A New Era

Annual Report 2017

DPI
The Polymer
Research Platform

Foreword
Into a New Era

DPI TEAM – Linda de Wit, Ronald Korstanje, Renée Hoogers, Thomas Manders, Peter Kuppens, Christianne Scharff-Bastiaens, Jan Smook, Jacques Joosten, Jan Stamhuis, Jeanne van Asperdt and Denka Hristova-Bogaerds
Absent in this picture:
Arie Brouwer, Monique Bruining (left DPI in 2017) and Leon Damen (joined DPI in 2017)

DPI's transformation to a new operational model is now well underway. While the previous research programme (DPI 1.0) nears completion, a new programme (DPI 2.0) has been put in place, supported and defined by the participating companies. The number of participations in DPI 2.0 remain below the targeted level, so efforts to attract more industrial partners are being stepped up.

Anniversary
For DPI, 2017 was a special year, marking our twentieth anniversary. The DPI Annual Meeting held in November 2017 therefore centred round this milestone in DPI's history. There was cause for celebration: in the twenty years since its establishment in 1997, DPI has grown into a widely recognised international centre of excellence in industry-driven polymer research. DPI's unique approach has come to represent the best practice in collaborative research and the DPI collaboration platform has helped to boost polymer research in both industry and academia. Some 200 guests from the Netherlands and abroad joined us in Eindhoven on this special occasion.

Publication of The Plastics Revolution
Another highlight at the Annual Meeting was the publication of a book about plastics that was initiated by DPI: *The Plastics Revolution: How the Netherlands Became a Global Player in Plastics*. The book, which provides a historical overview of the invention and subsequent development of plastics over the past hundred years, was published under the auspices of the Foundation for the History of Technology (SHT). Written by a team of three academic authors led by Professor Harry Lintsen of Eindhoven University of Technology, the book shows that polymer science and the plastic materials resulting from it have played a crucial role in shaping modern life. The book not only highlights the benefits that plastics have brought to the world, but also directs our attention to the challenges that these same materials pose to society and the natural environment today.

Circular Economy
There is widespread public concern about plastics, in particular about the disposal of plastic waste. This concern is gaining urgency in the context of environmental and sustainability challenges. There is a growing conviction that in order to address the grand challenges facing society today, a shift from a linear to a circular economy is needed. As an independent platform for industrial collaboration on polymer research, we think DPI has the knowledge and experience to be able to play a meaningful role in promoting and guiding initiatives to address the challenges relating to plastics. Both industry and science are increasingly becoming aware of the need for a turnaround to a more manageable scenario for plastics that will be sustainable in the long term.

"Plastics: The End or a New Beginning?"
With these considerations in mind, DPI – in collaboration with Frank Kuypers of SABIC – organised a meeting on the topic "Plastics: The End or a New Beginning?", which was held in conjunction with our Annual Meeting in November 2017. The meeting brought together executives from some 15 leading companies from across the world that were directly or indirectly involved in the production or use of plastics and plastic products. A wide variety of topics were discussed, key issues identified and suggestions made for further action. There was general agreement on the need to collaborate and to launch a number of initiatives to examine and address the issues. Meanwhile, follow-up consultations have taken place and resulted in actions such as the setting up of an internet-based exchange platform and the creation of a general framework for targeted research. The latter will be organised into three working strands, focusing on research aimed at new polymers (including bio-based), chemical recycling and materials recycling. DPI is playing a coordinating role in these activities. The aim is to engage parties from across the value chain, from producers all the way to consumers.

SEAFRONT
Over the years, DPI's involvement in EU activities has grown. An important EU project that was successfully completed in 2017 was SEAFRONT (Synergistic Fouling Control Technologies), which formed part of the Seventh Framework Programme (FP7). The aim of the project, with DPI and AkzoNobel as the main contractors, was to develop environmentally friendly coatings that prevent the undesirable accumulation of marine organisms on boats, ships, tidal

power plants and other aquatic installations. AkzoNobel is very enthusiastic about the SEAFRONT project and its successful completion with “a groundbreaking result”. For DPI, the project has been a valuable experience in professional project management in an industrial setting and an inspiration for undertaking similar projects in the future.

Scientific quality

With 19 PhD theses and 50 scientific papers published in 2017 by researchers working on DPI projects, DPI maintained its reputation of delivering a high volume of scientific output of a consistently high quality recognized by the international scientific community. Our Average Journal Impact Factor for 2017 stood at 5.42, the high level we have been achieving the past several years.

New IP Rules

The modification of our IP rules, which took place in 2014, is clearly showing positive results. The new IP rules, which are more compatible with differences in national IP policies, have already enabled DPI to engage new academic partners in several other countries, such as ETH Zurich in Switzerland and Texas A&M University in the US. For DPI’s industrial partners this means having access to a wider circle of specialised research groups across the world.

DPI Value Centre

Regrettably, DPI Value Centre, the separate value-creation organisation set up next to DPI in 2007, had to be closed down in 2017 owing to the discontinuation of government funding. For over ten years, DPI Value Centre fulfilled an important need among small and medium- sized companies (SMEs) in the rubber and plastic products sectors for support and guidance in innovation. Through DPI Value Centre, SMEs and start-ups were able to benefit from the knowledge and contacts available within the DPI and DPI Value Centre network. DPI Value Centre played an important role in coordinating new initiatives in the fields of bio-based plastics and new materials such as thermoplastic composites. It was also a binding factor and a driving force in securing SME participation in collaborative efforts for plastics recycling. DPI Value Centre also enabled other collaborative activities for SMEs, such as the circular economy knowledge network, which are usually beyond the practical scope of individual SMEs. In the course of a decade of successful operation, DPI Value Centre provided support to some 800 companies, coordinated 350 innovation projects, organised more than 150 workshops and meetings and extensively supported over 150 new enterprises, such as Ioniqa Technologies, now a successful company in e.g. PET recycling. So far, nothing comparable has come in the place of DPI Value Centre.

2018 and beyond

We are happy that the commitment of our industrial partners has enabled the continuation of the DPI collaboration platform with a new research programme. But we are not there yet. We will have to make greater efforts to attract more industrial partners so as to enhance DPI’s viability in the longer term and to ensure that the polymer industry can continue to benefit from a strong collaboration platform. Such a platform, while supporting industry’s research needs, will also play a key role in addressing the various challenges confronting humanity today.

Jacques Joosten – Managing Director

Contents

Organisation 2017

Supervisory Board

- **Dr. H.M.H. van Wechem**, *Chair*
- **Dr. D. Boersma**
- **J. de Jeu, MA MSc**
- **Dr. F. Kuijpers**
- **Prof. K.C.A.M. Luyben**
- **Dr. J.A. Roos**

Executive Board

- **Dr. J.G.H. Joosten**
  Managing Director, Chair
- **Vacancy**
  Scientific Director

Programme Area Coordinators

- **Dr. M.J. Bruining**
  Coatings Technology (Left in 2017)
- **Dr. D.G. Hristova-Bogaerds**
  Performance Polymers
- **R.J. Korstanje, MSc**
  Functional Polymer Systems
  Coatings Technology
- **Dr. J. Smook**
  Polyolefins
- **Dr. J.E. Stamhuis**
  Polyolefins
  Polymers for Oil and Gas

Scientific Programme Chairs

- **Prof.dr. V. Busico**
  Polyolefins
- **Prof.dr. C. Creton**
  Performance Polymers
- **Prof.dr. D.J. Broer**
  Coatings Technology

Organisation Staff

- **A.F.J. van Asperdt**
  Financial Administration
- **Dr. M.J. Bruining**
  General Affairs (Left in 2017)
- **L.A.W. Damen**
  Project Administration
  Financial Administration
- **R.P.F. Hoogers-Valken**
  Secretariat
- **P.J.J. Kuppens, AA**
  Controlling
- **C.H.L.M. Scharff-Bastiaens**
  Communications
- **L. de Wit**
  Project Administration

Staff European projects

- **A. Brouwer, MSc**
  Project Manager SEAFRONT
- **Dr. D.G. Hristova-Bogaerds**
  Project Manager EMMC-CSA
- **L. de Wit**
  EU Project Office

DPI: International Centre of Excellence in Polymers

In the last few years DPI has transformed itself into an International Centre of Excellence in Polymers. To achieve that goal, the institute has expanded its pre-competitive research programme with projects focusing on pre-commercial application themes.

Pre-competitive research programme

DPI's pre-competitive research programme currently embraces five programme areas. Companies and knowledge institutes can participate in one or more of these areas, each of which encompasses a substantial number of projects. The participating companies jointly define the programme content for the programme areas in which they participate. PhD students and post-docs from our partner knowledge institutes perform their research in close collaboration with scientists from our industrial partners. Shaping that collaboration between industry and academia is the key to building a coherent community that delivers research results to the envisaged high standard and prepares our scientists for their future careers, in industry or elsewhere.

PRE-COMPETITIVE PROGRAMME

DPI Rules & regulations apply to all projects

Polyolefins		Performance Polymers	
13 projects		**16 projects**	
Industry	**AAcademia**	**Industry**	**Academia**
• Borealis • Braskem • Dow Benelux • DSM • ExxonMobil • Lanxess Elastomers • Michelin • Reliance • SABIC • SCG Chemicals • Sinopec • Teijin Aramid	• Eindhoven University of Technology • ESCPI-Lyon • ETH Zurich • Japan Advanced Institute of Science and Technology • Johannes Kepler University Linz • Lomonosov Moscow State University • Martin-Luther University of Halle-Wittenberg • National Council for Scientific and Technological Development (CNPq) • Radboud University • The University of Texas at Austin • UFRGS Universidade Federal do Rio Grande do Sul • Universidade Federal do Rio de Janeiro • University of Chemistry and Technology Prague • University of Manitoba • University of Naples Federico II • University of Perugia • University of Turin	• AkzoNobel • Bayer • DSM • Food & Biobased Research Wageningen UR • FrieslandCampina • Petrobras • SABIC • SKF • Teijin Aramid	• CNRS Strasbourg • Delft University of Technology • Eindhoven University of Technology • KU Leuven • National Council for Scientific and Technological Development (CNPq) • National Technical University of Athens • Radboud University • The University of Manchester • Tsinghua University • Universidade Católica de Brasilia • Universidade Federal do Rio de Janeiro • University of Groningen • University of Twente
Expenditure € 1.29 million FTEs 12.9 (24 researchers)		Expenditure € 1.95 million) FTEs 17.7 (26 researchers)	

Industrial pre-commercial programme

The industrial pre-commercial programme consists of Value Chain projects and EU projects. The conditions for performing Value Chain projects are described below and those for EU projects are in accordance with published EU rules that are available on the relevant websites.

The Value Chain projects offer companies and/or research institutes the opportunity to establish consortia for innovation projects, in which they collaborate within the value chain. Every partner plays an active role in the project, which must be aimed at further development of an innovation. The projects are intended to generate economic activity within the foreseeable future (i.e. no later than two to five years after completion of the project).

DPI's role is to actively assist in establishing the collaboration and to coordinate the project. DPI's role can also be limited to acting as coordinator of a project.

DPI provides a model framework for the collaboration, but the detailed rules are agreed between the members of the consortium. As regards intellectual property, the basic principle is that the knowledge created during the course of the project (foreground knowledge) is the property of the inventing partner, and any background knowledge contributed to the project remains the property of the partner that provided it. Other partners have free access to the knowledge contributed to and/or generated during the project, but only for research purposes and to the extent necessary for developments in the project. Specific agreements are made to enable access to another partner's IP for commercial application of the knowledge outside the project.

PRE-COMPETITIVE PROGRAMME

DPI Rules & regulations apply to all projects		
Functional Polymer Systems	**Coatings Technology**	**Polymers for Oil and Gas**
9 projects	**4 projects**	**2 projects**
Industry • DSM • SABIC	**Industry** • AkzoNobel • Altana • DSM • Lawter • Saint-Gobain	**Industry** • Shell • SNF Floerger
Academia • Eindhoven University of Technology • Max Planck Institute for Polymer Research • University of Groningen • University of Twente • Wageningen University & Research	**Academia** • Eindhoven University of Technology • University of Groningen • Wageningen University & Research	**Academia** • University of Groningen
Expenditure € 0.41 million FTEs 4.3 (7 researchers)	Expenditure € 0.88 million FTEs 7.0 (11 researchers)	Expenditure € 0.06 million FTEs 0.5 (1 researcher)

NEWPOL (New Polymer Materials) programme

DPI is working together with NWO, the Netherlands Organization for Scientific Research, on the NEWPOL (New Polymer Materials) programme. NEWPOL is a public-private initiative focusing on developing new polymeric materials by encouraging cross-pollination between different research fields and disciplines.

DPI has organized the NEWPOL activities as a separate programme area, in which all of DPI's industrial partners are participating. The programme offers DPI a good opportunity to explore the possibilities of this model of cooperation.

The programme encompasses six projects on topics such as:

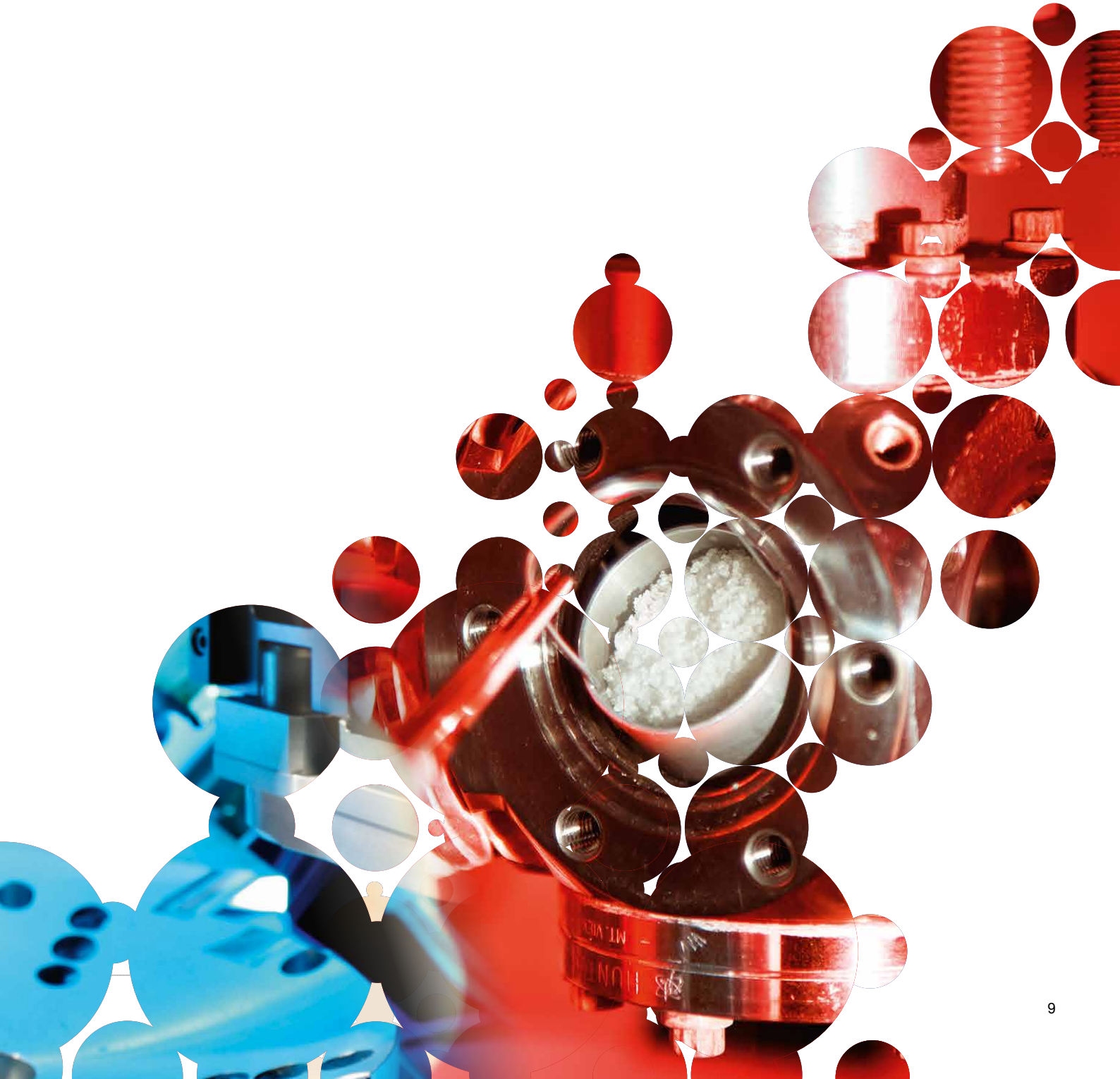
- colouring paint without pigments
- commodity polymers with self-organizing smart coatings that respond to environmental changes by changing color and/or shape
- supramolecular biomaterials for stem cell expansion
- self-synthesizing gels
- development of a SuperActive synthetic biomaterial to repair damaged tissues in the body
- flexible memories made from coordination polymers.

Universities involved:

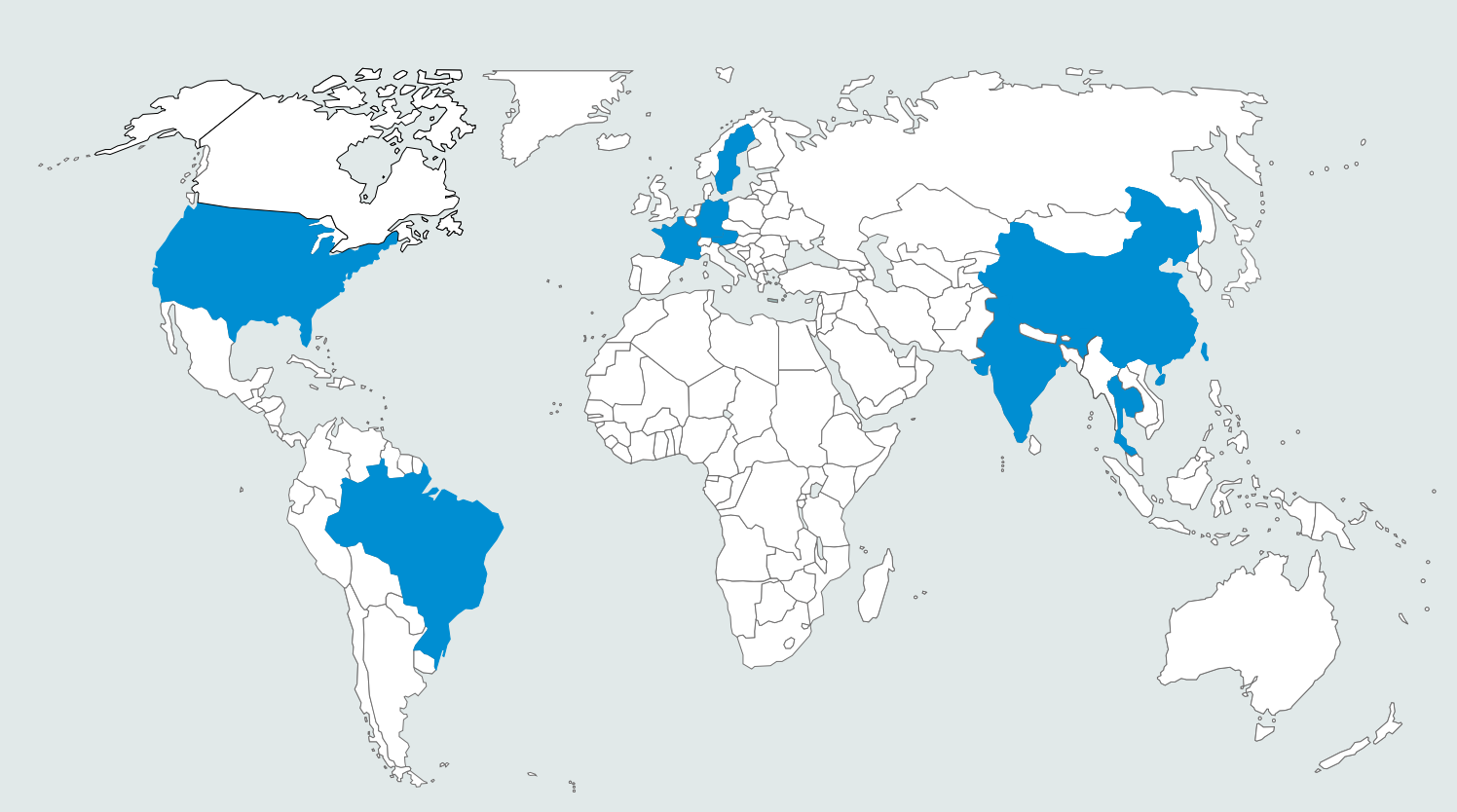
- Amsterdam UMC
  Delft University of Technology
- Eindhoven University of Technology
- University of Groningen
  Wageningen University & Research

INDUSTRIAL PRE-COMMERCIAL PROGRAMME

Model framework for collaboration	
Rules and regulations set by involved partners	Rules and regulations set by involved partners
SEAFRONT (1-1-2014/31-12-2017)	**EMMC-CSA** (1-9-2016/31-8-2019)
Partners • AkzoNobel / International Paint • BioLog • Bio-On • Biotrend • Bluewater Energy Services • Delft University of Technology • DPI • Eindhoven University of Technology • Fraunhofer IFAM • Hapag Lloyd • I-Tech • Minesto • Smartcom Software • Solintel • Solvay Specialty Polymers • University of Bristol • University of Gothenburg • University of Newcastle upon Tyne • Val FoU	**Partners** • Access e.V. • Dow Benelux • DPI • Ecole Polytechnique Federale de Lausanne • Fraunhofer IWM • Goldbeck Consulting • Granta Design • Helmholtz-Zentrum Geesthacht • Materials Design (MDS) • Politecnico di Torino • QuantumWise • SINTEF • TU Wienl • University of York • Uppsala University
Budget € 11.2 million (€ 8.0 million EU subsidy)	Budget € 3.77 million (€ 3.77 million EU subsidy)



Partners Industry 2017



Europe

ALTANA	Altana
Bayer	Bayer
BOREALIS Keep Discovering	Borealis
MICHELIN	Michelin
SAINT-GOBAIN	Saint-Gobain
SKF	SKF
SNF FLOERGER	SNF Floerger

North and South America

Braskem	Braskem
ExxonMobil	ExxonMobil
BR PETROBRAS	Petrobras

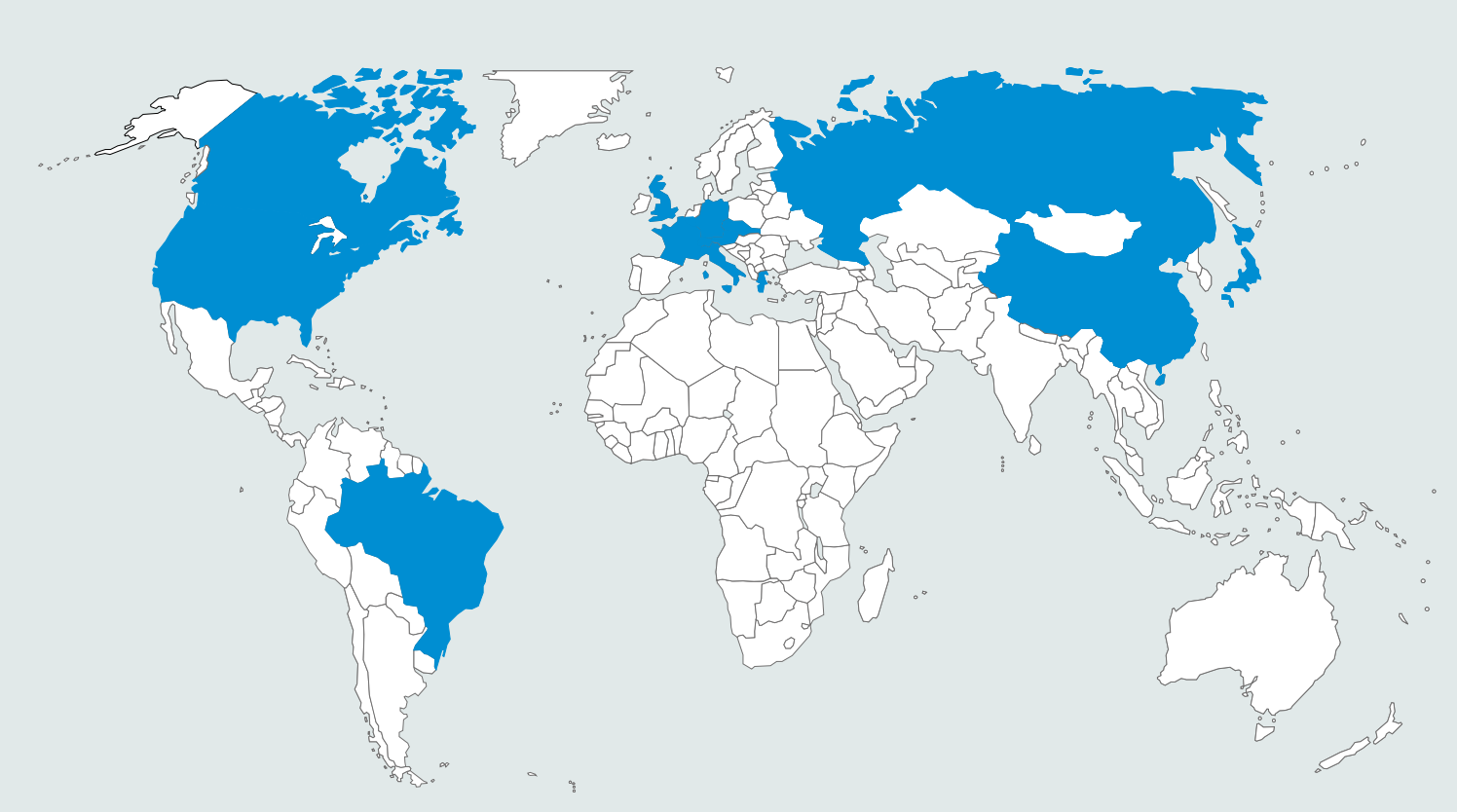
Asia

Reliance
SCG-Chemicals
Sinopec

The Netherlands

AkzoNobel
Dow Benelux
DSM
Food and Biobased Research Wageningen UR (Left DPI in 2017)
Friesland Campina
Lanxess Elastomers
Lawter
SABIC
Shell
Tejin Aramid

Partners Knowledge institutes 2017



Europe

CNRS Strasbourg

DWI an der RWTH Aachen

ESCPE-Lyon

ETH Zurich

Fraunhofer Institute for Structural Durability and System Reliability LBF
(No research projects in 2017)

Imperial College London
(No research projects in 2017)

Johannes Kepler University Linz

KU Leuven (Joined DPI in 2017)

Lomonosov Moscow State University

Loughborough University
(No research projects in 2017)

Martin-Luther-University Halle-Wittenberg

Max Planck Institute for Polymer Research

National Interuniversity Consortium of Materials Science & Technology (INSTM)
(No research projects in 2017)

National Technical University of Athens

The University of Manchester
(Joined DPI in 2017)

University of Naples Federico II

University of Perugia

University of Turin

University of Chemistry and Technology Prague (Joined DPI in 2017)

North and South America, Asia

Chang Chun Institute Of Applied Chemistry Chinese Academy Of Sciences	Changchun Institute of Applied Chemistry (No research projects in 2017)
JAIST	Japan Advanced Institute of Science and Technology (Rejoined DPI in 2017)
TEXAS The University of Texas at Austin	The University of Texas at Austin (Joined DPI in 2017)
CNPq	National Council for Scientific and Technological Development (CNPq)
清華大学 Tsinghua University	Tsinghua University
UFRGS	UFRGS Universidade Federal do Rio Grande do Sul
Universidade Católica de Brasília	Universidade Católica de Brasilia
Universidade Federal do Rio de Janeiro	Universidade Federal do Rio de Janeiro
University of Manitoba	University of Manitoba

The Netherlands

Amsterdam UMC Universitair Medische Centra	Amsterdam UMC
TU Delft	Delft University of Technology
TU/e Technische Universiteit Eindhoven University of Technology	Eindhoven University of Technology
Food & Biobased Research Wageningen UR	Food and Biobased Research Wageningen UR (No Research projects in 2017)
NWO	NWO
	Radboud Universiteit
university of groningen	Universiteit of Groningen
UNIVERSITY OF TWENTE	University of Twente
WAGENINGEN UNIVERSITY & RESEARCH	Wageningen University & Research

Summary of financial data 2017

Income

	(x EUR million)	%
Contributions from industrial partners	3.40	32.7
Revenue Patents	0.06	0.6
Revenue DPI Value Centre	0.04	0.4
Contributions from knowledge institutes	1.12	10.8
Subsidy (TKI Toeslag + NWO)	1.97	19.0
Revenue TKI SPM	0.86	8.2
EU projects	2.95	28.4
Total income	**10.40**	**100**

Expenditure

	(x EUR million)	%
By nature		
Personnel costs	5.45	62.3
Depreciation	0.01	0.1
Other costs	0.58	6.6
EU projects	2.71	31.0
Total expenditure	**8.75**	**100**
By Programme Area		
Polyolefins	1.29	28.1
Performance Polymers	1.95	42.4
Functional Polymer Systems	0.41	8.9
Coatings Technology	0.88	19.2
Polymers for Oil and Gas	0.06	1.3
Sub total	**4.59**	**100**
Knowledge Transfer	0.16	
Organisation and support	0.98	
Support to DPI Value Centre	0.04	
Provision	0.00	
EU projects	2.96	
Total expenditure	**8.75**	

Key Performance Indicators 2017

Number of industrial partners

European governmental funding (% of total funding)

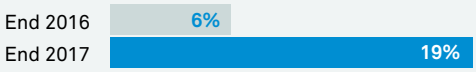
Number of partner knowledge institutes
(universities, etc.)

Participation of foreign knowledge institutes
as % of total expenditure

Industrial contribution (cash and in-kind)
as % of total income

Overhead costs
as % of total expenditure

Subsidy (TKI Toeslag + NWO)
as % of total income



Expenditure for knowledge transfer
x EUR million

Number of patents/reported inventions licensed or transferred to industrial partners and DPI Value Centre

2016	2
2017	0

Track record DPI researchers

Left in total	29
Employed by partner knowledge institute	6
Employed by non-partner knowledge institute	10
Employed by partner industrial company	4
Employed by non-partner industrial company or start-up	4
Unknown	5

Research output	2016	2017
Scientific publications	90	50
PhD theses	20	19

DPI Annual Meeting 2017
Celebrating DPI's twentieth anniversary

This year, DPI's Annual Meeting was a special occasion. It marked the institute's twentieth anniversary. The event took place on 7 and 8 November and the venue, fittingly, was the Pullman Hotel in Eindhoven. It was here that, twenty years ago, the kick off meeting was held for the establishment of DPI as one of the first Leading Technology Institutes in the Netherlands.

The anniversary event was well attended, with nearly 200 participants from across the world gathered at the hotel. DPI had drawn up a varied programme comprising research review meetings, poster sessions, keynote speakers, as well as a book launch.

Young DPI Meeting
In a parallel session in the afternoon of 7 November, some 25 young researchers gathered for the Young DPI Meeting – a traditional DPI activity which for various reasons had not taken place during the last two years. The participants were scientists who had started working on a DPI project in the past academic year. The idea was to give the young researchers an opportunity to get to know one another in an informal "fun" setting. This year, DPI had invited a juggler, who inspired and challenged the participants to exercise their skills at keeping balls up in the air, both individually and collectively.

Poster Awards
As in the previous years, the annual meeting gave scientists working on DPI projects an opportunity to present their research by means of posters and compete for the DPI Poster Award. In a departure from usual practice, all attendees of the annual meeting were invited to rate the posters. The first prize was awarded to Georgios Vogiatzis for his poster entitled "Physical aging of polymers: a molecular perspective". The second prize went to Apostolos Vagias ("Depth-resolved exploration of film quality in waterborne coatings (INCOAT)") and the third prize to Majid Moeinifard ("Micro-mechanical modelling of semi-crystalline a-iPP").

YOUNG DPI MEETING 2017
Keeping balls up in the air

Twentieth Anniversary
The morning programme of Wednesday 8 November was devoted to the celebration of DPI's Twentieth Anniversary. To mark the occasion, Jacques Joosten, Managing Director of DPI, took the audience on a virtual tour of DPI's history, highlighting the various milestones and achievements that had contributed to DPI's reputation as the best practice in collaborative research. Two keynote speakers had been invited: Prof. Stefan Mecking, of the University of Konstanz (Germany), whose topic was "Unconventional Polymer Architectures and Nanostructures from Functional Group Tolerant Catalysis" and Prof. Emmo Meijer, figurehead of the Chemicals Top Sector in the Netherlands, who spoke on the subject of the "Chemical Industry in Transition". Prof. Meijer stressed the importance of collaboration within what he called the Golden Triangle of government, industry and science. Only through proactive concerted efforts will it be possible to work towards sustainability and address today's key domains such as health and aging.

DPI Golden Thesis Award: a retrospective
Although the DPI Golden Thesis Award was not presented this year, it featured prominently in a retrospective session that was kicked off by Prof. Thijs Michels, Former

BOOK LAUNCH – Harry Lintsen, Jan Zuidam, Ger Challa, Klaas Kuin, Marijn Hollestelle and Rick Hölsgens

Scientific Chair of DPI, with a talk entitled "How can industry-driven research produce world-class science?". As part of the retrospective, a former winner of the Golden Thesis Award, Dr. Casper van Oosten of Merck Window Technologies, reported on the current status of his award winning research in a talk entitled "Responsive Liquid Crystal Networks – 8 Years Further".

Book launch

The afternoon programme of 8 November was devoted to the launch of the book *The Plastics Revolution: How the Netherlands Became a Global Player in Plastics.* The first copies of the book were presented to three prominent people who have played an important role in the plastics industry. Ger Challa, Professor emeritus of Polymer Chemistry and Technology at the University of Groningen. He is an eminent scientist whose work has had a major impact on chemistry and plastics. Jan Zuidam, Former Vice Chairman of the executive board of Royal DSM and Former chairman of VNCI, the Association of the Dutch Chemical Industry. He played an important role in the establishment of DPI. Klaas Kuin, former member of VNO-NCW, the largest employers' organisation in the Netherlands. He was also the Founder and former member of the Supervisory Board of DPI and Former manager of the Océ Research Department.

Besides highlighting the profound impact that plastics have had on human life, the book also pays attention to the current social debate on plastics and sustainability and the need for a transition to more sustainable scenarios. In his presentation on the occasion, the lead author of the book, Emeritus Professor Harry Lintsen of Eindhoven University of Technology, spoke of the imminence of a "second" plastics revolution as a stepping stone to such a transition.

Transition was in fact the subject of the final talk of the day, by Prof. Johan Schot, director of the internationally renowned Science Policy Research Unit (SPRU) and Professor in History of Technology and Sustainability Transition Studies at the University of Sussex (UK). According to Prof. Schot, if the plastics industry wants to make the transition needed it should itself take the lead rather than wait and be led by changes in other sectors.
To go by the enthusiastic reactions of the guests during the drinks and snacks at the end of the day, this special combination of Annual Meeting and Anniversary Event was a great success.

Highlighting Dutch contribution to the development of plastics

The book *The Plastics Revolution: How the Netherlands Became a Global Player in Plastics* provides a historical overview of the invention and further development of plastics during the past hundred years and the important role Dutch science and industry have played in the process. It shows how plastics, an entirely new category of materials, have had a profound impact on human life.

The book is written by a team of three authors led by Professor Harry Lintsen of the Eindhoven University of Technology in the Netherlands. The other two authors are Dr. Marijn Hollestelle (Foundation for the History of Technology) and Dr. Rick Hölsgens (Technischen Universität Dortmund). The Plastics Revolution is an initiative of DPI and is published under the auspices of the Foundation for the History of Technology (SHT) in the Netherlands.

As a key enabler of industry-driven collaborative research in polymer science and technology for the past two decades, DPI is proud to be the initiator of this book project. The history of the invention of plastics and their subsequent development in academia and industry as well as their widespread use in practice presents a fascinating story, which lies at the heart of The Plastics Revolution. The book shows that polymer science and the plastic materials resulting from it have played a crucial role in shaping modern life. Besides highlighting the benefits that plastics have brought to the world, it also directs our attention to the challenges that these same materials pose to society and the natural environment today. DPI believes that we can learn from history and hopes that The Plastics Revolution will help readers to view plastics in a broad and balanced perspective.

EU projects

For several years now, DPI has been involved – as coordinator or as a partner – in projects forming part of the Framework Programmes (FP7 and Horizon 2020) of the European Union.

SEAFRONT

The SEAFRONT (Synergistic Fouling Control Technologies) project launched in 2014 was successfully completed in 2017. This was the third European project coordinated by DPI within the Seventh Framework Programme of the European Commission. The aim of SEAFRONT was to develop environmentally friendly coatings that prevent the undesirable accumulation of marine organisms on boats, ships, tidal power plants, fisheries and other aquatic installations.

Project team

Five multinationals, seven SMEs and seven research institutes spread across eight EU Member States worked together to achieve the project goals within the four-year timeframe. DPI and AkzoNobel were the main contractors of the project. Other partners included Fraunhofer IFAM, I-Tech AB, University of Newcastle upon Tyne, Minesto AB, Solvay Specialty Polymers, Delft University of Technology, Eindhoven University of Technology, University of Bristol, Val FoU, Biotrend, BioLog, University of Gothenburg, Bio- On, Bluewater Energy Services, Smartcom Software, Solintel and Hapag Lloyd. The project budget amounted to EUR 11.2 million, including EUR 8 million from the European Commission.

Fouling control coatings

The efforts of the SEAFRONT team have yielded a ground-breaking result: the successful demonstration of a riblet coating system with integrated fouling control properties. In line with one of its objectives – to employ a multidisciplinary and synergistic approach to fouling control – the SEAFRONT team integrated multiple technology concepts such as surface structure, surface chemistry and bio-active/bio-based fouling control methodologies to arrive at one environmentally benign and drag-reducing solution for mobile and stationary maritime applications.

The riblet technology, inspired by a shark's skin, was the contribution of Bremen (Germany) based research institute Fraunhofer IFAM. AkzoNobel's existing non-biocidal fouling control technology, Intersleek® 1100 SR, was integrated into the riblet coating. Integration of anti-fouling technology based on Solvay's Tecnoflon® elastomers, developed in the project, is an obvious next step.

Combining riblet drag reducing texture with non-biocidal fouling control technology will really mean a big step ahead for the maritime sector. Potential savings can be estimated at three billion dollars and several tens of millions of metric tons of CO2 emissions. Enabling this reduction would mean a big step for global CO_2 emission reduction.

Applications

Anti-fouling also plays an important role in the harvesting of renewable tidal energy by means of subsea kites. SEAFRONT partner Minesto of Sweden, with its Deep Green tidal power plant, specialises in this field.

One of the sectors that is also very interested in the outcomes of the SEAFRONT project is aquaculture. The fishnets used in this sector are treated against fouling. The present state-of-the-art is dipping of fishnets in copper based coatings. These, coatings, however, are biocidal, so the sector is looking for alternatives. SEAFRONT partner Val FoU, a Norwegian R&D organisation, is active in the field of aquaculture.

Enhanced understanding

Besides achieving a breakthrough in the development of anti-fouling coatings, the SEAFRONT project has resulted in systemic insight into fouling. Thanks to the use of meta-genomics DNA fingerprinting technology, the understanding of the bacterial community in an underwater biofilm and the mechanisms of fouling development has vastly improved.

All in all, the SEAFRONT project has succeeded in achieving its objectives and delivered the basis for a potential breakthrough in 'green', fuel saving riblet coating systems with improved anti-fouling characteristics that could save billions. In total nineteen areas for further exploitation were identified and the partners will pursue technology development beyond SEAFRONT and take it to in-field demonstration trials.

More information about this project can be found on the website:
www.seafront-project.eu

SEVENTH FRAMEWORK PROGRAMME

EMMC-CSA

DPI is a partner in the project EMMC-CSA (European Materials Modelling Council - Coordination and Support Action), which comes under the EU's Horizon 2020 framework.

Modelling is a key pillar underpinning the development of new materials and products responding to societal needs and challenges and for ensuring competitiveness of European industry in the 21st century.

Scope
The aim of the project is to allow European Industry to reap the benefits of materials modelling more effectively and vigorously by helping to bridge the gap between academic innovation and industrial application.

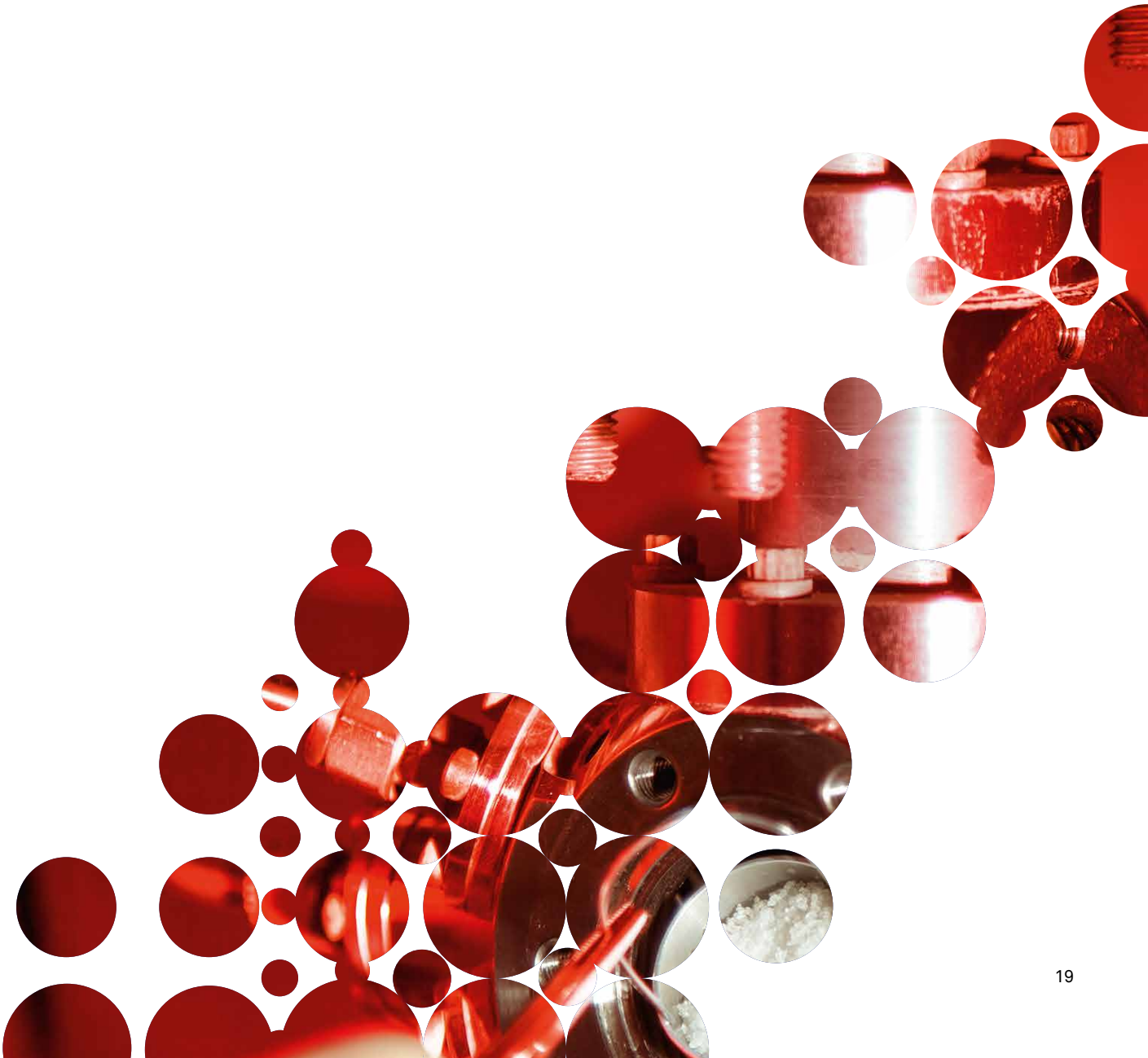
The project, which was launched in September 2016 and has a duration of three years, is being carried out by a consortium of 15 partners from 10 countries and involves 5 companies and 10 Research and Technology Organizations (RTOs).

DPI's role
The tasks of DPI are related to the translation of industrial challenges into modelling solutions and the development of strategies for a wider adoption of materials modelling by industry.

DPI is also represented in the EMMC Operational Management Board.

More information about the European Materials modelling council EMMC and this project can be found at:
https://emmc.info/about-emmc-csa/

Co-funded by the Horizon 2020 programme of the European Union



POLYOLEFINS

Polyolefins (PO) are the only class of synthetic macromolecules that can be produced catalytically with precise control of stereochemistry and, to a large extent, of (co) monomer sequence distribution. Therefore, as with the letters of the alphabet, the number of constituent elements which can be assembled into meaningfully organised structures is practically infinite and, accordingly, scope of application of polyolefins is continually growing.

OBJECTIVES

Polyolefin-based materials can be customised for a wide range of applications: from ultra-rigid thermoplastics to high-performance elastomers. This vast spectrum of performance is achieved by a variety of polyolefin molecular structures, whose common features are full atom economy in their synthesis, low cost, excellent properties, a long lifecycle and ease of recycling. The research programme of the Polyolefins programme area encompasses the entire spectrum of the knowledge chain, the aim being to increase proficiency in the ever-expanding applications. Although polyolefins represent one of the oldest (if not the oldest) thermoplastic polymer families, they are still very much characterised by continuous innovation. Both gradual and step change technology renewal yield new applications and reduce the manufacturing- and user eco-footprint. A specific example of this innovative capacity is the discovery of chain shuttling catalyst systems that enable the industrial production of polyolefin block (co)polymers with unprecedented structures, usable for a wide range of applications (from thermoplastic elastomers to optically active materials).

SUB-PROGRAMMES

Catalysis
Investigating, screening and developing (novel) homogeneous and heterogeneous catalyst systems, as well as new approaches for the immobilisation of molecular catalysts, new co-catalysts and activators.

Polymer structure, properties and processing
Understanding, modelling and predicting structure-processing property relationships in polyolefin-based polymer systems.

Polymer reactor engineering
Studying various reactor and technology unit operations to develop a quantitative description and acquire a thorough understanding of the crucial aspects of olefin polymerisation processes.

New methods and exploratory research
New polymerisation and polymer characterisation methods, high-throughput screening and experimentation, embryonic research and concept development.

POLYOLEFINS 2.0

The Polyolefins 2.0 programme kicked off early 2016 with the granting and start-up of two projects on topics selected by the industrial funding partners Borealis, Braskem, ExxonMobile, Reliance, SABIC, SCG Chemicals and Sinopec. In total 4 PhDs are working on these two projects at Eindhoven University of Technology, Lomonosov Moscow State University, University of Perugia and University of Naples Frederico II. A second Call for Proposals was launched in October 2016 for projects to be started in 2017.

FACTS AND FIGURES

Partners from industry
- Borealis
- Braskem
- Dow Benelux
- DSM
- ExxonMobil
- Lanxess Elastomers
- Michelin
- Reliance
- SABIC
- SCG Chemicals
- Sinopec
- Teijin Aramid

Partners from the research world
- Eindhoven University of Technology
- ESCPI-Lyon
- ETH Zurich
- Japan Advanced Institute of Science and Technology
- Johannnes Kepler University Linz
- Lomonosov Moscow State University
- Martin-Luther University of Halle-Wittenberg
- National Council for Scientific and Technological Development (CNPq)
- Radboud University
- UFRGS Universidade Federal do Rio Grande do Sul
- Universidade Federal do Rio de Janeiro
- University of Chemistry and Technology Praque
- University of Manitoba
- University of Naples Federico II
- University of Perugia
- University of Turin

Budget and organisation
Expenditure in 2017 totalled € 1.29 million. The total number of FTEs allocated at year-end 2017 was 12.9 (24 researchers). Prof.dr. Vincenzo Busico was Scientific Chairman and Dr. Jan Stamhuis and Dr. Jan Smook were Programme Area Coordinators of the Polyolefins programme.

Publications and inventions
This programme area generated a total of fifteen reviewed papers and five theses.

For details, see page 26

FUNCTIONAL POLYMER SYSTEMS

The Functional Polymer Systems (FPS) programme area performs research on polymers, small organic molecules and their prototype devices that are capable of an electrical, optical, magnetic, ionic or photo-responsive function and that offer potential for industrial application.

OBJECTIVES

The FPS research programme is structured along application lines in the following sub-programmes: polymer lighting and field-effect transistors; polymers for information and communication technology; solar cells (photovoltaics); and responsive materials, (bio)sensors and actuators.

SUB-PROGRAMMES

Polymers for information and communication technology
The objective of this sub-programme is to develop scalable techniques for structuring polymers on a nano- and micro-scale by combining 'top-down' approaches with 'bottom-up' techniques based on self-assembly or supramolecular chemistry in order to produce new or greatly enhanced properties for optical, electrical, biomedical and sensor applications. Research projects are focusing on IR-reflective windows, membranes with controlled pore-size and responsive surfaces making use of the available patterning tools.

Photovoltaics (PV)
This area is dedicated to exploring new materials and gaining a fundamental understanding of all (photo-) physical processes occurring in polymer and small organic molecule bulk heterojunction PV. Organic PV is one of many promising PV technologies offering the prospect of large area cost-effective PV for sustainable energy production in the long term. The research focuses on novel low-bandgap materials, hybrid (inorganic-organic) blends, stable materials under ambient conditions, non-radiative decay processes, efficient charge separation, morphology control, tandem solar cells and a thorough understanding of materials behaviour under operational device conditions.

Responsive materials and functional membranes
The purpose of the research is to develop new materials and processes that result in a change of shape and/or large displacement upon an external electrical, magnetic, optical and/or chemical trigger. Research projects focus on new piezo-electronic materials, membranes with controlled nano-pores, switchable surfaces and antireflective coatings.

FACTS AND FIGURES

Partners from industry
- DSM
- SABIC

Partners from the research world
- Eindhoven University of Technology
- Max Planck Institute for Polymer Research
- University of Groningen
- University of Twente
- Wageningen University & Research

Budget and organisation
Expenditure in 2017 totalled € 0.41 million. The total number of FTEs allocated at year-end 2017 was 4.3 (7 researchers). Roland Korstanje was Programme Area Coordinator of the Functional Polymer Systems programme.

Publications and inventions
The research programme in this programme area generated a total of six reviewed papers and five theses.

For details, see page 27

PERFORMANCE POLYMERS

Performance Polymers (PP) have considerable potential to contribute to reducing energy use, environmental impact and the effects of climate change through component consolidation, weight reduction, lifetime extension, recyclability and utilisation of renewable feedstock and create new opportunities for the construction, transport, appliances and electronics industries.

OBJECTIVES

This Performance Polymers (PP) programme area combines Engineering Polymers and Rubber Technologies and is positioned between bulk plastics and specialty polymers such as functional polymer systems. Performance polymers possess improved chemical, mechanical and/or physical properties, especially beyond ambient conditions. They are applied as material systems under (cyclic or continuous) load-bearing conditions and frequently consist of multi-component mixtures with various polymers, reinforcements and additives.

The performance requirements of complex parts and assemblies in polymer materials necessitate close technological cooperation between polymer supplier, converter and end user. That in turn calls for a thorough understanding of polymerisation and polymer modification, as well as the processing, properties and design of polymer systems. Moreover, the wide variety of base polymers in this programme area demands a special effort to identify commonality in those themes along the value chain. This is reflected in the strategy and objectives of the Performance Polymers programme area, which include investigation of fundamental issues in the value chain using a 'chain of knowledge' approach in terms of energy saving, durability, ultimate performance and sustainability.

FACTS AND FIGURES

Partners from industry
- AkzoNobel
- Bayer
- DSM
- Food & Biobased Research Wageningen UR
- FrieslandCampina
- Petrobras
- SABIC
- SKF
- Teijin Aramid

Partners from the research world
- CNRS Strasbourg
- Delft University of Technology
- Eindhoven University of Technology
- KU Leuven
- National Council for Scientific and Technological Development (CNPq)
- National Technical University of Athens
- Radboud University
- The University of Manchester
- Tsinghua University
- Universidade Católica de Brasilia
- Universidade Federal do Rio de Janeiro
- University of Groningen
- University of Twente

Budget and organisation
Expenditure in 2017 totalled € 1.95 million. The total number of FTEs allocated at year-end 2017 was 17.7 (26 researchers).Prof.dr. Costantino Creton was Scientific Chairman and Dr. Denka Hristova-Bogaerds was Programme Area Coordinator of the Performance Polymers programme.

Publications and inventions
The research programme in this programme area generated a total of seventeen reviewed papers and five theses.

For details, see page 27

Polymer and network chemistry and modification
Studies aimed at expanding the use of bio-based materials, by identifying their unique properties and reducing their eco-footprint. Further studies are designed to reduce the costs and energy use in polymerisation. Other objectives are network formation and the development of new concepts for monomer polymer molecular structure to achieve gradual changes in the balance of flow properties, static and dynamic mechanical behaviour and other functional properties.

Processing for properties, polymer physics and modelling
Understanding the relationship between the molecular structure, processing and properties of polymers. Studies of the processing effects of intermolecular interactions, e.g. hydrogen bonding. Processing, modification and vulcanisation studies of elastomer blends. Studies of complex flow behaviour, e.g. in particle reinforced visco-elastic materials.

Advanced reinforced thermoplastics and synthetic fibres
Studies of the interface effects in fibre-reinforced composite systems, the effects of nano-reinforcement on polymer material properties on macroscopic and microscopic scale with a focus on the effects at the matrix-filler interface, friction and wear studies of fibre-reinforced thermoplastics and elastomers.

Long term stability and performance
Investigation of the chemical and physical ageing mechanisms and their interaction, with the ultimate objective of predicting lifetime and attaining a fit-for-purpose design over the entire lifecycle. Studies of self-healing in polymeric materials as paradigm shift to realise improved fit-for purpose lifetimes.

Bio-Inspired Polymers
Development of advanced polymeric materials and methodologies inspired by natural polymeric structures and principles of natural systems such as self-assembly and biocatalysis, the main driver being sustainability. Bio-inspired polymers can be produced from renewable or fossil resources through either chemo catalysis or enzymatic/microbial catalysis. The structure-property relationships of the novel materials are studied to elucidate why they exhibit unique properties. One important line of research is intended to develop a generic toolbox for new bio-based polymers with a view to creating new business opportunities. Aspects addressed by a bio-based polymer programme include the identification of new or improved (multi-) functionalities of bio-based building blocks and polymers and the assessment of relevant technologies in the bio-based value chain.

COATINGS TECHNOLOGY

Within the Coatings Technology (CT) area frontier research in the general field of organic coatings is performed. The aim is to develop fundamental insights that will lead to innovative coatings technologies. The research is pre-competitive and is focussed at achieving sustainability, quality of life improvements, economic growth and preparing the coatings industry for future challenges.

OBJECTIVES

The research programme for Coatings Technology (CT) concentrates on exploring novel coating materials and technologies and acquiring fundamental insights into the structure-properties relationships of coatings to enable the coatings industry to meet future challenges. The research programme is based on three pillars: renewable raw materials and novel, environmentally friendly coating technologies; functional (smart) coatings; durability and testing of coatings.

SUB-PROGRAMMES

Renewable raw materials, formulation and powder coatings
There are currently three projects underway to study the feasibility of applying sustainable, renewable resources in coatings technology without compromising the properties of the final coating (film). The programme focuses on bio-based building blocks and raw materials as substitutes for materials derived from petrochemistry and their use in novel coating technologies. Systems being studied include polycarbonate powder coatings or waterborne polyurethane dispersions, as well as starch-based performance coating materials. The results are promising in that coatings have already been obtained which match and/or improve on the properties of purely synthetic coatings.

Functional (smart) coatings
'Smart coatings' are capable of responding to an external stimulus, such as light, temperature, pressure, pH, odours or gas. The stimulus causes a change in the coating's properties which may be permanent or reversible. Coatings with self-healing properties in response to mechanical damage or with light- or moisture-induced self-cleaning properties are of particular interest and have already been studied. Research on protective coatings that can adapt to their environment and/or conditions under which they are used is at the embryonic stage, but such systems, as well as tailored coatings for medical diagnostics (e.g. test strips) and implants, seem feasible in the future. The same applies for coatings with special optoelectronic and electronic properties that could be used in electronic devices and information technology.

Durability and testing of coatings
The aim is to gain a fundamental understanding of the degradation mechanisms of coatings used in outdoor exposure to enhance durability. Another objective of this sub-programme is to develop new testing methods for coatings, e.g. methods for testing adhesion, gloss or scratch resistance, which correlate to meaningful physical parameters. Last but not least, DPI collaborates intensively with the Materials Innovation Institute's 'Materials to Innovate' (M2i) programme in the study of anti-corrosion coatings.

FACTS AND FIGURES

Partners from industry
- AkzoNobel
- Altana
- DSM
- Lawter
- Saint-Gobain

Partners from the research world
- Eindhoven University of Technology
- University of Groningen
- Wageningen University & Research

Budget and organisation
Expenditure in 2017 totalled € 0.88 million. The total number of FTEs allocated at year-end 2017 was 7.0 (11 researchers). Dr. Monique Bruining and Ronald Korstanje (as of the second half of 2017) were Programme Area Coordinators of this programme area.

Publications and inventions
The research programme in this programme area generated a total of two reviewed papers and one thesis.

For details, see page 28

POLYMERS FOR OIL AND GAS

In the Polymers for Oil and Gas research programme two main areas are distinguised: firstly, the use of polymers in fluids for enhanced oil recovery (EOR) and other subsurface drilling/recovery applications. With the increasing complexity of oil recovery from existing and new reservoirs, EOR could contribute significantly to more efficient recovery of the world's energy resources. The second area addresses the behaviour of polymers in materials used under extreme/adverse conditions, e.g. in hydrocarbon transport and in deep-sea and/or pre-salt applications. This topic is researched in close collaboration with the Performance Polymers programme area.

OBJECTIVES

The aim of the Polymers for Oil and Gas programme is to generate tools and new insights into existing and new polymers for utilisation in the exploration, production and transport of oil and gas.

SUB-PROGRAMMES

Structure–property relationships and the design of new model macromolecules
Controlled radical polymerisation techniques will be employed to investigate the effects of macromolecular topology, for example branching, on polymer solution properties and on viscosity and/or visco-elasticity. These novel structures are evaluated in core flow experiments to determine their injectivity and impact on the recovery of oil in porous media. The effects of polymeric surfactants, i.e. high molecular weight amphiphilic structures that have the potential to decrease the interfacial tension and enhance oil recovery compared with that obtained with the current polymer flooding applications, are also being investigated.

Relating polymer rheology to apparent viscosity in porous media
The objective of this sub-programme is to develop reliable models to predict the relationship of polymer-apparent viscosity in porous media to porous-medium properties, bulk rheological parameters and superficial velocity in the medium and establish the relationship with enhanced oil recovery.

FACTS AND FIGURES

Partners from industry
- Shell
- SNF Floerger

Partners from the research world
- University of Groningen

Budget and organisation
Expenditure in 2017 totalled € 0.06 million. The total number of FTEs allocated at year-end 2017 was 0.5 (1 researcher). Dr. Jan Stamhuis was Programme Area Coordinator of the Polymers for Oil and Gas programme.

Publications and inventions
The research programme in this programme area generated a total of three reviewed papers and two theses.

For details see page 29

Output 2017

POLYOLEFINS

Projects

#754ft16: Computaional Modeling of Ziegler-Natta Propene Polymerization Catalysts: Chemical Reactivity

#785: High Impact Polypropylene: Structure Evolution and impact on Reaction

#787: In situ X-ray measurements

#791: A comprehensive integrated HTC&HTE workflow for the mechanistic study of (novel) olefin polymerization catalysts

#793: Novel Quadrupolar Nuclear Magnetic Resonance Methodology for the Study of MgCl2-Supported Ziegler-Natta Catalysts

#800: Quantitative Structure-Activity Relationships (QSAR) in Metallocene-Based Olefin Polymerization Catalysis

#801: Predictive modelling of mechanical anisotropy in oriented semi-crystalline polymers directly from morphological characteristics

#803: HEat Management in Polymerization Reactors (HEMPR)

#804: From homogeneous to "colloidal" olefin polymerization catalysts: effects of mass transport limitations on reaction kinetics and polymer microstructure

#809: Transparant High Impact Composites

#907: Gas Phase Propylene (Pre)Polymerisation: Impact of catalyst activation, prepolymerisation and support morphology on polypropylene production

#908: SUrface SPecies in Ziegler--Natta Catalysts by dnp sENS

#909: Reactivity and Mechanisms in Post-Metallocene Polyolefin Catalysis Studied by Dissolution Dynamic Nuclear Polarization

Theses

Mohammad Banaei
Hydrodynamics and Heat Transfer in Gas-Solid Fluidized Beds

Zizy Li
Heat transfer in fluidized beds with heat production

Aaron Jose Cancelas Sanz
High impact polypropylene: structure evolution and impact on reaction

Enrico Troisi
Structuring of polyolefins during processing conditions

Giuseppe Antinucci
Heterogeneous Ziegler-Natta Catalysts: Experimental and Computational study by means of Resonance- based Techniques

Scientific publications

O. Boyron, A. J. Cancelas, M. Taam, C. Boisson and T. McKenna
A new straightforward method for measuring xylene soluble for high impact polypropylene
Canadian Journal of Chemical Engineering 95(5) 939-943

Z. Li, T. C. E. Janssen, K. A. Buist, N. G. Deen, M. V. Annaland and J. A. M. Kuipers
Experimental and simulation study of heat transfer in fluidized beds with heat production
Chemical Engineering Journal 317(242-257

T. Kolkman, M. V. Annaland and J. A. M. Kuipers
Whole-field imaging of temperature and hydrodynamics in a gas fluidized bed with liquid injection
Chemical Engineering Science 168(23-40

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Effect of operating pressure on particle temperature distribution in a fluidized bed with heat production
Chemical Engineering Science 169(299-309

H. S. Zijlstra, J. Pahl, J. Penafiela and S. Harder
Masked lewis-acidity of an aluminum alpha-phosphinoamide complex
Dalton Transactions 46(11) 3601-3610

R. Zhang, T. Xiao, R. Graf, E. De-Boer, R. Verhoef, A. Kentgens, G. Yang, S. Rastogi and Y. F. Yao
Chain packing in the noncrystalline region of deuterated uhmwpe: A solid-state h-2 and c-13 nmr study
European Polymer Journal 96(494-504

E. M. Troisi, S. A. J. J. Arntz, P. C. Roozemond, A. H. Tsou and G. W. M. Peters
Application of a multi-phase multi-morphology crystallization model to isotactic polypropylenes with different molecular weight distributions
European Polymer Journal 97(397-408

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Industrial & Engineering Chemistry Research 56(30) 8729-8737

E. S. Blaakmeer, W. M. J. Franssen and A. P. M. Kentgens
Quadrupolar nutation nmr to discriminate central and satellite transitions: Spectral assignments for a ziegler-natta catalyst
Journal of Magnetic Resonance 281(199-208

T. Taniike, P. Chammingkwan, V. Q. Thang, K. Goto, T. Fujitani and M. Terano
Chemisorption-induced activation of mgcl2 film as realistic route for heterogeneous ziegler-natta surfaces under ultrahigh vacuum
Journal of Physical Chemistry C 121(43) 24085-24092

E. A. Andablo-Reyes, D. Auhl, E. L. de Boer, D. Romano and S. Rastogi
A study on the stability of the stress response of nonequilibrium ultrahigh molecular weight polyethylene melts during oscillatory shear flow
Journal of Rheology 61(3) 503-513

A. R. Martins, A. J. Cancelas and T. F. L. McKenna
A study of the gas phase polymerization of propylene: The impact of catalyst treatment, injection conditions and the presence of alkanes on polymerization and polymer properties
Macromolecular Reaction Engineering 11(1)

E. M. Troisi, H. J. M. Caelers and G. W. M. Peters
Full characterization of multiphase, multi-morphological kinetics in flow-induced crystallization of ipp at elevated pressure
Macromolecules 50(10) 3869-3883

A. J. Cancelas, V. Monteil and T. F. L. McKenna
Impact of catalyst injection conditions on the gas phase polymerization of propylene Reaction
Chemistry & Engineering 2(1) 75-87

M. A. Bashir, V. Monteil, C. Boisson and T. F. L. McKenna
Avoiding leaching of silica supported metallocenes in slurry phase ethylene homopolymerization
Reaction Chemistry & Engineering 2(4) 521-530

FUNCTIONAL POLYMER SYSTEMS

Projects

#762: Solution-Processed Small-Molecule Tandem OPV

#763: Design of novel donor-acceptor systems with optimized morphology and transport

#764: Responsive IR reflectors based on polymeric cholesteric liquid crystals

#766: Responsive and self-healing membranes with well-defined nanopores using block copolymers

#775: Switchable topologies using responsive polymers for controlled wetting and self cleaning surfaces

#776: Membranes with adjustable interior in their nanopores

#777: Tuning the optical properties of thin film coatings by using self-assembled protein particles

Theses

Qiang Wang
Solution-processed small-molecule organic solar cells

Hitesh Khandelwal
Infrared regulating smart windows

Merve Cetintas
Thermo-responsive block copolymers - Synthesis, self-assembly and membrane development

Dirk Jan Mulder
Adjustable nanoporous polymers based on smectic liquid crystals

Aijie Liu
Viral Protein Cages as Building Blocks for Functional Materials

Scientific publications

H. Khandelwal, A. P. H. J. Schenning and M. G. Debije
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Advanced Energy Materials 7(14)

A. H. Gelebart, D. J. Mulder, G. Vantomme, A. P. H. J. Schenning and D. J. Broer
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Chemistry of Materials 29(16) 6601-6605

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On the dimensional control of 2d hybrid nanomaterials
Chemistry-a European Journal 23(51) 12534-12541

I. Rorich, O. V. Mikhnenko, D. Gehrig, P. W. M. Blom and N. I. Craciun
Influence of energetic disorder on exciton lifetime and photoluminescence efficiency in conjugated polymers
Journal of Physical Chemistry B 121(6) 1405-1412

PERFORMANCE POLYMERS

Projects

#718: High Tg Liquid Crystal Thermosetting Resins: A New Generation High-performance Polymers for Advanced Composites

#738: Tailored water-based materials assembled from sponge-like building blocks

#744: Molecular Simulations of Polymer Networks: Stress-Strain Relations, Cavitation, and Dynamics in Confinement

#745: Microstructure-based Modeling of the Intrinsic Kinectics of Aging and Deformation of Polymer Glasses

#749: The chemistry of rubber modification and crosslinking:New approaches towards an old problem

#769: High performance Stereocomplex of Poly(lactic acid) SC-PLA

#782: How short-cut fibers influence friction, wear and noise generation of polymers

#783: COntact mechaNics, FrictIon and coNtact fatiguE on polymeric SURFACES

#786: Processing for Enhanced Product Performance

#788: Predicting the Fountain Flow Instability from Material Properties and Processing conditions

#805: Probing interfacial damage in composites with mechanofluorescence

#806: 2D Material Coatings for Fibres

#916: Development of Dynamic Nuclear Polarization (DNP) NMR for the study of polymer surfaces, interfaces, fillers and coatings

#917: Polymer extrusion of particle filled systems

#918: Optimization of interface strenght in advanced polymer composite materials

Theses

Madzarevic Zeljka
Tailoring the free volume of all-aromatic polyimide membranes for CO2/CH4 gas separation

Lorenzo Polgar
Thermoreversible cross-linking of rubber

Emanuele Parodi
Structure Properties Relations for Polyamide 6

Nadia Vleugels
Short Fibre-reinforced Elastomeric Composites

Chunliang Li
Green polycarbonates from orange oil: synthesis, functionalization, coating applications and recyclability

Scientific publications

T. Liang, H. P. C. van Kuringen, D. J. Mulder, S. Tan, Y. Wu, Z. Borneman, K. Nijmeijer and A. P. H. J. Schenning
Anisotropic dye adsorption and anhydrous proton conductivity in smectic liquid crystal networks: The role of cross-link density, order, and orientation
Acs Applied Materials & Interfaces 9(40) 35218-35225

C. L. Li, R. J. Sablong, R. A. T. M. van Benthem and C. E. Koning
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Interaction of artepillin c with model membranes
European Biophysics Journal with Biophysics Letters 46(4) 383-393

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European Polymer Journal 90(150-161

V. Kumar, D. J. Mulder, G. Cavallo, T. Pilati, G. Terraneo, G. Resnati, A. P. H. J. Schenning and P. Metrangolo
Structural characterization of new fluorinated mesogens obtained through halogen-bond driven self- assembly
Journal of Fluorine Chemistry 198(54-60

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Kgk-Kautschuk Gummi Kunststoffe 70(9) 39-51

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Effect of rubber polarity on cluster formation in rubbers cross-linked with diels-alder chemistry
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L. M. Polgar, E. Hagting, W. J. Koek, F. Picchioni and M. van Duin
Thermoreversible cross-linking of furan-containing ethylene/vinyl acetate rubber with bismaleimide
Polymers 9(3)

R. l'Abee, M. van Duin and H. Goossens
Deformation mechanisms of sub-micrometer thermoplastic vulcanizates obtained by reaction-induced phase separation of miscible poly(epsilon-caprolactone)/ dimethacrylate systems
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E. Parodi, L. E. Govaert and G. W. M. Peters
Glass transition temperature versus structure of polyamide 6: A flash-dsc study
Thermochimica Acta 657(110-122

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Effect of particle-size dynamics on properties of dense spongy-particle systems: Approach towards equilibrium
Physical Review E 96(1)

COATINGS TECHNOLOGY

Projects

#759: Novel Isocyanate-free, Chain-Extended Polyurethane Dispersions Containing Alternative Internal Dispersing Agents

#780: Self-replenishing high-surface-energy coatings

#781: Film Formation in Complex Colloidal Coatings

#910: Tuning the rheology of waterborne Polyurethane binoter + thickener mixtures

#911: Tuning the interactions between silica fillers and polymer binders towards hard and crack resistant water-based coatings

#912: Phase stability, dynamics and structure of binary aqueous polymer dispersions

#913: Laser speckle Imaging of drying dynamics in waterborne coatings

#914: In-situ investigation of the film information process in waterborne coatings

#915: Self-dispersible thermoplastic polymers

Thesis

Shuang Ma
Isocyanate-free approaches to polyurea dispersions and coatings

Scientific publications

H. M. van der Kooij, A. Susa, S. J. Garcia, S. van der Zwaag and J. Sprakel
Imaging the molecular motions of autonomous repair in a self-healing polymer
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H. H. Feng, J. B. ten Hove, T. T. Zheng, A. H. Velders and J. Sprakel
All-aqueous synthesis of silica-encapsulated quantum dots with functional shells
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LARGE-AREA THIN FILM ELECTRONICS

Scientific publications

J. J. van Franeker, K. H. Hendriks, B. J. Bruijnaers, M. W. G. M. Verhoeven, M. M. Wienk and R. A. J. Janssen
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J. J. van Franeker, D. Hermida-Merino, C. Gommes, K. Arapov, J. J. Michels, R. A. J. Janssen and G. Portale
Sub-micrometer structure formation during spin coating revealed by time-resolved in situ laser and x-ray scattering
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Solution-processed multilayer polymer light-emitting diode without intermixing
Applied Physics Letters 110(2)

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2-methoxyethanol as a new solvent for processing methylammonium lead halide perovskite solar cells
Journal of Materials Chemistry A 5(5) 2346-2354

A. Perrotta, C. Fuentes-Hernandez, T. M. Khan, B. Kippelen, M. Creatore and S. Graham
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R. Heuvel, J. J. van Franeker and R. A. J. Janssen
Energy level tuning of poly(phenylene-alt-dithienobenzothiadiazole)s for low photon energy loss solar cells
Macromolecular Chemistry and Physics 218(5)

C. Schaefer, J. J. Michels and P. van der Schoot
Dynamic surface enrichment in drying thin-film binary polymer solutions
Macromolecules 50(15) 5914-5919

POLYMERS FOR OIL AND GAS

Projects

#778: Strategies towards industrial production of new (branched) polyacrylamide structures for EOR

#808: Adsorption/retention of Polymer in Porous Media

Theses

Durgesh Kawale
Elastic Instabilities in Polymer-Solution Flow Through Porous Media

Frank van Mastrigt
SynThesis of Novel Branched Polymers for Enhanced Oil Recovery

Scientific publications

F. van Mastrigt, T. Stoffelsma, D. A. Z. Wever and F. Picchioni
Thermoresponsive comb polymers as thickeners for high temperature aqueous fluids
Materials Today Communications 10(34-40

D. Kawale, E. Marques, P. L. J. Zitha, M. T. Kreutzer, W. R. Rossen and P. E. Boukany
Elastic instabilities during the flow of hydrolyzed polyacrylamide solution in porous media: Effect of pore- shape and salt
Soft Matter 13(4) 765-775

D. Kawale, G. Bouwman, S. Sachdev, P. L. J. Zitha, M. T. Kreutzer, W. R. Rossen and P. E. Boukany
Polymer conformation during flow in porous media
Soft Matter 13(46) 8745-8755

EXCHANGE PROGRAMME BRAZIL

Project

#769: High performance Stereocomplex of Poly(lactic acid) SC-PLA

Thesis

Hao Liu
Influence of particle size and bimodality on the processing and performance of ultra-high molecular weight polyethylene

EXCHANGE PROGRAMME CHINA

Project

#794: Microbial Synthesis of Functional Polyhydroxyalkanoates (PHA)

NEWPOL (NEW POLYMER MATERIALS) PROGRAMME

Projects

#731.015.501: Photonic supralatices for pigment-free colour in waterbased coatings

#731.015.502: Responsive Commodity Polymers

#731.015.503: Supramolecular Biomaterials with a Dual Network Architecture for Stem Cell Expansion

#731.015.504: Self-Synthesizing Hydrogels

#731.015.505: Supramolecular Biomaterials with Antimicrobial and Regenerative Activity

#731.015.506: Towards flexible memories with coordination polymers with polar rotors

DPI ...

DPI is a foundation funded by Dutch industry, universities and the government which was set up to perform exploratory research in the area of polymer materials.

DPI operates at the interface of universities and industry, linking the scientific skills of university research groups to the industrial need for innovation.

DPI carries out pre-competitive research projects to add value to the scientific community through scientific publications and to the industrial community through the creation of intellectual property.

DPI provides a unique platform for generating awareness of new technology, in which participating industrial companies, competitors in the market place, communicate on a pre-competitive basis to trigger innovation.

DPI integrates the scientific disciplines and know-how of universities into the 'chain of knowledge' needed to optimise the conditions for making breakthrough inventions and triggering industrial innovation.

DPI aims to combine scientific excellence with a genuinely innovative impact in industry, thereby creating a new mindset in both industrial and academic research.

DPI aims to fill the innovation gap between industry and universities and so resolve the Dutch Paradox of scientific excellence and lack of innovation.

Some 75 researchers (PhDs and Post-Docs) are currently involved in DPI projects at knowledge institutes throughout the world.

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