Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

A novel non-linear one-dimensional model for viscoelastic lubricants[1] LUCA BIANCOFIORE, HUMAYUN AHMED, Bilkent University — Lubrication is essential to improve the performance of sliding surfaces. Power transmission in mechanical and biological systems relies on proper lubrication to minimize wear and energy losses. However, most practical applications involve conditions that cause or require the lubricant to exhibit viscoelastic behavior. In this study a novel 1D viscoelastic Reynolds equation is derived based on the Oldroyd-B constitutive relation. It comprises a system of five 1D equations describing the pressure, velocity and shear stress distribution in the film. The model is compared with direct numerical simulations of thin films for different geometries. The results are in good qualitative and quantitative agreement indicating the simplified model is valid within the context of lubrication theory. Firstly, the pressure presents strong variations as the lubricant elasticity becomes significant, but stagnates as the polymer relaxation time becomes slow compared to the characteristic flow time. Secondly, the net film pressure is shown to be a superposition of a Newtonian and viscoelastic component. The viscoelastic component depends on the surface geometry. Surfaces with constant slope exhibit a pressure decrease, whereas the opposite effect is observed in parabolic surfaces.

[1]117M434 TUBITAK 1001 grant

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Date submitted: 30 Jul 2019 Electronic form version 1.4