Confined fluids under time-varying tribological conditions

Towards a better understanding of lubricated friction

When the relative velocity between two surfaces suddenly stops or changes direction, local dynamic phenomena occur within the lubricated interface. These phenomena remain largely unexplained. The aim of the **Confluence** project was to identify these phenomena for a time-varying experimental condition and to characterize the lubrication mechanisms taking into account the complex rheology of the fluid confined between two surfaces, for film thickness ranging from the nm to hundreds of nm. We focused on: what are the mechanisms of formation/rupture of the lubricating film and friction? What are the roles played by the physico-chemistry and the flow properties of the lubricant? Answering these questions helps us to reduce friction loss and wear. It also contributes to better formulate industrial lubricants and to optimize the design of mechanical systems.

Our experimental and theoretical multi-scale analysis was based on the development and the use of tribometers allowing to visualize the contact in real time conditions as well as controlling the dynamics from the Hz to the kHz. The measurement of associated contact forces gives access to phenomena occurring on short time and space scales. This multi-scale approach, for contact pressures up to 1 GPa, velocities ranging from 10^{-10} to 1 m/s, was applied to model fluids. An *in-situ* mechanical and rheological spectroscopy of the confined interfacial medium was performed. An additional theoretical analysis was also carried out.

In this presentation, we will show that lubricated friction can now be fully analytically predicted, based on experimental data accounting for the nature and the molecular architecture. During a deceleration process, film forming mechanisms are explained and analytically described for the first time. Entrapment and squeeze phenomena during sudden halting are also described, highlighting the role of the pressure field (Figure). Understanding the film forming and friction mechanisms during an oscillation (cycles of acceleration/deceleration) was tackled.

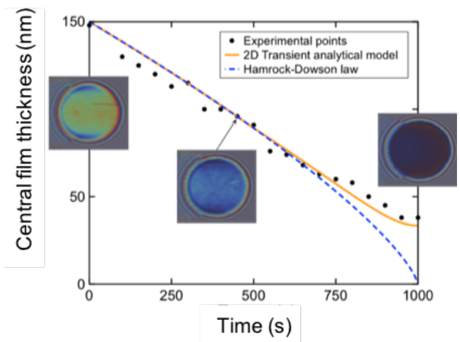

Figure : Analytical prediction of lubricant film thickness during a deceleration in a contact.