sample. In order to investigate the influence of different model fluids, the experiment was performed in an oil tank. The resulting tribofilms were investigated in terms of microscopy and ToF-SIMS (Time of Flight - Secondary Mass Spectrometry). The investigations help to reach conclusions on the tribofilm formation regarding phosphate and other elements containing layers.

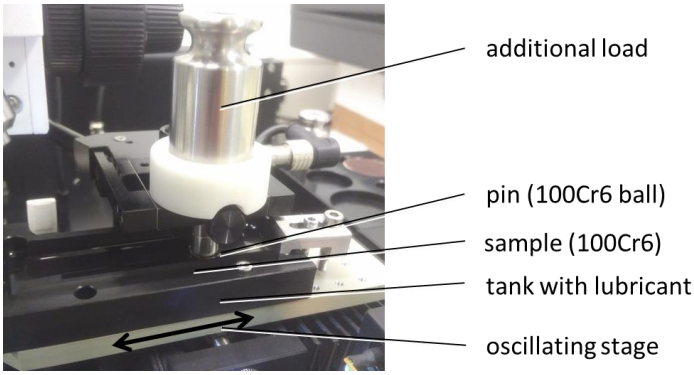


Fig. 1: Oscillating tribometer for tribofilm generation