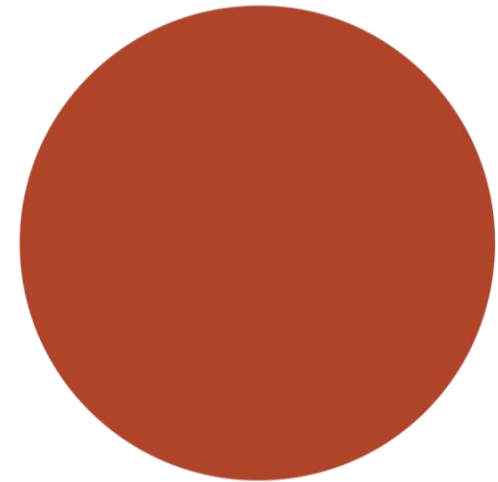


Performance polymers at DPI: 25 years of pre-competitive research for innovation

Costantino Creton

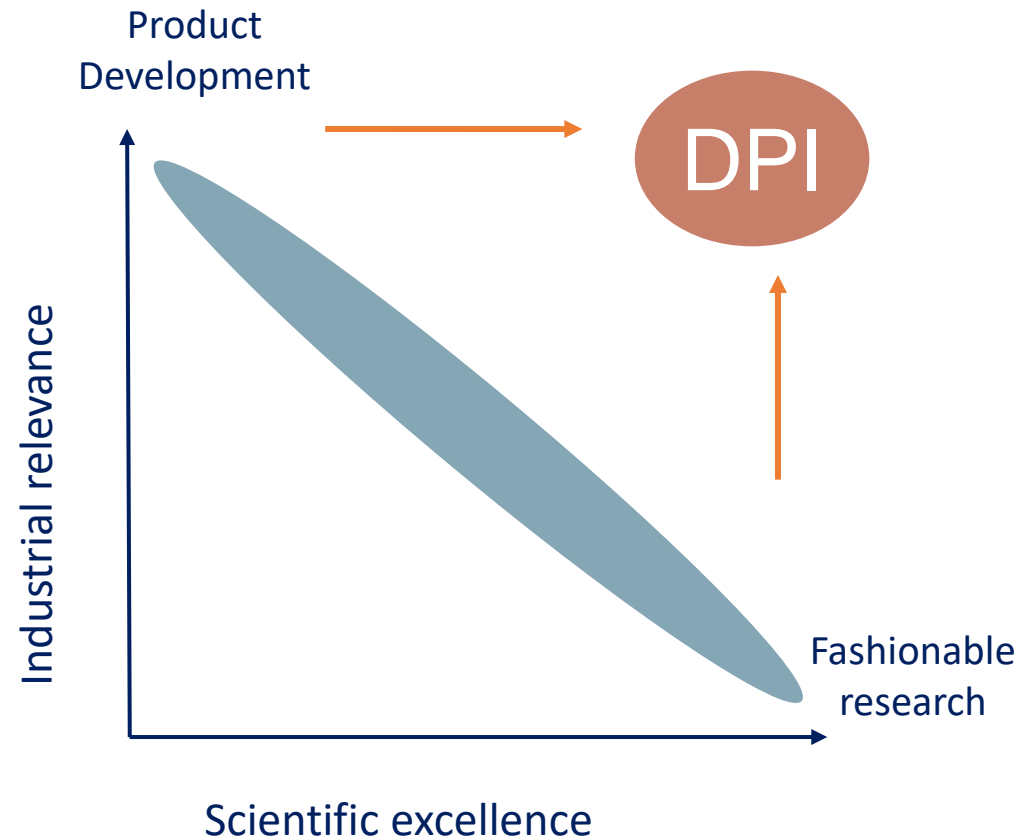
Scientific Chair Performance Polymers



General objectives of companies in precompetitive research



Research topics that are upstream from new product development and are not well-funded by public money



My own timeline at the PP program of the DPI

- **2010** : First contact and participation to first DPI event: nanocomposite workshop in Eindhoven
- **March 2011** : start as scientific chair of the PP program area.
- In 2011 there are **9 companies** in the TA Performance Polymers

2011 – 2013 : *Jan Stamhuis* as PAC

2013 – 2015 : *Ronald Korstanje* as PAC

In **2014** the Dutch government announces a drop of funding from 7 M€ annually to zero in three years

In **2015** start of DPI 2.0 with significant changes in the organisation and funding structure

From **2015** until now: For PP the PAC is ***Denka Hristova-Bogaerds***

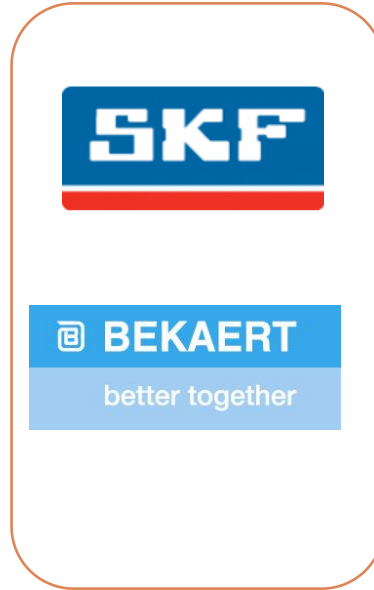
In **2016** PP 2.0 started with four companies : Sabc Specialties, Teijin Aramid, AkzoNobel and Shell

First focused call for proposals of DPI PP 2.0 in 2016

Performance Polymers Program: Industry Partners



2012



2022



Material producers

Converters

End Users

Performance Polymers Program: Academic Partners 2012



6 Dutch Universities and 5 European Universities

NL



UNIVERSITY OF TWENTE



Europe



National Technical
University of Athens



Performance Polymers Program: 29 Academic Partners in 2022

NL



UNIVERSITY OF TWENTE



Radboud Universiteit Nijmegen

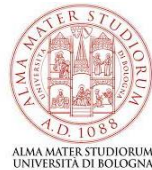
UK



EU



National Technical University of Athens



CN



Topics in performance polymers (May 2012)



29 active projects

5 active projects on aging, degradation and *self-repairing*

Stability and long term performance

Polymer and Network Chemistry and Modification

9 active projects many on *bio-based new chemistries*

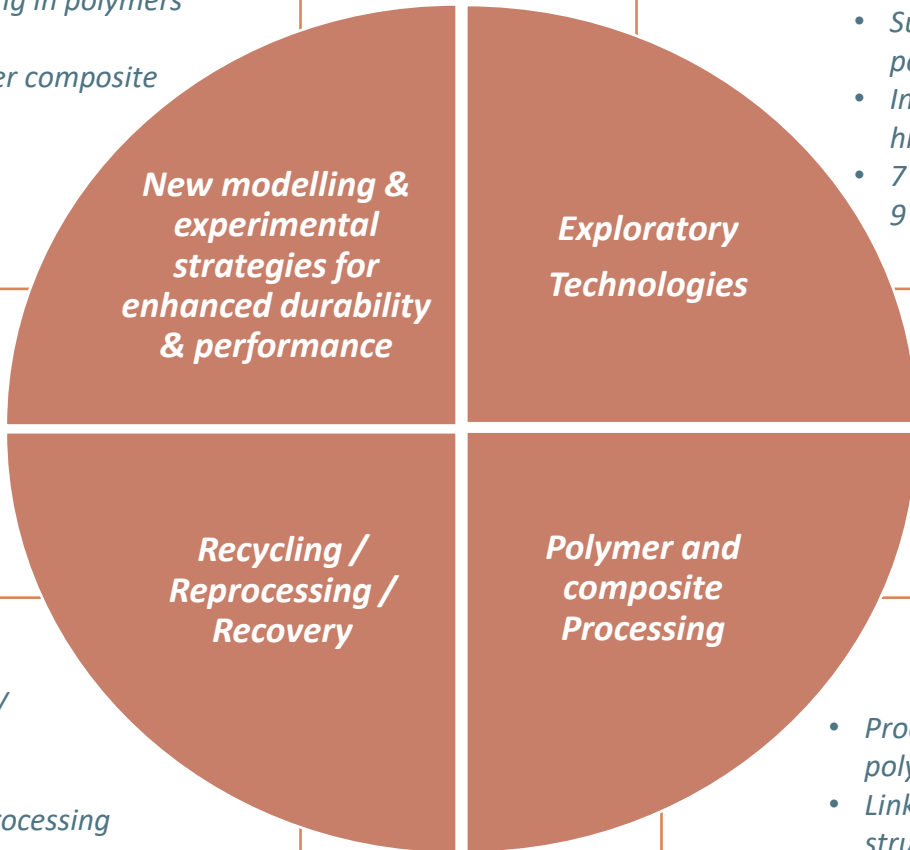
Advanced reinforced thermoplastics and synthetic fibres

Processing for Properties, Physics, Modelling

8 active projects on *nanocomposites*, short fibres, mainly structure-properties

7 active projects on *molecular modeling, continuum modeling, tribology*

Performance Polymers Program: Current Focus Areas

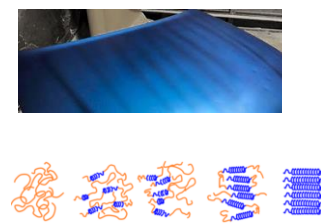
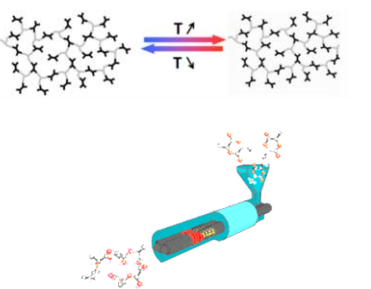
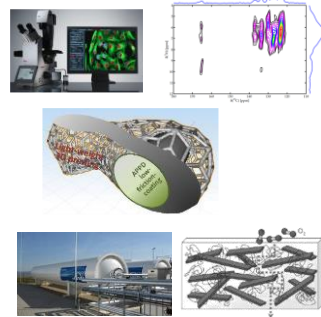
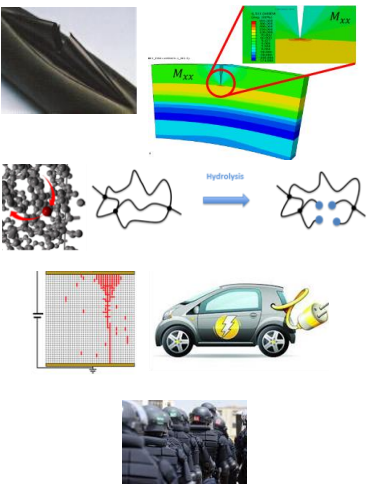


- *Composite Fatigue*
- *Chemical & Mechanical ageing in polymers*
- *Electrical ageing*
- *Impact mechanism in polymer composite*
- *Effect of multiple fillers on electrical conductivity*
- *10 projects, 13 PhDs, 8 post-docs, 14 Universities*

- *Advanced analytical & non destructive methods*
- *Surface treatment for enhanced polymer performance*
- *Informed design of novel polymeric high performance barrier materials*
- *7 projects, 7 PhDs, 2 post-docs, 9 Universities*

- *Reversible bonds for re-use / recycling of composites & thermosets*
- *Composites recycling / re-processing*
- *5 projects, 3 PhDs, 2 post-docs, 5 Universities*

- *Processing of complex multiphase polymeric systems*
- *Linking rheology to polymer molecular structures, morphology & performance*
- *3 projects, 3 PhDs, 2 post-docs, 5 Universities*





Some **highlights** of the performance polymers program over 25 years



Characterization and modeling of plasticity in polymer glasses

On the origin of strain hardening in glassy polymers

H.G.H. van Melick, L.E. Govaert*, H.E.H. Meijer

Dutch Polymer Institute (DPI), Section Materials Technology (MaTe), Eindhoven University of Technology,
P.O. Box 513, NL-5600MB Eindhoven, The Netherlands

Polymer 44 (2003) 2493-2502

236 citations

68 citations

Macromolecules 2005, 38, 7009-7017

Quantitative Prediction of Long-Term Failure of Polycarbonate

E. T. J. Klompen, T. A. P. Engels, L. C. A. van Breemen, P. J. G. Schreurs,
L. E. Govaert,* and H. E. H. Meijer

Dutch Polymer Institute (DPI), Section Materials Technology (MaTe), Eindhoven,
University of Technology, P.O. Box 513, NL-5600 MB, Eindhoven, The Netherlands

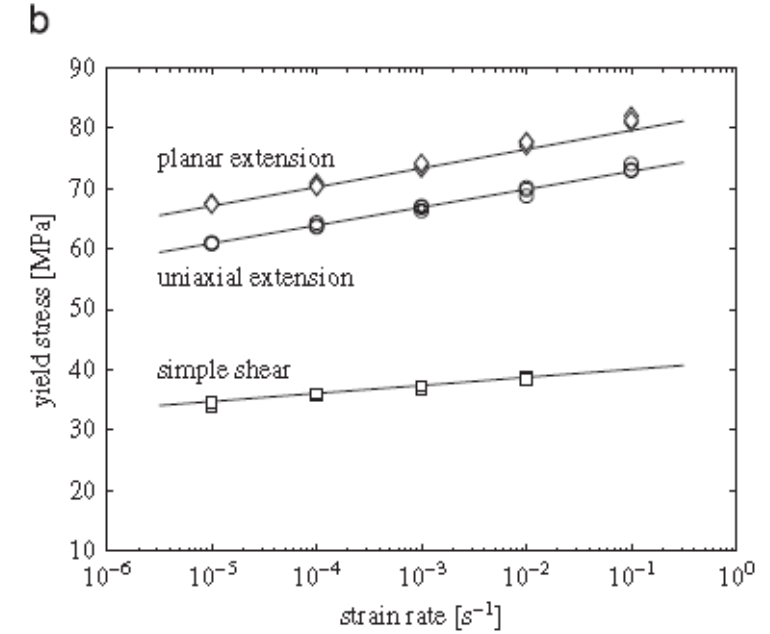
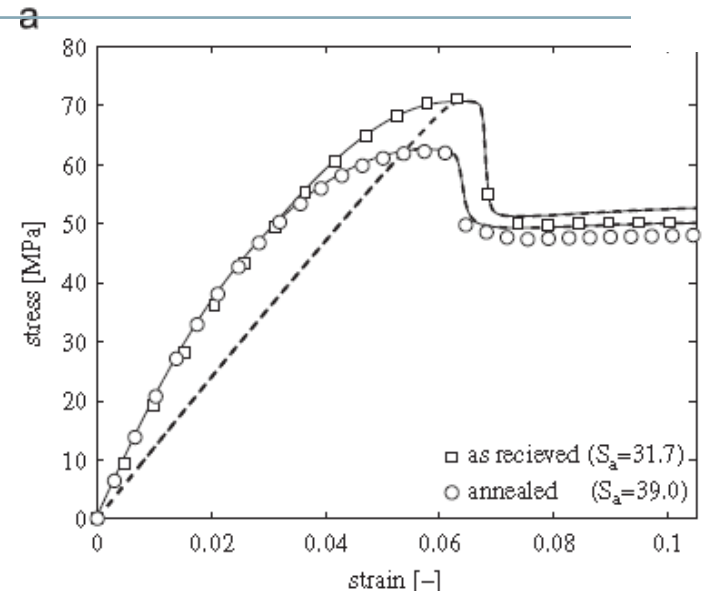
Extending the EGP constitutive model for polymer glasses to multiple relaxation times

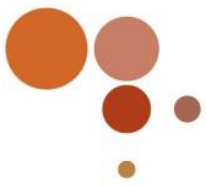
L.C.A. van Breemen^{a,b,*}, E.T.J. Klompen^{a,1}, L.E. Govaert^{a,b}, H.E.H. Meijer^{a,b}

^a Polymer Technology, Eindhoven University of Technology, P.O. Box 513, NL 5600 MB Eindhoven, The Netherlands
^b Dutch Polymer Institute (DPI), P.O. Box 902, NL 5600 AX Eindhoven, The Netherlands

Journal of the Mechanics and Physics of Solids 59 (2011) 2191-2207

66 citations





Glass transition temperature versus structure of polyamide 6: A flash-DSC study

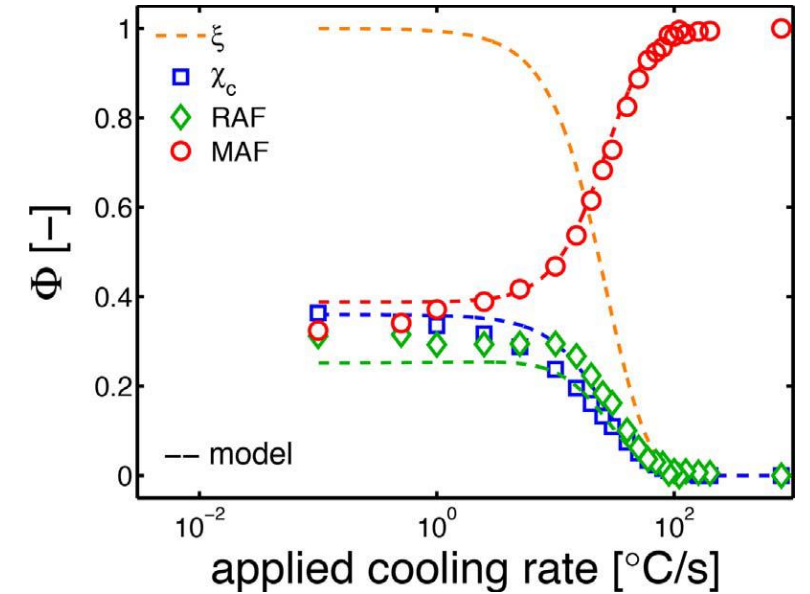
49 citations

E. Parodi^{a,b}, L.E. Govaert^a, G.W.M. Peters^{a,*}

^a Department of Mechanical Engineering, Materials Technology Institute, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, the Netherlands

^b Dutch Polymer Institute (DPI), P.O. Box 902, 5600 AX Eindhoven, the Netherlands

Thermochimica Acta 657 (2017) 110–122

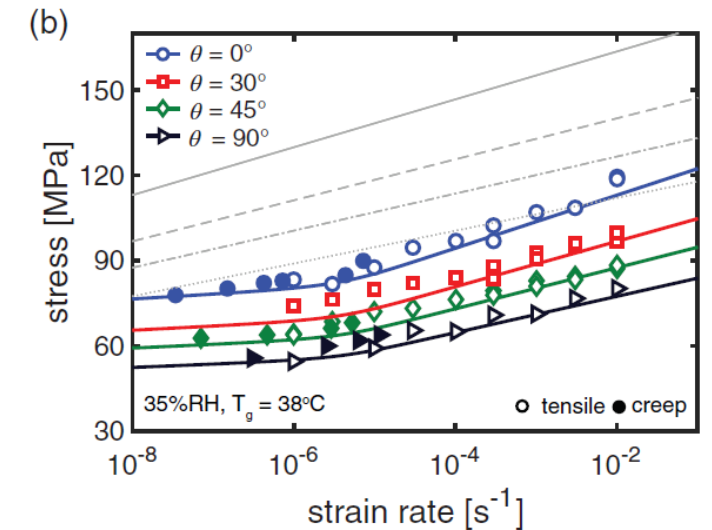
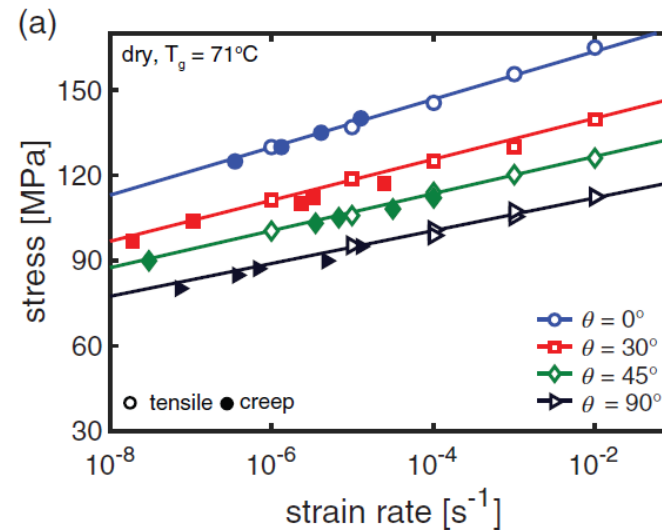


Influence of fiber orientation, temperature and relative humidity on the long-term performance of short glass fiber reinforced polyamide 6

Leonid V. Pastukhov^{1,2} | Marc J. W. Kanters³ | Tom A. P. Engels^{1,3} | Leon E. Govaert¹

J Appl Polym Sci. 2021;138:e50382.

4 citations



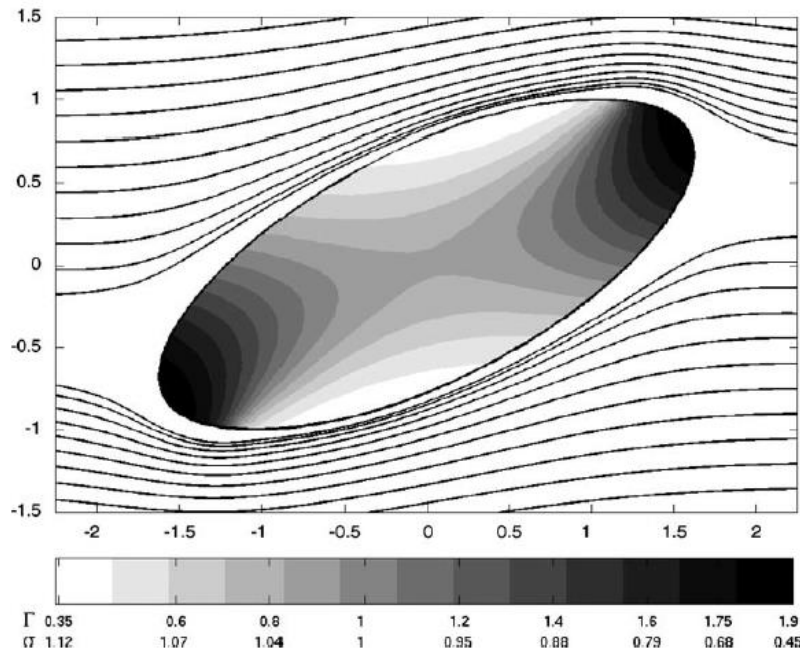


Numerical investigation of the effect of insoluble surfactants on drop deformation and breakup in simple shear flow

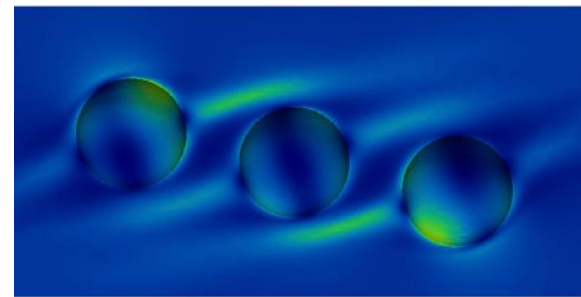
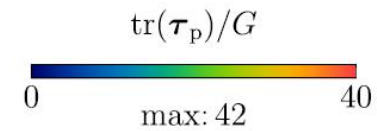
Ivan B. Bazhlekov*, Patrick D. Anderson, Han E.H. Meijer

Materials Technology, Dutch Polymer Institute, Eindhoven University of Technology, 5600 MB Eindhoven, The Netherlands

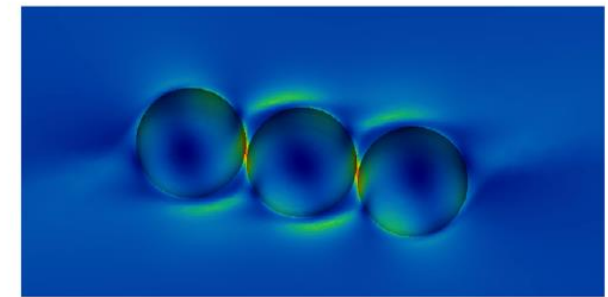
Journal of Colloid and Interface Science 298 (2006) 369–394



112 citations



$t\dot{\gamma} = 0$



$t\dot{\gamma} = 4$

Direct numerical simulation of particle alignment in viscoelastic fluids

N.O. Jaensson^{a,b,*}, M.A. Hulsen^a, P.D. Anderson^a

^aDepartment of Mechanical Engineering, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, The Netherlands

^bDutch Polymer Institute (DPI), P.O. Box 902, 5600 AX Eindhoven, The Netherlands

Journal of Non-Newtonian Fluid Mechanics 235 (2016) 125–142

27 citations

Atomistic modeling of polymer glasses : 11 papers and 650 citations

245 citations

Macromolecules 2006, 39, 4592–4604

Topological Analysis of Linear Polymer Melts: A Statistical Approach

Christos Tzoumanekas* and Doros N. Theodorou*

Department of Materials Science and Engineering, School of Chemical Engineering, National Technical University of Athens, Zografou Campus, 15780 Athens, Greece, and Dutch Polymer Institute (DPI), P.O. Box 902, 5600 AX Eindhoven, The Netherlands

Atomistic Simulations of Cavitation in a Model Polyethylene Network¹

Athanasios K. Morozinis^{a,b}, Christos Tzoumanekas^{a,b,*},
Stefanos D. Anogiannakis^a, and Doros N. Theodorou^{a,b}

^a *School of Chemical Engineering, Department of Materials Science and Engineering, National Technical University of Athens, 9 Heron Polytechniou Street, Zografou Campus, 15780 Athens, Greece*

^b *Dutch Polymer Institute, P.O. Box 902, 5600 AX Eindhoven, The Netherlands*

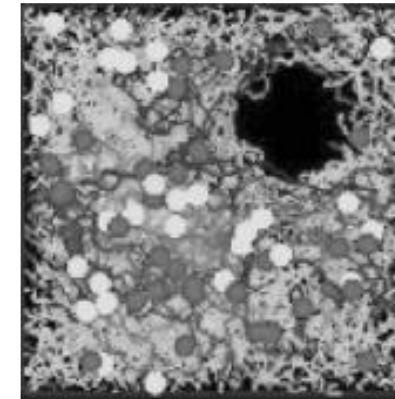
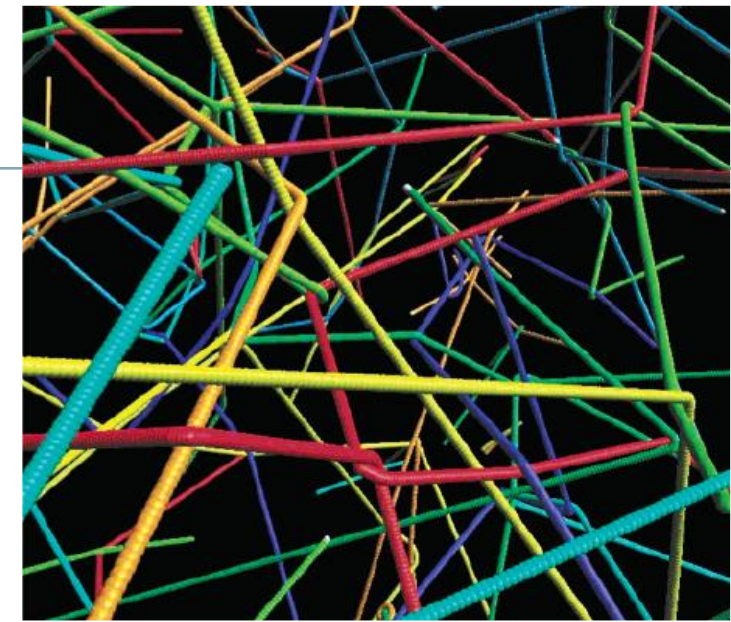
Free energy calculations by molecular simulations of deformed polymer glasses

Georgios G. Vogiatzis^{a,b}, Lambert C.A. van Breemen^a, Doros N. Theodorou^c,
Markus Hütter^{a,*}

^a *Polymer Technology, Department of Mechanical Engineering, Eindhoven University of Technology, PO Box 513, 5600 MB Eindhoven, The Netherlands*

^b *Dutch Polymer Institute, PO Box 902, 5600 AX Eindhoven, The Netherlands*

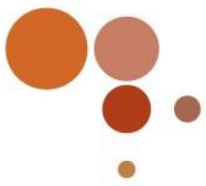
^c *School of Chemical Engineering, National Technical University of Athens, 9 Heron Polytechniou Street, Zografou Campus, GR-15780 Athens, Greece*



Polymer Science, Ser. C, 2013,
Vol. 55, No. 1, pp. 212–218

Computer Physics Communications 249 (2020) 107008





2 projects in parallel: University of Ghent and TUDelft

Experimental and numerical damage characterization of glass/
polypropylene multidirectional laminates under quasi-static
loading condition

J. Sommer^{a,b,*}, M. Hajikazemi^{a,b}, I. De Baere^a, W. Van Paeppegem^a

^a Department of Materials, Textiles and Chemical Engineering, Faculty of Engineering and Architecture, Ghent University, Technologiepark Zwijnaarde 46, Ghent, Belgium

^b Dutch Polymer Institute (DPI), P.O. Box 902, 5600 AX, Eindhoven, the Netherlands

Composites Science and Technology 227 (2022) 109569

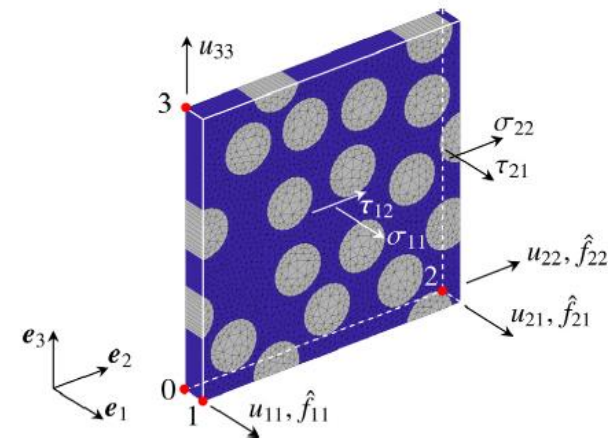
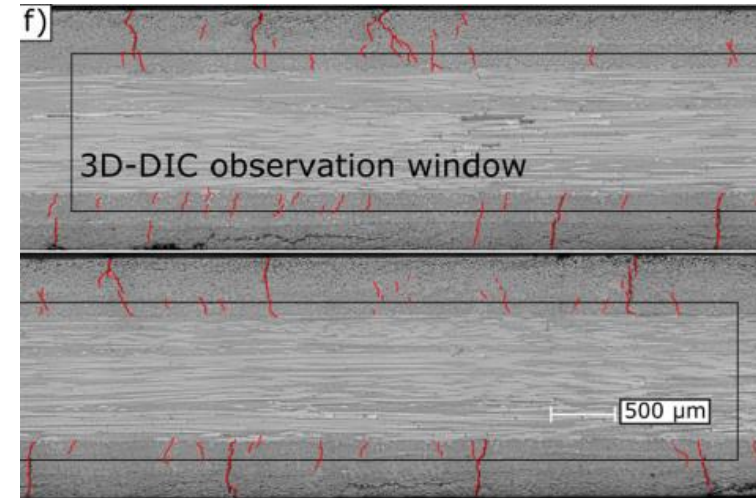
Strain-rate based arclength model for nonlinear microscale analysis of
unidirectional composites under off-axis loading

Dragan Kovačević^{a,b,*}, Frans P. van der Meer^a

^a Delft University of Technology, Faculty of Civil Engineering and Geosciences, PO Box 5048, 2600 GA Delft, The Netherlands

^b Dutch Polymer Institute (DPI), PO Box 902, 5600 AX, Eindhoven, The Netherlands

International Journal of Solids and Structures 250 (2022) 111697



How have the objectives of the PP program evolved ?



2012 objectives

- **New materials/engineering solutions**
 - providing the best compromise cost/performance
 - enabling new functional applications
- **Understanding Fundamental polymer and system properties**
 - Molecular properties of polymers
 - System properties
- **Understanding Polymer Processing**
 - Flow and solidification properties
 - Cross linking

2022 objectives

New methodologies for lifetime prediction

- understanding degradation

Understanding Properties of Composites and Heterogenous Materials

electrical, mechanical, permeability

Circular economy

Recycling strategies

Controlled degradation

Renewable resources

Energy materials



Physics of crystallization of PE : ~ 35 papers and 1400 citations (2006-2017)

172 citations

PRL **100**, 048302 (2008)

PHYSICAL REVIEW LETTERS

week ending
1 FEBRUARY 2008

Crystallization and Dissolution of Flow-Induced Precursors

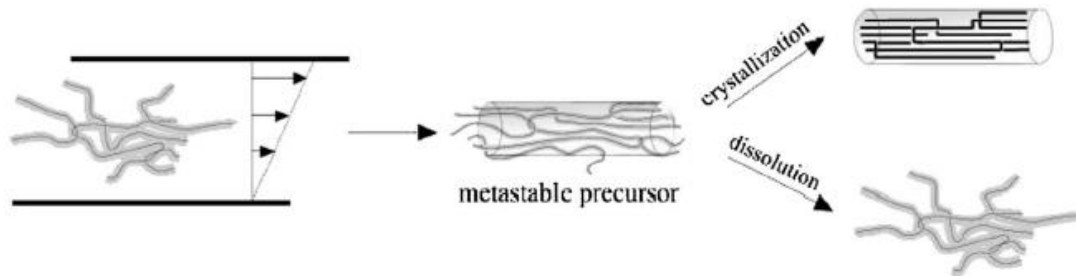
Luigi Balzano,^{1,4} Nileshkumar Kukalyekar,^{1,4} Sanjay Rastogi,^{1,3,4,*} Gerrit W.M. Peters,^{2,4} and John C. Chadwick^{1,4}

¹Department of Chemical Engineering, Eindhoven University of Technology, P.O. Box 513, 5600 MB, Eindhoven, The Netherlands

²Department of Mechanical Engineering, Eindhoven University of Technology, P.O. Box 513, 5600 MB, Eindhoven, The Netherlands

³Institute of Polymer Technology and Materials Engineering (IPTME), Loughborough University, Loughborough, LE11 3TU, United Kingdom

⁴Dutch Polymer Institute (DPI), P.O. Box 902, 5600 AX Eindhoven, The Netherlands



Macromolecules 2011, 44, 4952–4960

Heterogeneity in the Distribution of Entanglement Density during Polymerization in Disentangled Ultrahigh Molecular Weight Polyethylene

Anurag Pandey,^{†,‡} Yohan Champouret,^{†,‡} and Sanjay Rastogi^{*,†,‡,§}

103 citations

[†]Department of Materials, Loughborough University, Loughborough, LE11 3TU, U.K.

[‡]The Dutch Polymer Institute (DPI), P.O. Box 902, 5600 AX Eindhoven, The Netherlands

[§]Department of Chemical Engineering, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, The Netherlands

