Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Analysis of the onset of elastic instabilities in a homogenous stagnation point flow using dilute polymer solutions FILIPE CRUZ, SIMON HAWARD, MANUEL ALVES, CEFT, Departamento de Engenharia Química, Faculdade de Engenharia da Universidade do Porto, Porto 4200-465, Portugal, GARETH MCKINLEY, Hatsopoulos Microfluidics Laboratory, MIT, Cambridge, MA 02139, United States of America — We compare numerical and experimental results for viscoelastic flows in the optimized cross-slot extensional rheometer - OSCER (Haward et al., Phys Rev Lett 109:128301, 2012) up to the onset of elastically-driven flow instabilities. Model polymer solutions with almost constant shear viscosity are used in the experiments, and the FENE-CR constitutive model is used in the 2D numerical simulations together with an in-house finite-volume viscoelastic flow solver. We match the model parameters to the rheology of the fluids used in the experiments, and the simulations are conducted for a wide range of flow rates, ranging from Newtonian-like flow at low Weissenberg numbers (Wi) up to the onset of time-dependent elastic instabilities at high Wi. We test the applicability of a dimensionless stability criterion (McKinley et al., J Non-Newt Fluid Mech 67:19-47, 1996) for predicting the onset of flow instability for both the experimental and computational data sets, using a spatially-resolved procedure to locally compute the stability criterion in the vicinity of the stagnation point. By evaluating this dimensionless criterion on a pointwise basis we are able to clearly distinguish the OSCER flow geometry from the archetypal cross-slot geometry.

Filipe Cruz
CEFT, Departamento de Engenharia Química, Faculdade de Engenharia
da Universidade do Porto, Porto 4200-465, Portugal

Date submitted: 01 Aug 2014 Electronic form version 1.4