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# Effect of organic friction modifiers on lubrication of polymer-steel contact

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The rapid adoption of the tribologically promising polymer-steel pairing in many applications has prompted intense research to optimize its lubrication. This study has investigated the effect of a popular organic friction modifier (OFM) on the lubrication of polymer-steel contacts. Three types of polymers commonly used for tribological applications were studied: PEEK, POM and UHMWPE. The OFM showed a similar effect on friction and wear of PEEK and POM, while no significant effect was observed for UHMWPE. These results closely relate to the polarity of polymer surfaces.

**Keywords (from 3 to 5 max):** OFM, lubrication polymers, PEEK, POM, UHMWPE

## 1. Introduction

Polymers are becoming preferred materials in many tribological applications due to their advantages such as lightweight, reduced noise and self-lubricating properties. On the other hand, the mechanical strength and thermal stability of polymers are lower than those of metals, prompting a surge of activity to improve their tribological properties. Lubrication has the potential to reduce friction and wear. However, little is known about the lubrication of polymers, especially about the effect of lubricant additives. The authors have previously reported the effect of organic friction modifiers (OFMs), one of the most important lubricant additives, on lubrication of the PEEK-steel contact [1]. This study investigated the effect of OFMs on two other commonly used polymers for tribological applications: Polyoxymethylene (POM) and ultra-high molecular weight Polyethylene (UHMWPE).

## 2. Methods

Tribological tests were carried out on a mini traction machine (MTM) in a ball-on-disc configuration. The disc, covered with a PEEK, POM or UHMWPE plate, and the steel ball are driven independently to create a mixed rolling/sliding contact. Smooth (Ra = 0.01-0.02 µm) and rough (Ra ~ 0.5 µm) steel balls were prepared, as it has been reported that surface roughness plays an important role in a PEEK-steel lubricated contact [1]. Under the constant load, the entrainment speed was changed from low to high. A low viscosity poly−α−olefin (PAO) oil and oleoyl sarcosine, typically employed in a wide range of lubricants were used as a base-oil and OFM.

## 3. Results and Discussion

The Stribeck curves for the polymer-steel contact lubricated with PAO and PAO + OFM are summarized in Figure 1. In the case of PEEK-steel and POM-steel contacts the OFM showed similar effects, reducing friction with the smooth steel balls and increasing it with the rough steel balls. The wear of PEEK and POM plates paired with rough steel balls was also increased by the addition of OFM. On the other hand, in the case of UHMPE paired with smooth or rough balls, the OFM did not show any effect on friction (the Stirbeck curves for PAO and PAO + OFM were almost the same) or wear. These results can be explained by considering the chemical structure of the three polymers: PEEK and POM include polar groups, while UHMWPE consists of non-polar carbon-carbon bonds. Because absorption of OFMs is controlled by the surface polarity, the effect of OFMs on lubrication of polymer-steel contact is strongly affected by the polymer chemistry.

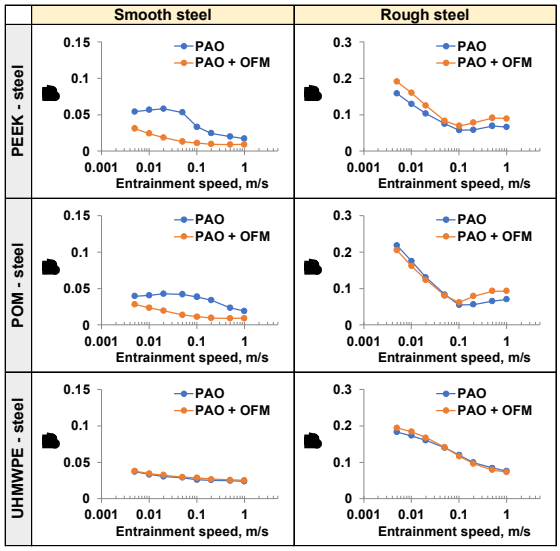


Figure 1: Stribeck curves for polymer-steel contact lubricated with PAO and PAO + OFM

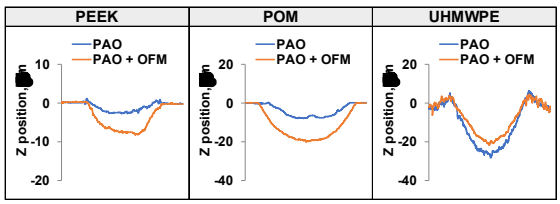


Figure 2: Wear profiles of polymer plates paired with rough steel balls

## 4. References

[1] Tatsumi, G. et al., "Effect of organic friction modifiers on lubrication of PEEK-steel contact," Tribology International, 151, 2020, 106513.