

Arrested Development:

Design of a polymer coating to control slip of yield-stress material

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Introduction

Mechanical characterization of materials strongly relies on the assumption that the instrument set-up used does not play a significant role in the measurement. However, instrument limitations and instabilities caused by the set-up narrow the validity of the previous assumption for most complex fluids of industrial interest. Wall-slip is a predominant phenomenon generated by the interaction between the fluid and the geometry. Wall-slip is avoided in laboratory practice through control of the physics (geometry roughness) or the chemistry (particle-wall interaction) of the surface.

The proposed project focuses on the chemical modification of the surface. Usual modifications comprehend the functionalization of the geometry surface with specific chemical groups that interact with the sample. These solutions have been proved to be working by several authors [1]. However, these usually required specific surfaces, careful grafting reactions, and/or non-sample specific polymer coating.

Goals

You will be working in design and thoroughly characterize a polymer coating, based on a bioactive compound[2], that can be applied and removed with ease to different surface. Moreover, you will test the possibility to modify the coating to expose particular functional groups on the surfaces to be material specific, extending promising characterizations performed for the initial formulation[3].

- 1) Design different functionalizations of the polymer coating and define the chemical route to produce them
- 2) Understand the compatibility with substrates of different materials
- 3) Evaluate the recyclability of the polymer after usage, to minimize material waste
- 4) Characterize the surface chemistry and the friction of the produced films
- 5) Evaluate the performance in slip prevention/promotion during shear rheological experiments

Learning opportunity

- 1) You will learn to chemically modify a commercial polymer
- 2) You will learn to properly characterize to coating (e.g. AFM, NMR, TGA, contact angle)
- 3) You will learn to perform standard rheology with a focus on slip detection

Type of project

- Master thesis
- Master research project or bachelor thesis (the project will be slightly different in this case)

References

- 1) Sochi T., Polymer Reviews, 2011
- 2) Brum, R. S. and Monich, P. R. and Fredel, M. C. and Contri, G. and Ramoa, S. D. A. S. and Magini, R. S. and Benfatti, C. A. M., Journal of Materials Science: Materials in Medicine, 2018
- 3) Bittmann P. and Schenkel J., Pratikum V report, 2023