

Technical University of Denmark



Effective viscosity of polymers

Sivebæk, Ion Marius; Samoilov, V.N.; Persson, B.N.J.

Publication date:
2012

Document Version
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

Citation (APA):
Sivebæk, I. M., Samoilov, V. N., & Persson, B. N. J. (2012). Effective viscosity of polymers. Poster session presented at Fundamental Aspects of Friction and Lubrication, Leiden, Netherlands.

DTU Library

Technical Information Center of Denmark

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Effective Viscosity of Confined Hydrocarbons

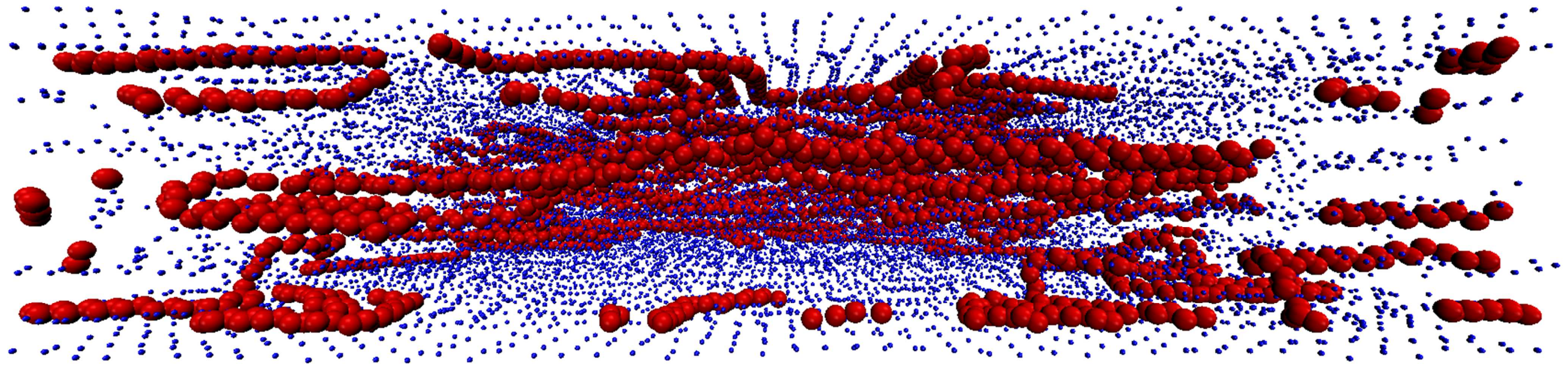
I. M. Sivebaek,^{1,2,3} V. N. Samoilov,^{1,4} and B. N. J. Persson¹

¹IFF, FZ-Jülich, 52425 Jülich, Germany

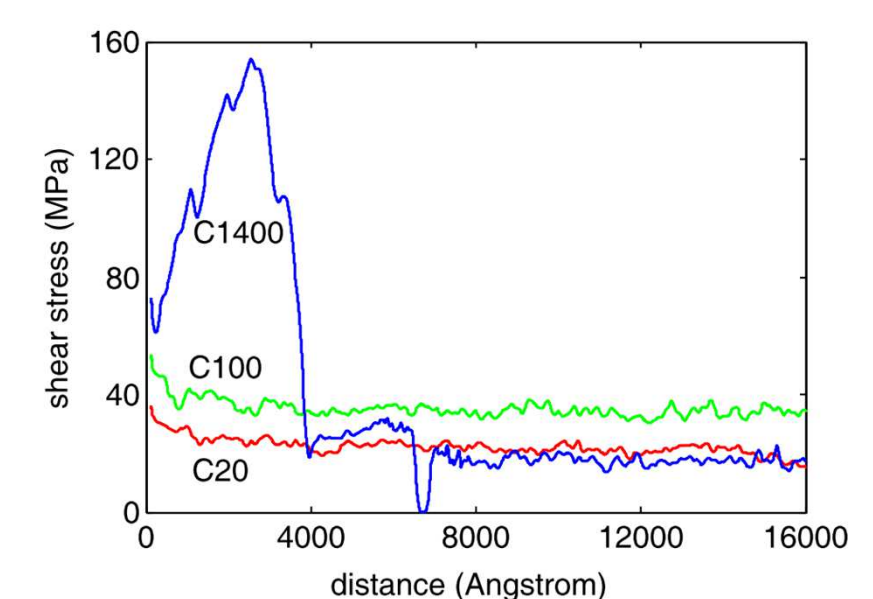
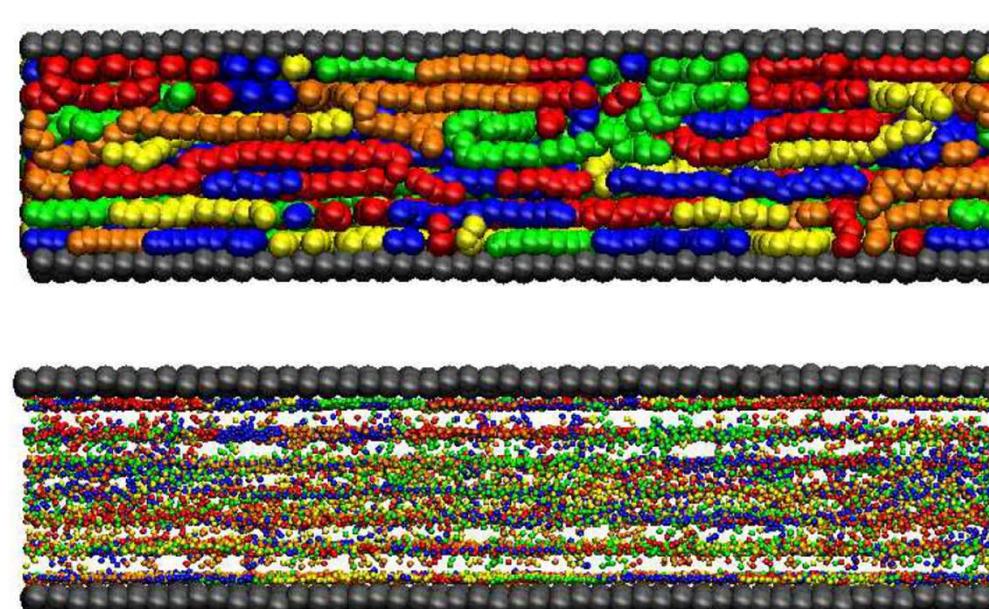
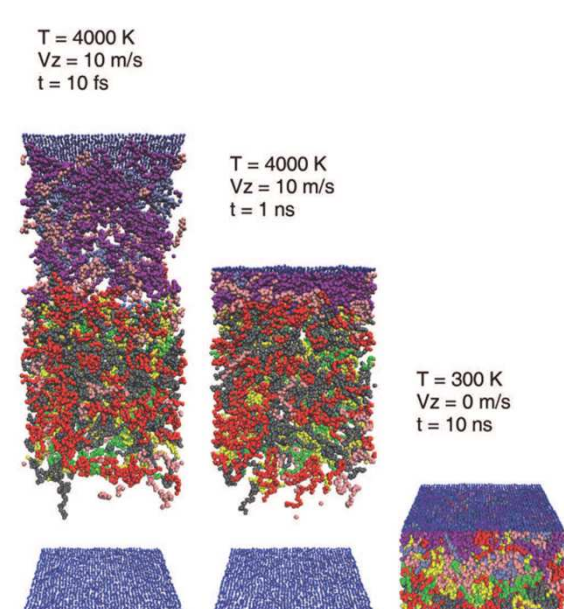
²Novo Nordisk A/S, Research and Development, DK-3400 Hillerod, Denmark

³Mechanical Engineering Department, Technical University of Denmark, DK-2800 Lyngby, Denmark

⁴Physics Faculty, Moscow State University, 117234 Moscow, Russia



Preparation



Surface Force Apparatus measurements at ambient temperature have shown that the logarithm of the effective viscosity depends linearly on the logarithm of the shear rate:

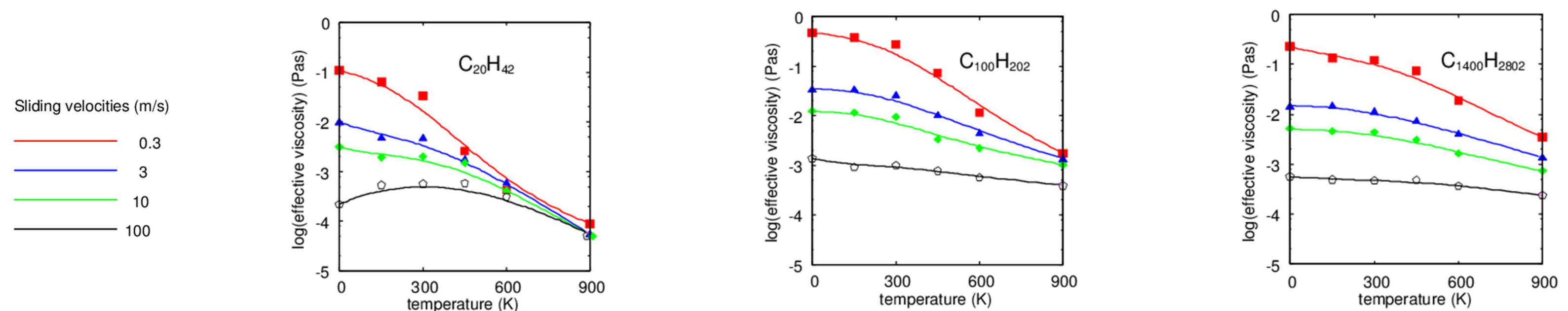
$$\log(\text{effective_viscosity}) = C - n * \log(\text{shear_rate})$$

With $n=0.9$ and $C=4.9$ for a large number of liquids and polymers: [Yamada S. Tribology Letters, 13 (3), 167 (2002)].

We present Molecular Dynamics (MD) friction calculations for confined hydrocarbon films with molecular lengths from 20 to 1400 carbon atoms. We find the same relation between the logarithm of the effective viscosity and the logarithm of the shear rate as in the Surface Force measurements. Also the same constants n and C were found by our calculations at ambient temperature (300K).

By heating and cooling of the hydrocarbons we have been able to establish that n varies from 1 (solid-like friction) at very low temperatures to 0 (Newtonian liquid) at very high temperatures, following an inverse sigmoidal curve. Only the shortest chain molecules melt, whereas the longer ones only show a softening in the studied temperature interval $0 < T < 900$ K. The results are important for the frictional properties of very thin (nanometer) films and to estimate their thermal durability: [Sivebaek, I.M., Samoilov, V.N., Persson, B.N.J. Physical Review Letters, 108 (3), 036102 (2012)].

Effective viscosity



n and C factors

