

# Determination of uniaxial and planar extensional viscosity using a Rosand high-pressure capillary rheometer

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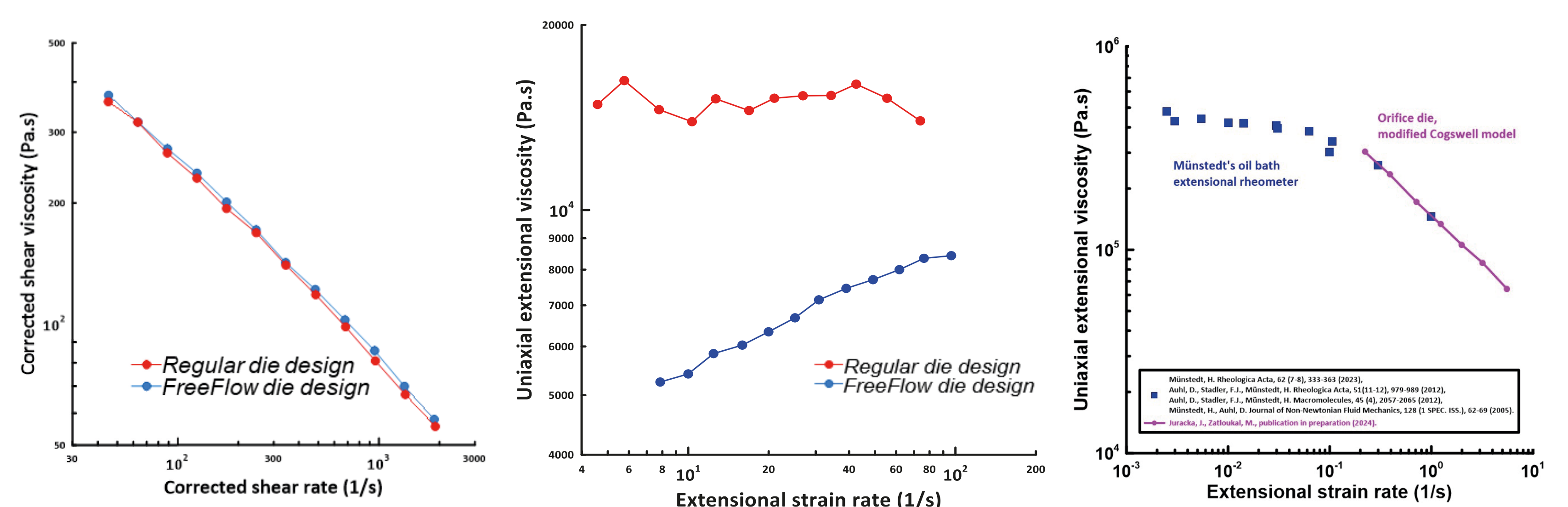
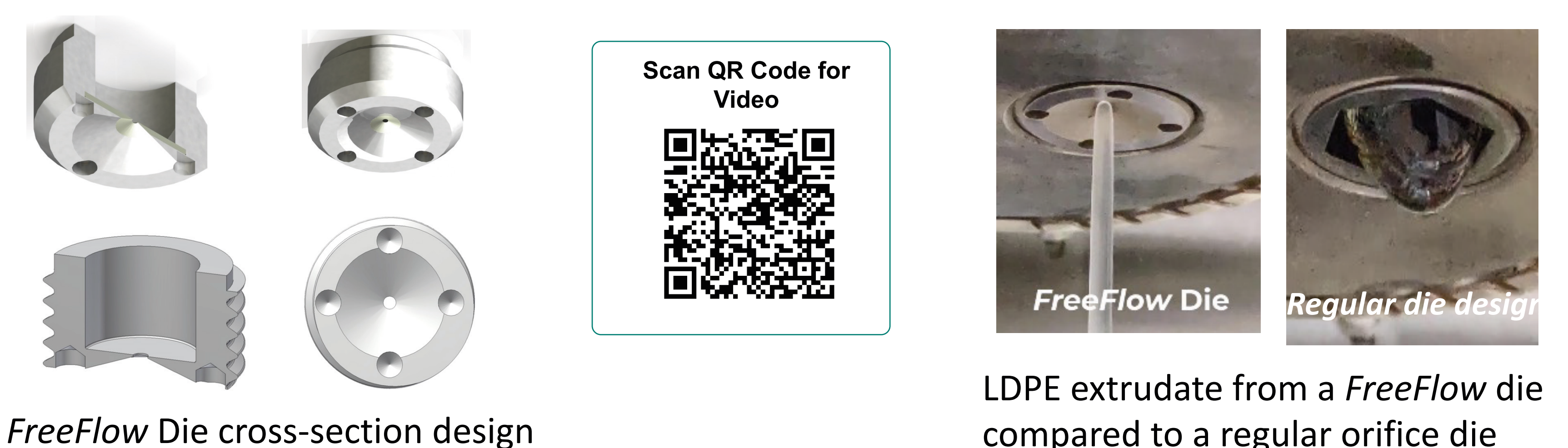
## Introduction

Extensional viscosity ( $\eta_e$ ) is a rheological characteristic that has a substantial impact on the processability of polymer melts and the final product's mechanical properties.  $\eta_e$  can be readily ascertained through entrance pressure drop ( $P_{en}$ ) measurements using high-pressure capillary rheometers, orifice dies and the Cogswell method. However, during  $P_{en}$  measurements, polymer can adhere to the underside of the orifice die, leading to an overestimation of  $P_{en}$ , rendering the determination of  $\eta_e$  inaccurate.

## New and Novel *FreeFlow* Dies

- Expanding on the pioneering work of Zatloukal, recent advancements in the design of ROSAND dies have led to the development of a new series of *FreeFlow* circular and rectangular orifice dies.
- Uniaxial and planar  $\eta_e$  can now be obtained effortlessly for various materials under controlled conditions.
- These innovative dies effectively eliminate the possibility of overestimating the entrance pressure drop, facilitating precise determination of both uniaxial and planar  $\eta_e$ .

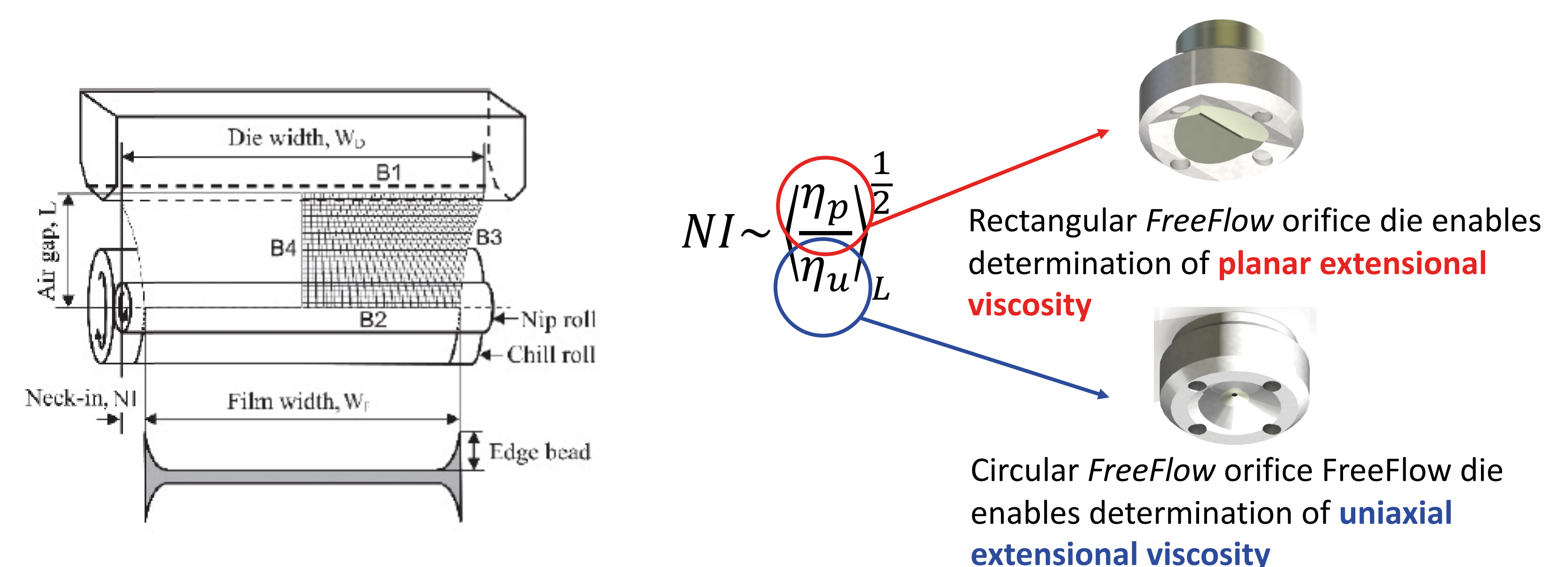
## *FreeFlow* Dies Design and Results



Despite significant differences in  $P_0$  at low shear rates, in the long capillary rheometer dies there are no significant differences in the shear viscosity curves (left graph). However, the uniaxial extensional viscosity is extremely sensitive to the quality of the  $P_0$  data (middle graph). The *FreeFlow* die design prevents sticking enabling properties such as strain hardening and strain softening (right graph) to be observed.

## Planar Extensional Viscosity with Rectangular *FreeFlow* Die

Neck-in (NI) and edge-bead in extrusion drawing in film-casting process reduce productivity and mechanical properties of the products. Neck-in tendency highly depends on viscoelasticity of the polymer.



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