The Moment of Truth

Annual Report 2014

DPI
Dutch Polymer Institute

Foreword
The Moment of Truth

The year 2014 saw the unfolding of the Dutch government's new Top Sectors policy. Over the past year, the contours of this policy and its implications have become clearer. The new policy has put an end to the *specific* funding schemes supporting individual institutions such as the Leading Technology Institutes (LTIs) – of which DPI is one – regardless of their past performance. A more *generic* policy has been introduced instead, with a different organisational set-up and a different incentives structure.

It is to be seen whether the strong knowledge infrastructure that the LTIs have helped to build will continue to thrive under this new policy. This at any rate holds for the polymer sector in the Netherlands, which over the past decade has benefited from the successful collaboration between industry and academia via the pivotal DPI platform. The bulk of polymer research in the Netherlands has been carried out under the auspices of DPI.

We are proud of DPI's successful track record. And we believe that DPI's bridging role deserves to be continued, notwithstanding the changes in the Dutch government's funding policy. This means that a new funding format needs to be put in place in which DPI is no longer structurally dependent on government funding. To this end, in 2014 we systematically sounded out our industrial partners and came up with a value proposition for a new format – DPI 2.0 – which was formally presented to all our industrial partners in January 2015.

DPI 2.0

The DPI 2.0 value proposition is to establish a pre-competitive international research programme in polymer science and technology with a focused portfolio and supported by commitment and funding from industrial partners. Any additional funding that can be obtained from national, regional or international organisations will be utilised to generate upward potential to enhance our overall offering to our partners.

We are pleased to report that so far 9 major companies have confirmed their participation in DPI 2.0. The commitment of these companies gives us confidence that DPI 2.0 is a sound proposition. In deciding to participate in DPI 2.0, these partners have no doubt weighed the pros and cons of participation in a collaborative platform versus bilateral collaboration between a company and a university. Their endorsement also shows that for these companies the added value of the DPI platform carries greater weight than the level of the financial contribution required.

Until now, the DPI industrial partner base has primarily consisted of producers and processors of polymeric materials. Now, we will also approach companies in other segments of the polymer value chain, such as the industrial end-users, who also stand to gain from a collaborative pre-competitive research programme addressing fundamental topics related to end-use applications of polymeric materials. Their participation will also enable DPI to develop attractive value propositions to seize the opportunities offered by public programmes such as the EU's Horizon 2020.

Why the DPI platform matters

Both the polymer industry and the universities have benefited from the research programmes of the DPI collaborative platform. Over the past ten years, DPI has built a strong international network of top-level scientists and academic groups specialised in polymer chemistry, polymer physics and polymer processing. The DPI organisation has become highly competent in setting up and managing coherent research programmes that identify and utilise the best possible academic expertise to address the needs of its industrial partners and to ensure a steady supply of competently trained polymer experts. These research programmes have been instrumental in enhancing the academic effort in polymer research in both qualitative and quantitative terms.

DPI TEAM (April 2015) – Top row: Thomas Manders and Ronald Korstanje
Second row: Renée Hoogers, Linda de Wit, Christianne Bastiaens, Peter Nossin, Monique Bruining, Jacques Joosten and Peter Kuppens
Third row: John van Haare and Denka Hristova-Bogaerds
Absent in this picture: Jeanne van Asperdt, Jan Stamhuis and Sybrand van der Zwaag

We believe that the continuation of the DPI platform will help to prevent the erosion of the polymer knowledge base that seems imminent in some areas, especially in the current climate of reduced R&D spending in Europe coupled with the changes in the incentive schemes. An increasing shift towards more narrowly based bilateral collaborations between companies and universities, without the balancing effect of broadly based collaborative platforms, could lead to a decline in academic activity in a number of areas that are of importance to the polymer industry in the long term.

International dimension
DPI's international network has always been one of its strong points. It offers a wider platform for comprehensive and in-depth research on internationally relevant topics in polymer science. Also, it enables DPI to obtain the right polymer expertise in the face of fluctuations in academic priorities in time and from region to region.

With the use of polymeric materials set to grow tenfold in the next few years – especially in countries, such as those in Asia, that are currently marginal users – polymer research on an international level is becoming more essential than ever. Enhancing our understanding of the fundamental aspects of such materials will enable us to optimise the functionalities of established polymeric materials, explore the potential of new polymeric materials and find lifecycle based solutions to the growing environmental and sustainability concerns in the world.

In order to participate in and contribute to developments in polymer science on an international level, we will have to further strengthen the DPI network by attracting more and stronger international partners, both industrial and academic. A more international approach will also be to the benefit of Dutch companies, no matter where in the world their activities are based. In this regard, we are pleased that we have a number of international companies on board for DPI 2.0, representing research interests in important areas of polymeric materials application.

Scientific quality
For many years now, DPI has been delivering a high volume of scientific output of a consistently high quality, widely recognised and appreciated by the international scientific community. This has among other things been reflected in a high Journal Impact Factor (2014: 4.45). In 2014, this excellence in research was independently confirmed in a study carried out by Elsevier on behalf of the Netherlands Enterprise Agency, an operational unit of the Dutch Ministry of Economic Affairs. It is part of a wider programme to benchmark academic achievements in research programmes being executed under the auspices of Top Consortia for Knowledge and Innovation (TKIs) in the Netherlands.

In addition to publication output, citation impact and patent citations, the study – which focused on publications in the field of Smart Polymeric Materials – also examined two aspects that form the cornerstones of the DPI research platform: international collaboration and collaboration between academia and industry.

The Netherlands ranks second globally for co-authored articles resulting from international collaboration. And in terms of publications representing academic-corporate collaboration the Netherlands is in fact the world leader. The FWCI score for the Netherlands for both these categories of publications was also very high – the fourth highest in the world.

Earlier economic studies have acclaimed DPI's strength in bringing together industrial and academic partners in a competently managed pre-competitive research programme. We are proud that this Elsevier report clearly shows that DPI research also stands out scientifically. It confirms our conviction that scientific and industrial relevance are not mutually exclusive.

Current programme
It goes without saying that in the current transition phase too – characterised by strained circumstances – DPI is managing the research programme in keeping with our normal practice, under a strict regime of responsible and controlled use of financial resources in the best interests of our industrial partners. We have had to be cautious in entering into any new project or programme commitments. As a consequence, in 2014 we had a total of only around 110 FTE in research positions in our running programme. This figure will decline further as the running projects are phased out in the next two years. For 2015, we have granted only a very small number of new projects. A transition scenario has been defined to ensure that the transition from the current programme to the proposed DPI 2.0 programme takes place in an efficient and transparent manner.

The moment of truth
For DPI as well as for the polymer sector, especially in the Netherlands, the year 2015 is the moment of truth. What course will polymer research take? The go/no-go decision on DPI 2.0 will be made towards the end of the year. Either way, the decision will impact the future course of polymer research. We sincerely hope that our existing industrial partners and potential new partners will endorse and embrace the DPI 2.0 value proposition and join us in continuing to build and maintain a strong, industrially relevant polymer knowledge base through a competently managed international pre-competitive research programme.

Jacques Joosten – Managing Director

Sybrand van der Zwaag – Scientific Director

DPI VALUE CENTRE TEAM (April 2015)
Top row: Peter Koppert, Gert Poppe, Martin van Dord and Johan Tiesnitsch
Second row: Louis Jetten, Anne van der Linden, Gerrie Verhoeven, Jos Lobée, Arie Brouwer, Eelco Rietveld, Femke Roos and Lonneke de Graaff
Third row: Ineke Laeven, Judith Tesser and Thomas den Hengst

Contents

Organisation 2014

Supervisory Board

- **Dr. H.M.H. van Wechem**, *Chair*
- **Dr. J.A. Roos**
- **Prof.dr. C.J. van Duijn**, *(left in 2014)*
- **Dr. F. Kuijpers**
- **Prof. K.C.A.M. Luyben**
- **Dr. M. Wubbolts**, *(left in 2014)*

Council of Participants

- **Dr. L. Hviid**, Shell, *Chair*

Scientific Reference Committee

- **Prof.dr. A.J. Schouten**
  University of Groningen, *Chairman*
- **Prof.dr. L. Leibler**
  Ecole Supérieure Physique et Chimie Industrielles, Paris
- **Prof.dr. H. Sirringhaus**
  University of Cambridge
- **Prof.dr. B. Voit**
  Institut für Polymerforschung, Dresden

Executive Board

- **Dr. J.G.H. Joosten**
  Managing Director, Chairman
- **Prof.dr. S. van der Zwaag**
  Scientific Director

Programme Area Coordinators

- **Dr. M.J. Bruining**
  Corporate Research
- **Dr. M. Crego Calama**
  High-Throughput Experimentation, Coatings Technology (left in 2014)
- **Dr. J.A.E.H. van Haare**
  Functional Polymer Systems, Large-Area Thin-Film Electronics
- **R.J. Korstanje, MSc**
  Performance Polymers
- **Dr. P.M.M. Nossin**
  Bio-Inspired Polymers
- **Dr. J.E. Stamhuis**
  Polyolefins,Enhanced Oil Recovery, Emerging Technologies

Scientific Programme Chairmen

- **Prof.dr. V. Busico**
  Polyolefins
- **Prof.dr. C. Creton**
  Performance Polymers
- **Prof.dr. F. de Schryver**
  Functional Polymer Systems and Large-Area Thin-Film Electronics
- **Prof.dr. C.D. Eisenbach**
  Coatings Technology (left in 2014)
- **Prof.dr. U.S. Schubert**
  High-Throughput Experimentation (left in 2014)
- **Prof.dr. G. Eggink**
  Bio-Inspired Polymers
- **Prof.dr. S. van der Zwaag**
  Coatings Technology, Polymers for Enhanced Oil Recovery, Emerging Technologies and Corporate Research

Organisation Staff

- **A.F.J. van Asperdt** - *Fin. Administration*
- **C.H.L.M. Bastiaens** - *Communications*
- **Dr. M.J. Bruining** - *General Affairs*
- **M.M.G. Heuvelmans** - *Fin. Administration*
- **R.P.F. Hoogers-Valken** - *Secretariat*
- **S.G. Koenders** - *Project Administration*
- **P.J.J. Kuppens, AA** - *Controlling*
- **A.C.M. Looymans** - *Project Administration*

Staff European projects

- **Dr. J.A.E.H. van Haare**
  Project Manager SEAFRONT
- **Dr. D.G. Hristova-Bogaerds**
  Project Manager COMPNANOCOMP
- **R.J. Korstanje, MSc**
  Project Manager SHINE
- **A.C.M. Looymans**
  EU Project Office
- **A.M.G. Steinmann**
  EU-SEAFRONT Project Office

PERSONNEL CHANGES AT DPI

In 2014, Dr. Marcel Wubbolts of DSM and Prof.dr. Hans van Duijn of Eindhoven University of Technolgy withdrew from the Supervisory Board. Two new members were appointed in 2015: Dr. Diederik Boersma, Global R&D Manager for Enhanced Oil Recovery (EOR) and Global Chemical EOR Technology Manager at Shell; and Jan de Jeu, Vice President of the Board of the University of Groningen.

Dr. Lene Hviid, Manager IRD Materials & Corrosion at Shell Global Solutions, was appointed chair of DPI's Council of Participants as of November 2014. She succeeds Dr. Gerrit ten Brinke, who left the board in 2013 and whose role was temporarily fulfilled by Dr. Herman van Wechem.

As reported in last year's Annual Report, Prof.dr. Sybrand van der Zwaag, of the Faculty of Aerospace Engineering at Delft University of Technology (Netherlands), took up the role of Scientific Director of DPI as of 1 January 2014, succeeding Prof.dr. Martien Cohen Stuart, who retired at the end of 2013.

Prof.dr. Ulrich Schubert, Scientific Chairman for the technology area High-Throughput Experimentation, left DPI as the technology area was terminated end 2014. Prof.dr. Claus Eisenbach acted as Scientific Chairman of the Coatings Technology area. As of mid 2014, Prof.dr. Sybrand van der Zwaag took over his role as Chairman.

Dr. Mercedes Crego Calama, Programme Area Coordinator for High-Throughput Experimentation and Coatings Technology, left DPI to pursue a career elsewhere.

Following the discontinuation of government subsidy for DPI as from 2014, we had to implement significant adjustments to the DPI Office organisation over the past year, resulting in some staff cuts. The following people left DPI in the first quarter of 2015: Annemarie Steinmann (DPI project administration); Sherida Koenders (DPI project administration) and Miranda Heuvelmans (DPI finance).

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 focussing on pre-commercial and societal themes.

PRE-COMPETITIVE PROGRAMME

DPI Rules & regulations apply to all projects

Polyolefins

20 projects

Industry

- Accelrys
- Borealis
- Braskem
- Dow Benelux
- DSM
- ExxonMobil
- Freeslate
- Lanxess Elastomers
- LyondellBasell
- Michelin
- SABIC
- SCG Chemicals
- Sinopec
- Teijin Aramid

Academia

- Consorzio Interuniversitario Nazionale per la Scienza e Technologia die Materiali (INSTM)
- Eindhoven University of Technology
- ESCPE-Lyon
- Fraunhofer Institute for Structural Durability and System Reliability LBF
- Japan Advanced Institute of Science and Technology
- Johann Kepler University Linz
- Karlsruhe Institute of Technology
- Loughborough University
- Martin-Luther University of Halle-Wittenberg
- National Council for Scientific and Technological Development (CNPq)
- Polymer Technology Group Eindhoven
- Queens University
- Radboud University Nijmegen
- UFRGS Universidade Federal do Rio Grande do Sul
- Universidade Federal do Rio de Janeiro
- University of Amsterdam
- University of Antwerp
- University of Erlangen
- University of Manitoba
- University of Naples Federico II
- University of Ottawa
- University of Perugia
- University of Turin
- University of Udine

Expenditure € 1.68 million
FTEs 24.2 (34 researchers)

Performance Polymers

18 projects

Industry

- AkzoNobel
- BASF
- Bayer
- Bekaert
- DSM
- Industrial Technology Research Institute Taiwan
- Petrobras
- SABIC
- SKF
- Teijin Aramid

Academia

- CNRS Strasbourg
- Delft University of Technology
- DWI an der RWTH Aachen
- Eindhoven University of Technology
- Fraunhofer Institute for Structural Durability and System Reliability LBF
- National Technical University of Athens
- University of Groningen
- University of Twente

Expenditure € 0.59 million
FTEs 13.1 (19 researchers)

Functional Polymer Systems

13 projects

Industry

- BASF
- DSM
- ECN
- Industrial Technology Research Institute Taiwan
- Philips
- Rolic Technologies
- SABIC
- Solvay
- TNO

Academia

- Delft University of Technology
- ECN
- Eindhoven University of Technology
- Imperial College London
- Max Planck Institute für Polymerforschung
- University of Groningen

Expenditure € 0.49 million
FTEs 12.8 (15 researchers)

Coatings Technology

7 projects

Industry

- AkzoNobel
- Altana
- DSM
- Lawter
- Saint-Gobain

Academia

- Changchun Institute of Applied Chemistry
- Eindhoven University of Technology
- University of Haute-Alsace
- Wageningen University

Expenditure € 0.53 million
FTEs 15.1 (16 researchers)

Pre-competitive research programme

DPI's pre-competitive research programme currently embraces ten technology 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 programmes for the specific technology 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 the research results to the envisaged high standard and prepares our scientists for their future careers, in industry or elsewhere.

The interaction between academic researchers and industrial scientists takes various forms. Each project team submits quarterly reports to DPI, while twice a year every researcher also gives a presentation for all of the partners in the specific technology area to highlight and explains its research results. This enables DPI to monitor, evaluate and steer the projects. The research results are shared within the technology area and all of the partners are free to use the knowledge that is acquired, with the exception of knowledge that is part of an invention. When an invention is reported and partners are interested in using that knowledge, DPI files a patent application and the industrial partners involved in that specific technology area have the first claim to it.

DPI Rules & regulations apply to all projects

High-Throughput Experimentation	Bio-Inspired Polymers	Large-Area Thin-Film Electronics	Emerging Technologies	Corporate Research
3 projects	**10 projects**	**8 projects**	**1 project**	**11 projects**
Industry • Chemspeed Technologies • Evonik • Forschungsgesellschaft Kunststoffe • Microdrop Technologies	**Industry** • Food and Biobased Research, Wageningen UR • FrieslandCampina • Petrobras • SABIC • Teijin Aramid	**Industry** • DSM • Philips • Solvay • TNO	**Industry** • DPI partners • M2i partners **Academia** • Delft University of Technology	**Industry** • All DPI partners take part in Corporate Research
Academia • Fraunhofer Institute for Structural Durability and System Reliability LBF • Friedrich-Schiller University Jena • Radboud University Nijmegen	**Academia** • Eindhoven University of Technology • Food and Biobased Research, Wageningen UR • Friedrich-Schiller-University Jena • National Council for Scientific and Technological Development (CNPq) • Tsinghua University • Universidade Católica de Brasilia • Universidade Federal do Rio de Janeiro	**Academia** • Eindhoven University of Technology • Imperial College London • Max Planck Institute für Polymerforschung • University of Algarve • University of Groningen • University of Twente • University of Wuppertal	**Polymers for Enhanced Oil Recovery** **3 projects** **Industry** • Shell • SNF Floerger **Academia** • Delft University of Technology • University of Groningen	**Academia** • Delft University of Technology • Eindhoven University of Technology • ESRF, Grenoble • Foundation for fundamental research on matter (FOM) • Radboud University Nijmegen • TI Food and Nutrition (TIFN) • University of Groningen • University of Twente • Wageningen University
Expenditure €0.20 million FTEs 1.6 (6 researchers)	Expenditure € 0.89 million FTEs 16.1 (27 researchers)	Expenditure € 0.34 million FTEs 11.7 (17 researchers)	Expenditure € 0.14 million FTEs 3.3 (4 researchers)	Expenditure € 0.60 million FTEs 9.1 (11 researchers)

Industrial pre-commercial programme

The industrial pre-commercial programme consist of Value Chain projects and EU projects. The conditions for performing Value Chain projects are described below and those of EU projects are generally known and are available on the web.

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 the 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 between the partners and to coordinate the project. DPI can also act as coordinator of a project. Particularly when SMEs are involved, DPI works together with the DPI Value Centre.

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 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-COMMERCIAL PROGRAMME

Model framework for collaboration		
Rules and regulations set by involved partners	**Rules and regulations set by involved partners**	**Rules and regulations set by involved partners**
CompNanoComp (1-10-2011/ 30-9-2014)	**SHINE** (1-2-2013/31-7-2016)	**SEAFRONT** (1-1-2014/31-12-2017)
Partners • DPI • Rhodia • National Technical University of Athens • Eindhoven University of Technology • Centre National de la Recherche Scientifique - Laboratoire Polymères et Matériaux Avancés • General Electric • European Centre for Nanostructured Polymers • University of Ulm • Lomonosov Moscow State University • Institute of Macromolecular Compounds St. Petersburg • National Research Centre Kurchatov Institute • Phys Chem Ltd	**Partners** • DPI • Acciona Infraestructuras • Arkema • BIWI SA • Cidetec • Critical Materials • ESPCI ParisTech • Forschungszentrum Jülich • Fraunhofer UMSICHT • MTA-TTK • SKF Engineering & Research Centre • Teijin Aramid • Delft University of Technology	**Partners** • DPI • International Paint Ltd • 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 • Hapag Lloyd
Budget €2.2 million (€1.5 million EU subsidy)	Budget €6.4 million (€4.0 million EU subsidy)	Budget €11.2 million (€8.0 million EU subsidy)

Projects driven by societal themes

DPI is confronted with new demands from society in relation to scientific research into polymers. A major international issue is that of 'plastic soup', the vast volumes of plastic waste that accumulate in certain areas of the oceans and seas and harm the ecosystem. DPI has become increasingly aware in recent years that companies, knowledge institutions and the government are not its only stake-holders. Society at large can also benefit from the knowledge and expertise generated by the DPI community as a source of possible solutions for societal issues such as 'plastic soup'.

SOCIETAL PROGRAMME

Plastic Marine Litter
(to prevent plastic from ending up in the oceans)

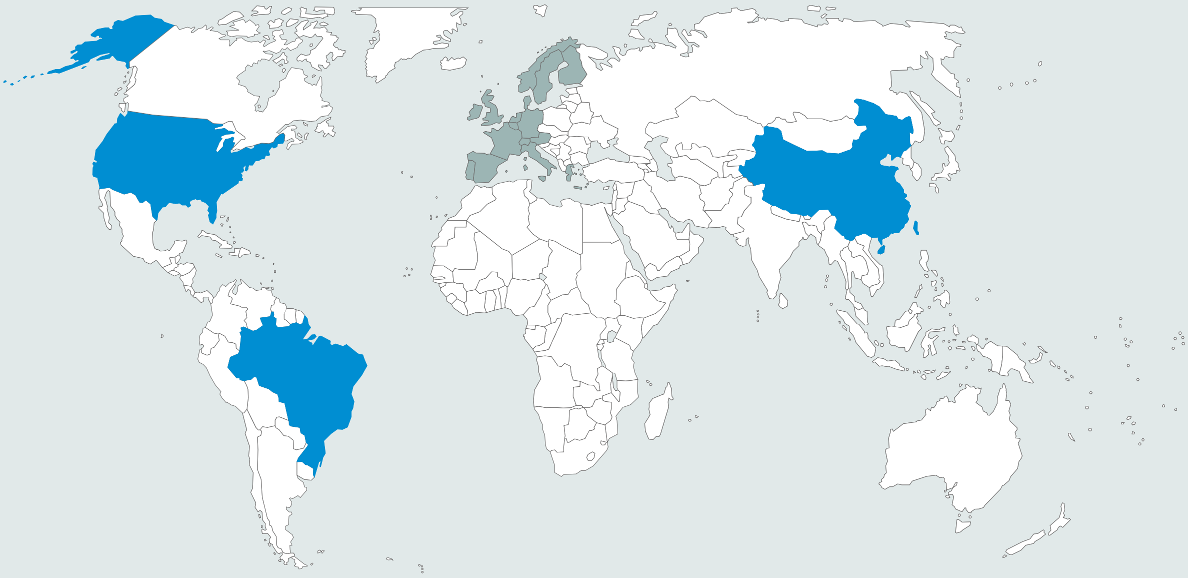
Start date 1-9-2012

Partners

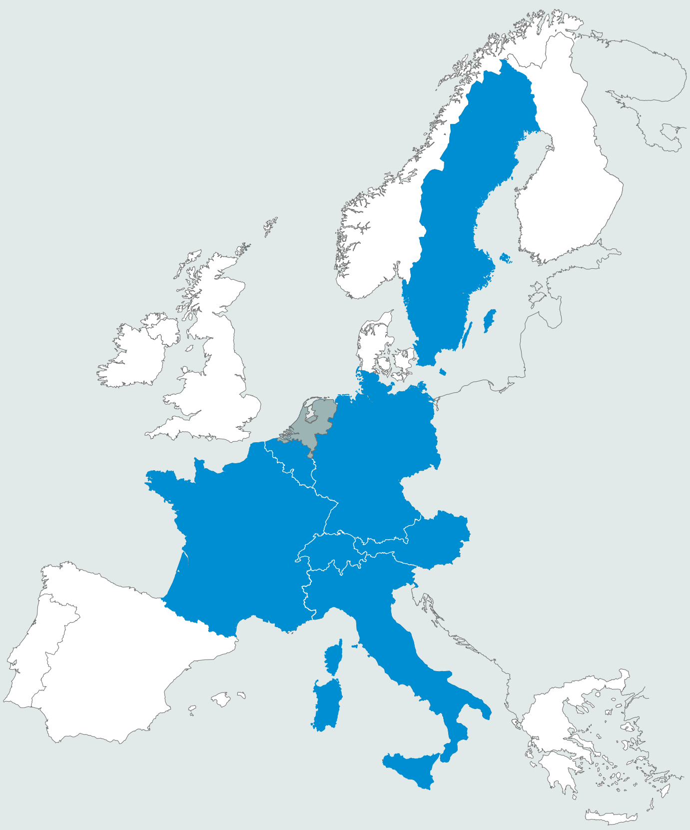
- DPI
- DPI Value Centre
- IMSA
- Stichting De Noordzee
- University Utrecht
- Kruidenier Foodservices
- SABIC
- Van Gansewinkel

Partners Industry 2014

North and South America, Asia



Europe



- Altana
- BASF
- Bayer
- Bekaert
- Borealis
- Chemspeed Technologies
- Evonik
- Forschungsgesellschaft Kunststoffe
- LyondellBasell

- Accelrys
- Braskem
- ExxonMobil
- Freeslate
- Industrial Technology Research Institute Taiwan
- Petrobras
- SCG-Chemicals
- Sinopec

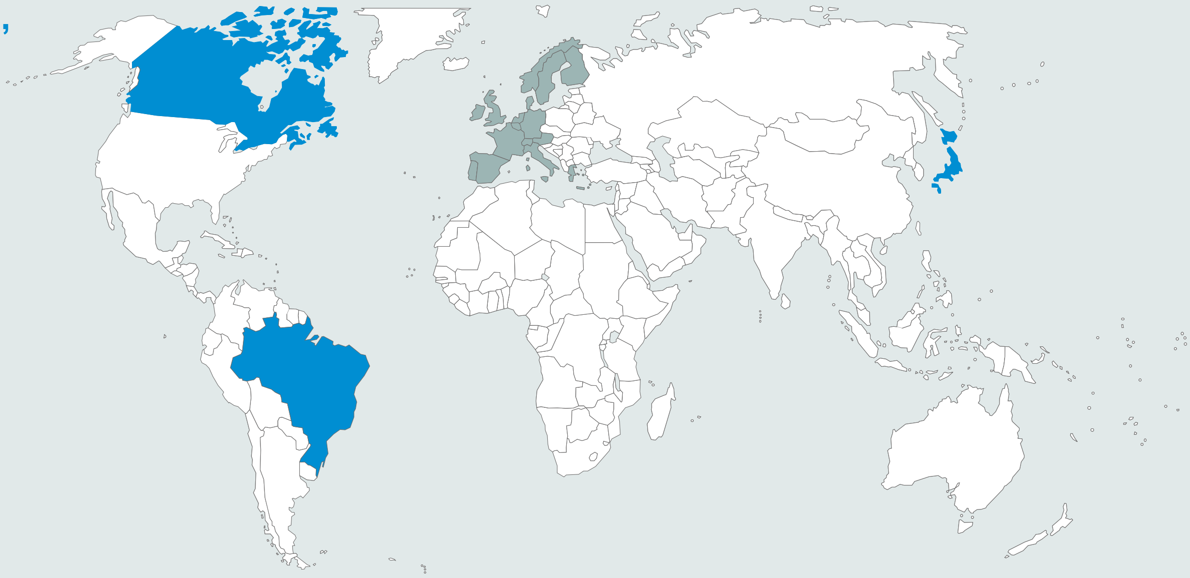
- Michelin
- Microdrop Technologies
- Rolic Technologies
- Saint-Gobain
- SKF
- SNF Floerger
- Solvay

The Netherlands

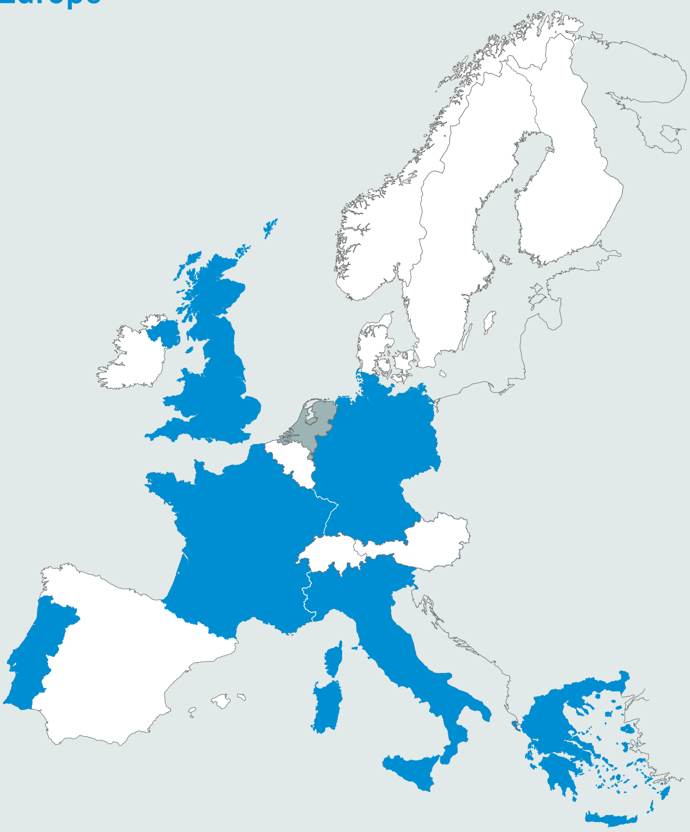
- AkzoNobel
- Dow Benelux
- DSM
- ECN
- Food and Biobased Research Wageningen UR
- FrieslandCampina
- Lanxess Elastomers
- Lawter
- Philips
- SABIC
- Shell
- Teijin Aramid
- TNO

Partners Knowledge institutes 2014

North and South America, Asia



Europe



	CNRS Strasbourg
	INSTM
	DWI an der RWTH Aachen
	ESCPE-Lyon
	ESRF, Grenoble
	Fraunhofer Institute for Structural Durability and System Reliability LBF
	Friedrich-Schiller-University, Jena
	Imperial College London
	Johann Kepler University Linz
	Karlsruhe Institute of Technology
	Loughborough University
	Martin-Luther-University Halle-Wittenberg

Ministry of Economic Affairs

- Changchun Institute of Applied Chemistry
- Japan Advanced Institute of Science and Technology
- National Council for Scientific and Technological Development
- Queens University
- Tsinghua University
- UFRGS Universidade Federal do Rio Grande do Sul
- Universidade Católica de Brasilia
- Universidade Federal do Rio de Janeiro
- University of Manitoba
- University of Ottawa

- Max-Planck Institute für Polymer Forschung
- Nanoforce Technology (No research projects in 2014)
- National Technical University of Athens
- University of Algarve
- University of Antwerp
- University of Erlangen
- University of Haute-Alsace
- University of Naples Federico II
- University of Perugia
- University of Turin
- University of Udine
- University of Wuppertal

The Netherlands

- Delft University of Technology
- ECN
- Eindhoven University of Technology
- FOM
- Food and Biobased Research Wageningen UR
- NWO
- Polymer Technology Group Eindhoven
- Radboud University Nijmegen
- University of Amsterdam
- University of Groningen
- University of Twente
- Wageningen University

Summary of financial data 2014

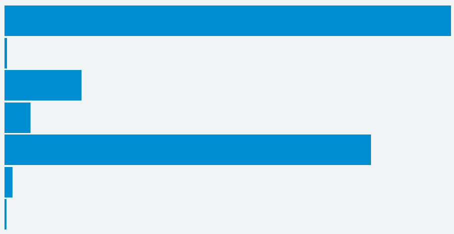
Income

Income	(x EUR million)	%
Contributions from industrial partners	3.85	33.4
In-kind contributions from industrial partners	0.26	2.3
Revenue Patents	0.03	0.3
Revenue DPI Value Centre	0.50	4.3
Contributions from knowledge institutes	1.36	11.8
Contributions from Ministry of EA	0.00	0.0
Revenue TKI SPM	0.29	2.5
EU FP7 projects	5.14	44.7
Industrial pre-commercial research programme Value Chain	0.08	0.7
Solving societal themes and challenges	0.00	0.0
Total income	**11.51**	**100**

Expenditure

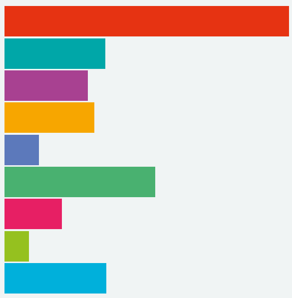
By nature

	(x EUR million)	%
Personnel costs	6.34	48.2
Depreciation	0.04	0.3
Other costs	1.09	8.3
In-kind contribution	0.37	2.8
EU FP7 projects	5.21	39.6
Industrial pre-commercial research programme Value Chain	0.1	0.8
Solving societal themes and challenges	0	0.0
Total expenditure	**13.15**	**100**



By Technology Area

	(x EUR million)	%
Polyolefins	1.68	30.8
Performance Polymers	0.59	10.8
Functional Polymer Systems	0.49	9.0
Coatings Technology	0.53	9.7
High-Throughput Experimentation	0.20	3.6
Bio-Inspired Polymers	0.89	16.3
Large-Area Thin-Film Electronics	0.34	6.2
Enhance Oil Recovery	0.14	2.6
Corporate Research	0.60	11.0
Sub total	**5.46**	**100**



Knowledge Workers Scheme	0.00
Knowledge Transfer	0.16
Organisation and support	1.27
Support to DPI Value Centre	0.47
In-kind contribution	0.37
EU FP7 projects	5.21
Industrial pre-commercial research programme Value Chain	0.10
Solving societal themes and challenges plus geographical outreach	0.11
Total expenditure	**13.15**

Key Performance Indicators 2014

Number of industrial partners

2013	38
2014	37

European governmental funding (% of total funding)

2013	7%
2014	45%

Number of partner knowledge institutes
(universities, etc.)

2013	45
2014	45

Participation of foreign knowledge institutes
as % of total expenditure

2013	12%
2014	18%

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

End 2013	46%
End 2014	35%

Overhead costs
as % of total expenditure

2013	4%
2014	10%

Contribution Ministry of Economic Affairs
as % of total income

End 2013	27%
End 2014	0%

Expenditure for knowledge transfer
x EUR million

2013	0.53
2014	0.16

Number of patents filed by DPI

2013	8
2014	2

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

2013	0
2014	6

Track record DPI researchers

Left in total	50
Employed by partner knowledge institute	17
Employed by non-partner knowledge institute	6
Employed by partner industrial company	8
Employed by non-partner industrial company or start-up	10
Unknown	9

Research output	2013	2014
Scientific publications	170	111
PhD theses	21	20

DPI Value Centre
Working together on innovation and business success

In 2014 DPI Value Centre once again undertook a variety of activities throughout the Netherlands to support entrepreneurs in the polymer sector in their pursuit of innovation and business success. And once again, we were happy to see that our efforts were helpful in generating new business activity in polymers, thereby also making a societal and economic contribution. This strengthens us in our conviction that we are doing the right thing. In 2014 DPI Value Centre was actively involved in 137 projects, ranging from feasibility studies to consortiums, and provided support to 42 start-ups.

BAN•SB – Bringing together start-ups and investors

Business Angels Network • Smart & Biobased
DPI Value Centre launched the Business Angels Network • Smart & Biobased (BAN•SB) in 2014. The network fills a need among chemicals start-ups looking for funding, and it offers investors an opportunity to put their money into interesting business cases. Gert Poppe, New Business project leader at DPI Value Centre: “From the very outset, we decided to focus on chemicals (including biobased chemicals) and smart materials, because we believe this offers great added value, both for the young entrepreneurs and for the business angels. The past year has shown us that when you bring together start-ups and investors operating in the same domain, they soon engage in mutually valuable discussions on essential matters. For start-ups in this field, the BAN•SB scheme is a very attractive new way to tap into ‘smart capital’. In the coming year we plan to expand the network with many new business angels, so we will be actively looking for investors.”

“We have seen that it pays to work together on innovation. The results we achieved in 2014 were the fruits of effective collaboration within the polymer sector, between enthusiastic people from government, industry, knowledge institutes and network organisations – and, of course, the entrepreneurs themselves. It’s the entrepreneurs who provide the main thrust. It all starts with the passionate entrepreneur. We at DPI Value Centre are proud that we are able to help them achieve their ambitions and that they appreciate our help. For them, our value lies in the support we offer through our professional team of technology and business experts, the extensive interregional and international network we have in the sector and our customer-oriented hands-on approach. Everything we do is tailored to meet the innovation needs of the entrepreneur. We passionately believe collaboration is the key to innovation and business success,” says Arie Brouwer, Managing Director of DPI Value Centre.

Joint Development and Value Chain projects on the rise
Collaboration between companies on innovation continues to grow. In 2014, as in previous years, DPI Value Centre supported many companies in setting up joint development projects. Each of these projects involved collaboration between two or more SMEs. In many cases, several large companies and SMEs within a value chain joined forces.

SUPREME DUTCH
Airless tyres: no pumping, no flats

DPI Value Centre once again played a valuable role in the formation of consortia and in starting up collaborative projects in the chain, such as R&D projects under the Dutch government's MIT scheme, which seeks to stimulate innovation in the Top Sectors in the Netherlands.

An important new trend is the stimulation of innovation in the Netherlands via regional incentives schemes. In 2014, DPI Value Centre increased its collaboration with the four regions (North, East, South and West). The activities included setting up innovation projects addressing topics such as biobased, lightweight, packaging and the circular economy in the framework of the EU's new ERDF *(Dutch: EFRO)* 2014-2020 programme.

Supporting and inspiring innovation
In keeping with its tradition of organising events to support and inspire innovation and to share knowledge, DPI Value Centre organised a number of events in 2014. A variety of workshops, lectures, presentations, webinars and other special events were held, each targeting a specific audience. Topics included thermoplastic composites in the automotive industry, trends in polymers, the circular economy, design challenges with biobased plastics, the added value of transnational cooperation and setting up a business in the polymer sector.

Start-up: Supreme Dutch
DPI Value Centre supported two young entrepreneurs who developed indestructible tyres, branded as *Supreme Dutch*. These innovative new tyres are of the *airless* type, which means no pumping and no flats. Made from a combination of materials with a micro-closed cell structure, the tyres offer a comfortable ride, are thrice as durable as conventional tyres, can be mounted on existing as well as new rims and are recyclable.

Joint development project
DPI Value Centre helped set up a joint project for the development of polyester (PET) carpet yarn with properties very similar to those of polyamide (PA) carpet yarn. The collaboration involves two large companies, two SMEs and one knowledge institute. The aim is twofold: to develop PET carpet yarn that is suitable for use in (a part of) the high-end carpeting market and to develop fully recyclable PET carpeting and carpet tiles.

European project: **SEAFRONT**

The third European project coordinated by DPI within the Seventh Framework Programme of the European Commission started in January 2014. The goal of the SEAFRONT (Synergistic Fouling Control Technologies) project is to develop environmentally friendly coatings that prevent the undesirable accumulation of marine organisms on boats, ships, tidal power plants, fisheries and other aquatic installations. The coatings will be designed to improve operational efficiency, substantially reduce CO_2 emissions and have no negative impact on the marine ecosystem. DPI and AkzoNobel are the main contractors of the EU project.

New coatings

The fouling control coatings to be developed within the project will not leach chemical or other harmful substances that are non-biodegradable in the marine environment. In addition, the coatings will reduce the hydrodynamic resistance of ships and boats, decreasing fuel consumption and thus substantially reducing CO_2 emissions. Finally, the new coatings will lead to considerable savings in operational costs by improving the efficiency of tidal power installations and reducing the frequency of maintenance and cleaning in off-shore infrastructure and aquaculture applications.

Project team

The SEAFRONT project will be implemented within the Seventh Framework Programme (FP7) under the Ocean of Tomorrow call. Five multinationals, seven SMEs and seven research institutes spread across eight EU Member States will work together to achieve the goals within the four-year timeframe. DPI is the project coordinator and International Paint Ltd., a business unit of AkzoNobel and a world leader in the field of fouling control coatings, will bring any new coatings based on technology developed within the project to the market. In focusing on the delivery of sustainable products and solutions, the goals of this project perfectly match the strategic ambitions of AkzoNobel. The project budget amounts to 11.2 million Euros including 8 million Euros from the European Commission.

Scope

In addition to the development of environmentally friendly coatings, SEAFRONT aims to significantly enhance the fundamental understanding of fouling organisms and the mechanisms of settlement and adhesion. Particular attention will be paid to a better understanding of marine biofilm or so-called marine slime. This part of the research will be led by Professor Tony Clare of Newcastle University (UK), an internationally renowned marine biologist. The insights gained in these studies will enable SEAFRONT to develop concepts and technologies for enhanced performance, the ultimate goal being a completely non-fouling surface.

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

European project: **COMPNANOCOMP**

The European COMPNANOCOMP project started in October 2011 and was completed in October 2014. The aim of the project was to develop multiscale simulation methodology and software for predicting the morphology (spatial distribution and state of aggregation of nanoparticles), thermal (glass temperature), mechanical (viscoelastic storage and loss moduli, plasticity, fracture toughness and compression strength), electrical and optical properties of soft and hard polymer matrix nanocomposites from the atomic-level characteristics of their constituent nanoparticles and macromolecules and from the processing conditions used in their preparation.

The novel modelling methodology is meant to significantly improve the reliable design and processability of nanocomposites contributing to the EU Grand Challenges for reduction of CO_2 emission, energy savings by light-weight high-strength nanocomposites, mobility and improved living environment.

The COMPNANOCOMP initiative consisted of two collaborative projects executed by an EU consortium (8 partners) under the Seventh Framework Programme and a Russian consortium (4 partners) under the auspices of the Federal Russian government. DPI was the coordinator of this project, with Denka Hristova-Bogaerds as the Project Leader.

COMPNANOCOMP was evaluated by the European Commission as a "successful and well executed project, an excellent example of good cooperation and management". The results generated within the cooperative project were presented – and are still being presented – at well-known conferences and published in highly ranked journals.

Some recent publications from the project:

D.N. Theodorou, G.G. Vogiatzis, G. Kritikos, *"Self-Consistent-Field Study of Adsorption and Desorption Kinetics of Polyethylene Melts on Graphite and Comparison with Atomistic Simulations"*, Macromolecules, 2014, 47 (19), 6964-6981

D.V. Guseva, P.V. Komarov and A. V. Lyulin, *"Self-Consistent-Field Study of Adsorption and Desorption Kinetics of Polyethylene Melts on Graphite and Comparison with Atomistic Simulations , Macromolecules, in press*

SEVENTH FRAMEWORK PROGRAMME

European project: **SHINE**

The SHINE project is a Seventh Framework Programme which aims for the development of self-healing elastomers for dynamic seals and vibration and noise abatement systems. It will consider the concept on the basis of covalent and non-covalent bonding, which can provide a repeatable healing response as a result of reversible reactivity. SHINE will investigate both the healing mechanisms of pure elastomers and composites made of elastomers. The methods for the design of these types of elastomer, tailor-made fillers and self-healing composites are given in a systematic manner. The SHINE project is intended to develop elastomers with mechanical properties comparable to conventional ones (with 60% recovery of the initial properties after healing), repeatable self-healing (preventive versus curative healing), operable at temperatures that are relevant for the typical applications and without human intervention. If successful, the results of the SHINE project will help to reduce the maintenance costs of infrastructures and machine parts.

The consortium consists of two universities, four research centres, five large companies and one SME. All the partners will combine their expertise and competences to develop innovative self-healing elastomers.

The project started on 1 February 2013 with a total budged of 6.4 M€, with a 4 M€ contribution from the EU. It will end on 31 July 2016.

The first dissemination has taken place, in the form of publications and posters on various conferences, related to the development of new polyurethane materials with very efficient self-healing properties.

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

Cross Technology Area Workshop 2014
New Horizons in Polymer Characterisation

Once a year DPI organises a thematic cross-TA workshop. The purpose of such a meeting is to reflect on relevant aspects of polymer science, and to try to identify developments that deserve attention from the polymer community. In this way DPI seeks to strengthen the chain-of-knowledge approach, connecting industry and academia in terms of ideas and expertise.

Last year's meeting, held in Eindhoven (Netherlands) on 23 January 2014, focused on new horizons in polymer characterisation. Different characterisation techniques, which address structural as well as molecular characterisation, were discussed. Specialists from both industry and academia were invited to speak about new developments in polymer characterisation. The morning session was devoted to the technology areas Polyolefins, Performance Polymers, Functional Polymer Systems, Coatings Technologies and Bio-inspired Polymers and centred around the current limitations and challenges in the characterisation of polymeric systems in these areas. In the afternoon, experts in different characterisation techniques presented the state of the art in these techniques. At the end of each session, questions from both the presenters and the audience were discussed. No less than 23 presenters and a large number of posters gave the 125 participants more insight into this interesting field of research. Speakers from industry represented AkzoNobel, DSM, FEI, FrieslandCampina, LyondellBasell, SABIC and Teijin Aramid; the academic speakers came from Delft University of Technology, Eindhoven University of Technology, European Synchrotron Radiation Facility, Leibniz Institute of Polymer Research Dresden, Radboud University Nijmegen, Utrecht University and Wageningen University & Research Centre. Polymer characterisation involves assessing which polymer is present in a sample, what its morphology is and how this relates to its physical properties. Knowing the molecular mass and molecular structure, morphology, thermal and mechanical properties and the relations between these properties is not only crucial to determining the most appropriate polymer for a specific application, but can also be instrumental in designing new polymers with better qualities.

There are many different methods of chemical and physical characterisation, each with their own specific advantages and disadvantages. In the workshop, many of these techniques in their different forms were discussed, including electron microscopy (TEM/SEM), scattering techniques, rheometry, combinatorial techniques (TGA, MS, IR) and NMR. The challenges in polymer characterisation were approached from two angles: (a) taking a given polymeric material as the starting point and determining which of the available methods should be used; and (b) taking the method as a starting point and determining which of them can be used for which polymers.

The overall conclusion of the day was that no single method on its own is sufficient to determine all the parameters of polymers. In practically all cases, what is needed is a combination – or hyphenation – of techniques. There are still a lot of possibilities to explore and find just the right method to address the specific challenge that presents itself.

DPI Annual Meeting 2014
The Road to the Future

The DPI Annual Meeting 2014 was held on 11-12 November and the venue was once again the Papendal Hotel conference centre in Arnhem (Netherlands). The programme included the Annual Meeting, the Technology Area review meetings, the half-yearly meeting of the Council of Participants and DPI Value Centre's annual Polymer Innovation Day.

Annual Meeting
The Annual Meeting was attended by some 230 people from both industry and academia. The plenary session of the meeting, chaired by Prof. Sybrand van der Zwaag, Scientific Director of DPI, featured a presentation by DPI Managing Director Dr. Jacques Joosten, who gave an update on developments at DPI; the DPI University Lecture and the DPI Industry Lecture by two leading guest speakers; and the presentation of the DPI Golden Thesis Award and the DPI Poster Awards. In a parallel programme, the DPI Value Centre held its annual Polymer Innovation Day.

GOLDEN THESIS AWARD 2014
Winner of the award Mark van Eldijk

DPI Today and Tomorrow
In his presentation, "DPI Today and Tomorrow", Dr. Jacques Joosten gave an overview of activities completed or taking place in 2014, including an update on EU programmes, activities in the Netherlands and regional activities. The main topic of his presentation was the future of DPI. Dr. Joosten explained that a proposal for DPI 2.0, involving changes to DPI's funding structure and portfolio, had become necessary following changes in the Dutch government's funding policy, as a result of which direct government funding of DPI had been stopped. The DPI 2.0 initiative would secure the continuity of the DPI pre-competitive international research programmes in polymer science and technology on the basis of commitment and funding by industrial partners with a focused portfolio. Dr. Joosten added that upward potential would be generated from additional funds from EU, NWO, STW, FOM, Chemelot and Dutch National Funding in order to create additional number of research positions. The proposal, which had been discussed in the half-yearly meeting of the DPI Council of Participants held earlier that day, was to be formally submitted to DPI's industrial partners before the end of the year. A final decision by the partners on their participation in DPI 2.0 is expected by the end of Q1 2015.

Guest lectures
The DPI University Lecture was given by Professor Vincenzo Busico of the Federico II University of Naples (Italy), whose topic was 'Polyolefin catalysis: there is life between supra and nano'. The DPI Industry Lecture was given by Frans Janssen, Subject Matter Expert Polymers and Composites at the Shell Technology Centre in Amsterdam, who spoke on the subject of "Flexible Composite Pipes for Oil & Gas Service: Improving Suitability Assessments Using the Solubility".

DPI Golden Thesis Award
The Annual Meeting also featured the presentation of the DPI Golden Thesis Award. The 2014 award was granted to Mark van Eldijk for his thesis entitled "Elastin-like Polypeptides in Protein Nanotechnology". Mark did his PhD

DPI HIGHLIGHT

DPI Golden Thesis Award
The DPI Golden Thesis Award 2014 was granted to Mark van Eldijk for his thesis entitled "Elastin-like Polypeptides in Protein Nanotechnology". Mark did his PhD work at Radboud University in Nijmegen (Netherlands) under the supervision of Prof. Jan van Hest. The other two candidates were: Gert-Jan Wetzelaer (University of Groningen), with a thesis on "Change Transport and Recombination in Organic-Semiconductor Diodes"; and Diego Wever (University of Groningen), with a thesis on "Synthesis and Evaluation of Novel Linear and Branched Polyacrylamides for Enhanced Oil Recovery". The award was presented during the plenary session of the DPI Annual Meeting 2014 in Arnhem on 11 November.

THESIS AWARD NOMINEES 2014
Diego Wever, Mark van Eldijk and Gert-Jan Wetzelaer

DPI POSTER AWARD 2014
Winners of the poster prizes Hitesh Khandelwal (third prize), Selen Solak (first prize) and Dirk-Jan Mulder (second prize)

work at Radboud University in Nijmegen (Netherlands) under the supervision of Prof. Jan van Hest. The Golden Thesis Award is granted annually for the best PhD thesis resulting from DPI-funded research. Mark van Eldijk was unanimously selected as the winner from among the three finalists competing for this year's award. The other two candidates were: Gert-Jan Wetzelaer (University of Groningen), with a thesis on "Change Transport and Recombination in Organic-Semiconductor Diodes"; and Diego Wever (University of Groningen), with a thesis on "Synthesis and Evaluation of Novel Linear and Branched Polyacrylamides for Enhanced Oil Recovery".

DPI Poster Award

In keeping with tradition, the Annual Meeting gave scientists working on DPI projects an opportunity to present their research by means of posters. The posters were judged by the following criteria: scientific excellence, industrial relevance, presentation of the introduction and conclusions and amount of information). At the end of the plenary session, Prof. Sybrand van der Zwaag announced the names of the winners of the Poster Award. The First Prize went to Selen Solak of the Max Planck Institute for Polymer Research, for the winning poster "Bulk heterojunction solar cells with trap free electron transport". The second and third prizes were granted to scientists working at the Chemical Technology Department of Eindhoven University of Technology: Dirk-Jan Mulder (second prize, poster title: The design and preparation of a nanoporous liquid crystal polymer with an adjustable pore interior) and Hitesh Khandelwal (third prize, poster title: Responsive Infrared Reflector based on Cholesteric Liquid Crystals).

In his closing remarks, Prof. Sybrand van der Zwaag thanked the people who had left DPI during the past year: Prof. Claus Eisenbach, Scientific Chairman Coatings Technology; Prof. Uli Schubert: Scientific Chairman High-Throughput Experimentation; Dr. Mercedes Crego Calama: Programme Area Coordinator.

Appreciation for DPI's role

As in previous years, a dinner was held at the close of the first day of the Annual Meeting. Attended by some 200 people, the dinner provided participants an ideal opportunity to get to know one another better in a relaxed, amiable setting. We asked a number of participants how they had experienced the Annual Meeting and what they thought of their participation in DPI.

Most comments emphasized international collaboration, cross-sector networking and industry-academia chain of knowledge benefits as the strong points of the DPI platform. It was also pointed out that by working together through the DPI platform companies can do more than they would be able to do individually or through bilateral collaboration.

Polymer Innovation Day 2014

DPI Value Centre's Polymer Innovation Day 2014 was held in combination with the DPI Annual Meeting at the same venue. Attracting around 350 participants (including the DPI attendees), the event centred on the theme "Collaboration in the Value Chain: Best Practices". As usual, the meeting targeted start-ups, SMEs and multinationals and aimed to promote collaboration among these players on innovation in the field of polymers.

The participants were offered an extensive, full-day programme of lectures and presentations on a variety of topics. And as always, there was plenty of opportunity for networking, for example at the business market. The business market formed an ideal setting for the lunch break and flash presentations by eleven innovative new businesses.

The Polymer Innovation Day once again proved to be an excellent meeting point and exchange platform for ideas and knowledge for entrepreneurs, R&D scientists and managers, as well as policymakers at both national and regional level.

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 life cycle and ease of recycling. The research programme of the Polyolefins Technology 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.

Budget and organisation
Expenditure in 2014 totalled € 1.68 million. The total number of FTEs allocated at year-end 2014 was 24.2 (34 researchers). Prof.dr. Vincenzo Busico acted as Scientific Chairman and Dr. Jan Stamhuis as Programme Area Coordinator of the Polyolefins programme.

Publications and inventions
This technology area generated a total of fifteen reviewed papers and four theses.

FACTS AND FIGURES

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

Partners from the research world
- Consorzio Interuniversitario Nazionale per la Scienza e Technologia die Materiali (INSTM)
- Eindhoven University of Technology
- ESPCE-Lyon
- Fraunhofer Institute for Structural Durability and System Reliability LBF
- Japan Advanced Institute of Science and Technology
- Johann Kepler University Linz
- Karlsruhe Institute of Technology
- Loughborough University
- Martin-Luther University of Halle-Wittenberg
- National Council for Scientific and Technological Development (CNPq)
- Polymer Technology Group Eindhoven
- Queens University
- Radboud University Nijmegen
- UFRGS Universidade Federal do Rio Grande do Sul
- Universidade Federal do Rio de Janeiro
- University of Amsterdam
- University of Antwerp
- University of Erlangen
- University of Manitoba
- University of Naples Federico II
- University of Ottawa
- University of Perugia
- University of Turin
- University of Udine

For details, see page 34

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

The Performance Polymers (PP) technology 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 technology 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 Technology 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.

SUB-PROGRAMMES

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.

FACTS AND FIGURES

Partners from industry
- AkzoNobel
- BASF
- Bayer
- Bekaert
- DSM
- Industrial Technology Research Institute Taiwan
- Petrobras
- SABIC
- SKF
- Teijin Aramid

Partners from the research world
- CNRS Strasbourg
- Delft University of Technology
- DWI an der RWTH Aachen
- Eindhoven University of Technology
- Fraunhofer Institute for Structural Durability and System Reliability LBF
- National Technical University of Athens
- University of Groningen
- University of Twente

Budget and organisation
Expenditure in 2014 totalled € 0.59 million. The total number of FTEs allocated at year-end 2014 was 13.1 (19 researchers). Prof.dr. Costantino Creton acted as Scientific Chairman and Ronald Korstanje acted as Programme Area Coordinator of the Performance Polymers programme.

Publications and inventions
This Technology Area generated a total of six reviewed papers.

Detailed information on page 35

FUNCTIONAL POLYMER SYSTEMS

The Functional Polymer Systems (FPS) Technology 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, switichable surfaces and anti-reflective coatings.

FACTS AND FIGURES

Partners from industry
- BASF
- DSM
- ECN
- Industrial Technology Research Institute Taiwan
- Philips
- Rolic Technologies
- SABIC
- Solvay
- TNO

Partners from the research world
- Delft University of Technology
- ECN
- Eindhoven University of Technology
- Imperial College London
- Max Planck Institute für Polymerforschung
- University of Groningen

Budget and organisation
Expenditure in 2014 totalled € 0.49 million. The total number of FTEs allocated at year-end 2014 was 12.8 (15 researchers). Prof.dr. Frans de Schryver acted as Scientific Chairman and Dr. John van Haare as Programme Area Coordinator.

Publications and inventions
The research programme in this Technology Area generated a total of seventeen reviewed papers and four theses. Two inventions were reported.

For details, see page 35

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
- Changchun Institute of Applied Chemistry
- Eindhoven University of Technology
- University of Haute-Alsace
- Wageningen University

Budget and organisation
Expenditure in 2014 totalled € 0.53 million. The total number of FTEs allocated at year-end 2014 was 15.1 (16 researchers). Prof. Claus Eisenbach acted as Scientific Chairman and Dr. Mercedes Crego Calama as Programme Area Coordinator of the Coatings Technology Area for the first half of 2014. As of mid 2014, Prof.dr. Sybrand van der Zwaag acted as Scientific Chairman and Dr. Monique Bruining as Programme Area Coordinator of this Technology Area.

Publications and inventions
The research programme in this Technology Area generated a total of five reviewed papers and two theses.

For details, see page 36

HIGH-THROUGHPUT EXPERIMENTATION

High-Throughput Experimentation (HTE) and combinatorial materials research open the way to the rapid construction of libraries of polymers, blends and materials through systematic variation of composition. Detailed characterisation of such libraries will help to develop an in-depth understanding of structure property relationships.

OBJECTIVES

In the long term, it is envisioned that 'materials informatics' will facilitate the design and preparation of customised materials and devices with predetermined properties based on previously established structure-property relationships. DPI's unique combination of leading industrial and academic partners provides an excellent basis for successful output. It also guarantees early pre-competitive evaluation of the new (platform) technologies and their rapid transfer into the commercial R&D programmes of the industrial partners.

SUB-PROGRAMMES

Synthesis, catalysis & formulation
Besides fundamental research on the use of microwave irradiation, studies are conducted into the feasibility of scaling up microwave assisted polymerisation procedures. The synthesis efforts have been intensified in the direction of water-soluble polymers. In addition to fast synthesis and formulation platforms, other subjects being investigated include the incorporation of high-throughput screening techniques for molar mass, polymerisation kinetics and thermal and surface properties.

Thin-film library preparation & screening
This sub-programme focuses on gaining a detailed understanding of thin-film preparation technologies, the application of these technologies and the screening of thin-film material properties with automated atomic force microscopy and nano indentation technologies. Areas of application include the processing of light emitting materials, surface patterning, cell screening and the preparation of conductive tracks on polymeric substrates.

Combinatorial compounding
The objective is to develop a process to accelerate the preparation, characterisation and optimisation of plastic formulations. The combinatorial extrusion line used for this purpose has been equipped with in-line and on-line screening techniques (e.g. IR, UV/Vis, rheometry, ultrasonic spectroscopy) as well as systems for data acquisition, analysis and visualisation.

Materials informatics & modelling
This programme concerns data handling, database construction and the build-up of integrated knowledge capture systems for combinatorial materials and polymer research as well as experimental design, hard and soft modelling tools and tools for deriving quantitative structure-property relationships. A model is being developed for the screening of MALDI matrices to facilitate faster screening of molar mass.

Characterisation techniques
This sub-cluster is engaged in the development of detailed characterisation methods. An important aspect of the research is the combination of different measurement techniques to characterise multiphase or multi-component materials at macro, micro and nano scale. Another focal point is the analysis of branched polymers by means of two-dimensional liquid chromatography. Tools and models for nano scale characterisation of interfaces using AFM technology are also being developed.

FACTS AND FIGURES

Partners from industry
- Chemspeed Technologies
- Evonik
- Forschungsgesellschaft Kunststoffe
- Microdrop Technologies

Partners from the research world
- Fraunhofer Institute for Structural Durability and System Reliability LBF
- Friedrich-Schiller University Jena
- Radboud University Nijmegen

Budget and organisation
Expenditure in 2014 totalled €0.20 million. The total number of FTEs allocated at year-end 2014 was 1.6 (6 researchers). Prof.dr. Ulrich Schubert acted as Scientific Chairman and Dr. Mercedes Crego Calama and Dr. Monique Bruining as Programme Area Coordinator.

Publications and inventions
This Technology Area generated a total of thirty reviewed papers and one patent application was filed.

For details, see page 37

BIO-INSPIRED POLYMERS

Within the Bio-Inspired Polymers (BIP) programme, the main driver for the development of future materials is sustainability, with nature being regarded as an important source of inspiration for finding new leads and possibilities.

OBJECTIVES

The aim of the Bio-Inspired Polymers (BIP) programme is to develop advanced polymeric materials and methodologies for new and existing applications. The development of these materials is inspired by natural polymeric structures and principles of natural systems such as self-assembly and bio-catalysis.

Bio-Inspired Polymers can be produced from renewable or fossil resources through either chemocatalysis 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.

FACTS AND FIGURES

Partners from industry
- Food & Biobased Research Wageningen UR
- FrieslandCampina
- Petrobras
- SABIC
- Teijin Aramid

Partners from the research world
- Eindhoven University of Technology
- Food and Biobased Research, Wageningen UR
- Friedrich-Schiller-University Jena
- National Council for Scientific and Technological Development (CNPq)
- Tsinghua University
- Universidade Católica de Brasilia
- Universidade Federal do Rio de Janeiro

Budget and organisation
Expenditure in 2014 totalled € 0.89 million. The total number of FTEs allocated at year-end 2014 was 16.1 (27 researchers). Prof.dr. Gerrit Eggink acted as Scientific Chairman and Dr. Peter Nossin as Programme Area Coordinator of the Bio-Inspired Polymers Technology Area.

Publications and inventions
The research programme in this Technology Area generated a total of ten reviewed papers and one thesis. Three inventions were reported.

For details, see page 38

LARGE-AREA THIN-FILM ELECTRONICS

Large-Area Thin-Film Electronics (LATFE) is the step in the value chain devoted to studying fundamental issues related to processing for large-area deposition and disruptive architectures for large-area organic electronic devices. Large-Area Thin-Film Electronics is an excellent example of a highly interdisciplinary research area, extending from chemistry and physics to engineering.

OBJECTIVES

Whereas Functional Polymer Systems (FPS) focuses on materials development and initial device performance, Large-Area Thin-Film Electronics (LATFE) is the obvious next step in the value chain. The fundamental knowledge generated should facilitate the reliable production and operation of organic electronic devices.

SUB-PROGRAMMES

Large-area material deposition using solution processing
The objective is to study fundamental issues of large-area polymer and small-molecule material deposition using roll-to-roll solution processing (gravure, flexo, screen, slot-die) to make the transition from lab scale to industrial scale for reliably processed devices. For patterning of structures inkjet printing is explored. Although lab-scale devices have superb performance, we lack the industrial processes and the fundamental knowledge about large-area material deposition from solution and patterning needed to choose the right deposition method per layer for mass production.

Disruptive device architectures
The purpose of this research is to develop disruptive device architectures for more reliable and easier production and to understand the failure mechanisms occurring in industrially produced devices. Current device architectures require very thin films (~ 100 nm) with less than 2% thickness deviation, which imposes very strict demands on the processing and production of devices. At the moment, this results in poor yields, high costs and many uncomprehended failures. There is an urgent need for new device architectures that allow more robust processing and production and improve yield without affecting device performance (efficacy, homogeneity of light output).

FACTS AND FIGURES

Partners from industry
- DSM
- Philips
- Solvay
- TNO

Partners from the research world
- Eindhoven University of Technology
- Imperial College London
- Max Planck Institute für Polymerforschung
- University of Algarve
- University of Groningen
- University of Twente
- University of Wuppertal

Budget and organisation
Expenditure in 2014 totalled € 0.34 million. The total number of FTEs allocated at year-end 2014 was 11.7 (17 researchers). Prof.dr. Frans de Schryver acted as Scientific Chairman and Dr. John van Haare as Programme Area Coordinator.

Publications and inventions
This Technology Area generated a total of seven reviewed papers and two theses. One patent application was filed.

For details, see page 39

POLYMERS FOR ENHANCED OIL RECOVERY

Polymers for Enhanced Oil Recovery represent an important application of water-soluble polymers. With the increasing complexity of oil recovery from existing and new reservoirs, this technology could contribute significantly to more efficient recovery of the world's energy resources. Originally a sub-programme in the Emerging Technologies (EMT) technology area, DPI has now created a new, separate technology area for polymers for enhanced oil recovery.

OBJECTIVES

Although the underlying mechanisms may be similar for a range of applications of water-soluble polymers, this specific application warrants the establishment of a specific programme focusing on the structure-property relationships of polymers in solutions and their behaviour in the reservoir.

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
- Delft University of Technology
- University of Groningen

Budget and organisation
Expenditure in 2014 totalled € 0.14 million. The total number of FTEs allocated at year-end 2014 was 3.3 (4 researchers). Prof.dr. Sybrand van der Zwaag acted as Scientific Chairman and Dr. Jan Stamhuis as Programme Area Coordinator of the Polymer of the Enhanced Oil Recovery programme.

Publications and inventions
This Technology Area generated a total of two reviewed papers and one reported invention.

For details, see page 39

EMERGING TECHNOLOGIES: ADVANCED COMPOSITES

The aim of the Emerging Technologies (EMT) Technology Area is to promote the exploration investigation of new ideas from industry concerning new technologies that do not fit into any of the existing technology areas. When a company approaches DPI with a proposal for a project on a new topic, DPI will find an academic partner to carry out the research.

OBJECTIVES

Projects in the Emerging Technologies Technology Area are handled like any other DPI projects. However, after two years a decision is made on whether the project will be extended for another two years, by which time at least one other industrial party, in addition to the industrial party that initiated the project, must be willing to participate. The project can then be absorbed into another technology area. As in the case of projects in the Corporate Research Technology Area, the intellectual property (IP) generated in the first two years is owned by all of DPI's partners. If a project is continued after two years, the IP is treated in the same way as in other technology areas. In 2012, Water-Soluble Polymers, Smart Packaging and Advanced Composites were selected as the focus areas for Emerging Technologies. Potential projects in these areas are currently being discussed with industry. However, other opportunities are emerging that would promote DPI's mission of studying and developing new sustainable polymer technologies in cooperation with industry and academia.

SUB-PROGRAMMES

A project to investigate High Performance Matrices for Advanced Composites is being carried out in association with Delft University of Technology and is part of a collaboration with the Dutch materials programme, M2i. In this joint programme, DPI is studying base materials, for example matrix and fibres, whilst M2i is investigating the design and properties of composites. Interface studies and processing/composite manufacturing are a joint focus area.

FACTS AND FIGURES

Partners from industry
- DPI partners
- M2i partners

Partners from the research world
- Delft University of Technology

Organisation
Prof.dr. Sybrand van der Zwaag acted as Scientific Chairman and Dr. Jan Stamhuis as Programme Area Coordinator of the Emerging Technologies programme.

Publications and inventions
This Technology Area has not generated reviewed papers or reported inventions in 2014.

For details, see page 39

CORPORATE RESEARCH

The role of the Corporate Research programme is to initiate and support enabling science and conceptual new science that is of interest to all of the partners in DPI because of its long-term potential impact.

OBJECTIVES

This programme is primarily science-driven, based on a vision of future industrial needs and opportunities. It operates at the forefront of scientific knowledge and capabilities in the field of polymer science. The programme activities are arranged in several sub-clusters.

SUB-PROGRAMMES

Enabling science

- Polymer characterisation (surfaces and interfaces (applying mainly microscopic techniques), molecular characterisation (SEC techniques on cross-linked architectures and networks, for example, and analysis of molar mass distribution)).
- Structure vs. performance: multi-scale modelling, fluid dynamics (rheology) and solid-state properties (bulk materials and surface properties).

New science

Development of new concepts in polymer chemistry and polymer physics with a view to meeting long-term requirements in terms of sustainability, durability and bio-related polymer systems.

Infrastructure

Corporate Research also strengthens the research infrastructure by investing in equipment for the benefit of the entire DPI community.

DPI fellowship programme

Under this programme, talented young researchers with a tenured or tenure-track position at a Dutch university can be appointed as a 'DPI fellow'. The aim of the programme is to secure their commitment to the Dutch polymer science community and give them the opportunity to attain scientific leadership qualities in an area matching DPI's current or future strategy.

Bio-Related Materials (BRM) programme

In association with FOM and TIFN, DPI has established an Industrial Partnership Programme on biomaterials and bio-related materials. The aim of the programme is to understand how to move from the scale of complexes and aggregates to the mesoscopic scale, taking account of both the time dependent interactions and structures in their chemical detail and the resulting dynamic and spatially varying mesoscale physical properties.

Understanding the visco-elasticity of elastomer-based nanocomposites (VEC) programme

Filled rubbers are widely used in industry. Adding silica particles to a polymer matrix increases the mechanical properties of the material but causes various non-linear effects, notably a dramatic decline in elasticity under high strain (the Payne effect). This effect is still not understood very well. During this project systematic experiments will be conducted with rubbers of varying compositions. On the macroscopic scale, we are performing rheological measurements and combining them with microscopic characterisations in order to link behaviour on a macroscopic scale with the microstructure of the sample.

FACTS AND FIGURES

Partners from industry

- All DPI partners take part in Corporate Research

Partners from Academia

- Delft University of Technology
- Eindhoven University of Technology
- ESRF, Grenoble
- Foundation for fundamental research on matter (FOM)
- Radboud University Nijmegen
- TI Food and Nutrition (TIFN)
- University of Groningen
- University of Twente
- Wageningen University

Budget and organisation

Expenditure in 2014 totalled € 0.60 million. The total number of FTEs allocated at year-end 2014 was 9.1 (11 researchers). Prof.dr. Sybrand van der Zwaag acted as Scientific Chairman and Dr. Monique Bruining as Programme Area Coordinator of the Corporate Research programme.

Publications and inventions

This research programme generated a total of nineteen reviewed papers and seven theses.

For details, see page 40

Output 2014

POLYOLEFINS

Projects

#641: High-Troughput Computational Pre-Screening of Catalysts

#674: Rheology Control by Branching Modeling

#708: Structure-property relations of olefinic block copolymers

#709: Integrated Models for PolyOlefin Reactors

#710: Linking chemically specific structure information to physical properties of polyolefins.

#711: Mass transfer & kinetics in heterophasic copolymerization of propylene

#714: Putting values to a model for Flow Induced Crystallization

#728: Structural investigations on MAO and design of alternative well-defined cocatalysts and single-component catalysts

#731: Main group metal-alkyl cocatalysts and scavengers in molecular olefin polymerization catalysis: a mechanistic investigation

#732: Strategies for stabilizing trivalent vanadium and chromium propylene polymerization catalysts

#750: Optimisation and Calibration of High-Temperature Liquid Chromatographic Separation of Polypropylene and Propylene based Copolymers

#751: Predictive Modelling of Polyolefin Reactors

#753: Impact of the geometric parameters of catalyst supports on the kinetics and morphology of polyolefins

#754: Direct insight into elusive active Ti species of high-yield Ziegler-Natte Catalysts

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

#757: Influence of entanglement on rheological response of Ultra High Molecular Weight Polyethylene from linear to nonlinear viscoelastic behaviour

#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

#795: The molecular and morphological origin of large improvement of stress-strain properties of polyethylenes

Theses

Thomas Kröner
Mass Transport and Kinetics in the Heterophasic Copolymerization of Propylene

Evert Koopman
Simple numerical techniques for mesoscale polymers

Fabian Karbach
Silica-supported Catalysts for Ethylene Oligomerization

Ivan Kryven
Topology evolution in macromolecular networks

Scientific publications

A. Alizadeh and T. F. L. McKenna
Condensed mode cooling for ethylene polymerization: The influence of the heat of sorption
Macromolecular Reaction Engineering 8(5) 419-433

C. Ehm, G. Antinucci, P. H. M. Budzelaar and V. Busico
Catalyst activation and the dimerization energy of alkylaluminium compounds
Journal of Organometallic Chemistry 772(161-171

D. Cavallo, M. J. W. Kanters, H. J. M. Caelers, G. Portale and L. E. Govaert
Kinetics of the polymorphic transition in isotactic poly(1-butene) under uniaxial extension. New insights from designed mechanical histories
Macromolecules 47(9) 3033-3040

E. A. Andablo-Reyes, E. L. de Boer, D. Romano and S. Rastogi
Stress relaxation in the nonequilibrium state of a polymer melt
Journal of Rheology 58(6) 1981-1991

E. Morra, E. Giamello and M. Chiesa
Probing the redox chemistry of titanium silicalite-1: Formation of tetrahedral ti3+ centers by reaction with triethylaluminum
Chemistry-a European Journal 20(24) 7381-7388

E. van Ruymbeke, V. Shchetnikava, Y. Matsumiya and H. Watanabe
Dynamic dilution effect in binary blends of linear polymers with well-separated molecular weights
Macromolecules 47(21) 7653-7665

G. Talarico and P. H. M. Budzelaar
Analysis of stereochemistry control in homogeneous olefin polymerization catalysis
Organometallics 33(21) 5974-5982

I. Kryven and P. D. Iedema
Transition into the gel regime for free radical crosslinking polymerisation in a batch reactor
Polymer 55(16) 3475-3489

L. Rocchigiani, V. Busico, A. Pastore, G. Talarico and A. Macchioni
Unusual hafnium-pyridylamido/ern heterobimetallic adducts (ern = znr2 or alr3)
Angewandte Chemie-International Edition 53(8) 2157-2161

M. Namkajorn, A. Alizadeh, E. Somsook and T. F. L. McKenna
Condensed-mode cooling for ethylene polymerization: The infl uence of inert condensing agent on the polymerization rate
Macromolecular Chemistry and Physics 215(9) 873-878

M. van Drongelen, D. Cavallo, L. Balzano, G. Portale, I. Vittorias, W. Bras, G. C. Alfonso and G. W. M. Peters
Structure development of low-density polyethylenes during film blowing: A real-time wide-angle x-ray diffraction study
Macromolecular Materials and Engineering 299(12) 1494-1512

N. Yaghini and P. D. Iedema
Molecular weight/branching distribution modeling of low-density-polyethylene accounting for topological scission and combination termination in continuous stirred tank reactor
Chemical Engineering Science 116(144-160

S. Maurelli, E. Morra, S. Van Doorslaer, V. Busico and M. Chiesa
Epr investigation of ticl3 dissolved in polar solvents - implications for the understanding of active ti(iii) species in heterogeneous ziegler-natta catalysts
Physical Chemistry Chemical Physics 16(36) 19625-19633

V. Agarwal, T. B. van Erp, L. Balzano, M. Gahleitner, M. Parkinson, L. E. Govaert, V. Litvinov and A. P. M. Kentgens
The chemical structure of the amorphous phase of propylene-ethylene random copolymers in relation to their stress-strain properties
Polymer 55(3) 896-905

Z. Ma, L. Balzano, G. Portale and G. W. M. Peters
Flow induced crystallization in isotactic polypropylene during and after flow
Polymer 55(23) 6140-6151

PERFORMANCE POLYMERS

Projects

#671: Optimized plastication in extruders for better economy and product properties

#742: Membranes with Adjustable Interior in their Nanopores

#743: Curable Semi-aromatic or aliphatic Semi-crystalline Thermoplastics

#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

#746: Particles at Fluid-Fluid Interfaces

#747: Polyamide/silica nanocomposites: a systematical investigation

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

#755: MONodisperse OLIGOamide building blocks for thermoplastic elastomers (TPEs) revisited

#756: Do contacts in electrically conductive particulate composites really exist?

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

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

#784: Reactive Polymer Colloids for Design of Interfaces in Fiber/matrix Composite Materials

#786: Processing for Enhanced Product Performance

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

Scientific publications

C. Hintze, R. Stocek, T. Horst, R. Jurk, S. Wiessner and G. Heinrich
Dynamic behavior of short aramid fiber-filled elastomer composites
Polymer Engineering and Science 54(12) 2958-2964

E. Miloskovska, E. Nies, D. Hristova-Bogaerds, M. van Duin and G. de With
Influence of reaction parameters on the structure of in situ rubber/silica compounds synthesized via sol-gel reaction
Journal of Polymer Science Part B-Polymer Physics 52(14) 967-978

E. Miloskovska, M. R. Hansen, C. Friedrich, D. Hristova-Bogaerds, M. van Duin and G. de With
In situ silica nanoparticle formation in a rubber matrix monitored via real-time saxs and solid-state nmr spectroscopy
Macromolecules 47(15) 5174-5185

H. P. C. van Kuringen, G. M. Eikelboom, I. K. Shishmanova, D. J. Broer and A. P. H. J. Schenning
Responsive nanoporous smectic liquid crystal polymer networks as efficient and selective adsorbents
Advanced Functional Materials 24(32) 5045-5051

N. Grossiord, B. A. J. Noordover, H. E. Miltner, T. Hoeks, V. Alexandre, J. Loos, B. van Mele, J. Meuldijk and C. E. Koning
A latex-based route to disperse carbon nanotubes in poly(2,6-dimethyl-1,4-phenylene ether)/polystyrene blends
Macromolecular Materials and Engineering 299(2) 228-236

R. J. A. Steenbakkers, C. Tzoumanekas, Y. Li, W. K. Liu, M. Kroger and J. D. Schieber
Primitive-path statistics of entangled polymers: Mapping multi-chain simulations onto single-chain mean-field models
New Journal of Physics 16 015027

FUNCTIONAL POLYMER SYSTEMS

Projects

#681: Hybrid solar cells based on Si nanoparticles and conjugated polymers

#682: Creation of functional nanostructures in solution/dispersion

#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

#765: New supramolecular architectures exhibiting piezoelectric properties

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

#767: Towards solution processable near-IR and IR-reflective coatings and mirrors with high transparency in the UV-visible regime

#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

#790: Responsive micro-structured gels

Theses

Dharmapura Murthy
Charge Generation and Recombination in Nanostructured Photovoltaic Materials

Maarten J.M. Wirix
Creation, Visualization and Quantification of Nanostructures for Organic Solar Cells

Olivier Picot
Functional Films and Fibres based on Liquid Crystal Coatings

Gert-Jan Wetzelaer
Charge Transport and Recombination in Organic-Semiconductor Diodes

Scientific publications

C. P. Umesh, A. T. M. Marcelis and H. Zuilhof
Fluorine-containing triphenylenes. Liquid crystalline properties and surface ordering
Liquid Crystals 41(12) 1911-1922

C. P. Umesh, S. Gangarapu, A. T. M. Marcelis and H. Zuilhof
Discotic liquid crystalline tris(hexahexyloxytriphenylene)triazines with separate columns of triphenylene and triazine cores
Liquid Crystals 41(12) 1862-1872

D. Q. Liu and D. J. Broer
Self-assembled dynamic 3d fingerprints in liquid-crystal coatings towards controllable friction and adhesion
Angewandte Chemie-International Edition 53(18) 4542-4546

D. Q. Liu and D. J. Broer
Light controlled friction at a liquid crystal polymer coating with switchable patterning
Soft Matter 10(40) 7952-7958

G. A. H. Wetzelaer and P. W. M. Blom
Ohmic current in organic metal-insulator-metal diodes revisited
Physical Review B 89(24)

G. J. A. H. Wetzelaer and P. W. M. Blom
Diffusion-driven currents in organic-semiconductor diodes
Npg Asia Materials 6(e110

H. Khandelwal, F. Roberz, R. C. G. M. Loonen, J. L. M. Hensen, C. W. M. Bastiaansen, D. J. Broer, M. G. Debije and A. P. H. J. Schenning
Infrared reflector based on liquid crystal polymers and its impact on thermal comfort conditions in buildings
Liquid Crystals Xviii 91820S

H. Khandelwal, R. C. G. M. Loonen, J. L. M. Hensen, A. P. H. J. Schenning and M. G. Debije
Application of broadband infrared reflector based on cholesteric liquid crystal polymer bilayer film to windows and its impact on reducing the energy consumption in buildings
Journal of Materials Chemistry A 2(35) 14622-14627

H. N. An, J. Groenewold, S. J. Picken and E. Mendes
Conformational changes of a single magnetic particle string within gels
Soft Matter 10(7) 997-1005

I. Stengel, C. A. Strassert, L. De Cola and P. Bauerle
Tracking intramolecular interactions in flexibly linked binuclear platinum(ii) complexes
Organometallics 33(6) 1345-1355

M. J. M. Wirix, P. H. H. Bomans, H. Friedrich, N. A. J. M. Sommerdijk and G. de With
Three-dimensional structure of p3ht assemblies in organic solvents revealed by cryo-tem
Nano Letters 14(4) 2033-2038

M. Kuik, G. J. A. H. Wetzelaer, H. T. Nicolai, N. I. Craciun, D. M. De Leeuw and P. W. M. Blom
25th anniversary article: Charge transport and recombination in polymer light-emitting diodes
Advanced Materials 26(4) 512-531

N. Grossiord, P. de Bruyn, D. J. D. Moet, R. Andriessen and P. W. M. Blom
Characterization of precursor-based zno transport layers in inverted polymer solar cells
Journal of Materials Chemistry C 2(41) 8761-8767

O. V. Mikhnenko, M. Kuik, J. Lin, N. van der Kaap, T. Q. Nguyen and P. W. M. Blom
Trap- limited exciton diffusion in organic semiconductors
Advanced Materials 26(12) 1912-1917

P. I. Gordiichuk, G. J. A. H. Wetzelaer, D. Rimmerman, A. Gruszka, J. W. de Vries, M. Saller, D. A. Gautier, S. Catarci, D. Pesce, S. Richter, P. W. M. Blom and A. Herrmann
Solid-state biophotovoltaic cells containing photosystem i
Advanced Materials 26(28) 4863

S. A. Muntean, M. A. J. Michels and A. V. Lyulin
Myoglobin interactions with polystyrene surfaces of different hydrophobicity
Macromolecular Theory and Simulations 23(2) 63-75

V. Seshan, D. H. K. Murthy, A. Castellanos-Gomez, S. Sachdeva, H. A. Ahmad, S. D. Janssens, W. Janssen, K. Haenen, H. S. J. van der Zant, E. J. R. Sudholter, T. J. Savenije and L. C. P. M. de Smet
Contactless photoconductance study on undoped and doped nanocrystalline diamond films
Acs Applied Materials & Interfaces 6(14) 11368-11375

Reported inventions

#764: H. Khandelwal, M. Debije, C.W.M. Bastiaansen, A.P.H.J. Schenning and D.J. Broer
Responsive wideband IR reflectors based on composites of polymeric cholesteric liquid crystals with low-molar mass liquid crystals

#792: J. Sprakel, Huanhuan Feng, F. Leermakers and M. Boehmer
Stabilization of nanoparticles in concentrated polymer solution and melts

COATINGS TECHNOLOGY

Projects

#713: Physical aspects and modeling of weathering of polyester-urethane coatings

#758: Self-replenishing hydrophobic coatings with intrinsic hardness cured by LED's

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

#760: Microstructure control in polyurethane (PU) ionomers

#779: Preparation and Characterization of Model Waterborne Clearcoats

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

#781: Film Formation in Complex Colloidal Coatings

Theses

Oliver Reichel
Synthesis and Properties of Photochromic Layered Silicates and Model Experiments for Colouring and Reinforcement in Organic Coatings by Layered Silicates

Yingyuan Li
Bio-based Poly(urethane urea) Dispersions

Scientific publications

H. Makki, K. N. S. Adema, E. A. J. F. Peters, J. Laven, L. G. J. van der Ven, R. A. T. M. van Benthem and G. de With
A simulation approach to study photo-degradation processes of polymeric coatings
Polymer Degradation and Stability 105(68-79

K. N. S. Adema, H. Makki, E. A. J. F. Peters, J. Laven, L. G. J. van der Ven, R. A. T. M. van Benthem and G. de With
Depth-resolved infrared microscopy and uv-vis spectroscopy analysis of an artificially degraded polyester-urethane clearcoat
Polymer Degradation and Stability 110(422-434

W. K. Wijting, A. van Reenen, J. Laven, R. A. T. M. van Benthem and G. de With
Competitive adsorption of (phosphorylated) ethoxylated styrene oxide polymer and polyacrylic acid on silica coated iron oxide pigment
Colloids and Surfaces a-Physicochemical and Engineering Aspects 449(19-30

Y. Y. Li, B. A. J. Noordover, R. A. T. M. van Benthem and C. E. Koning
Reactivity and regio-selectivity of renewable building blocks for the synthesis of water-dispersible polyurethane prepolymers
Acs Sustainable Chemistry & Engineering 2(4) 788-797

Y. Y. Li, B. A. J. Noordover, R. A. T. M. van Benthem and C. E. Koning
Chain extension of dimer fatty acid- and sugar-based polyurethanes in aqueous dispersions
European Polymer Journal 52(12-22

HIGH-THROUGHPUT EXPERIMENTATION

Projects

#690: Libraries of poly (ethylene oxide)via parallel living anionic polymerization

#729: High-throughput screening technologies applied to compatibility maps

#730: Cellular pharmacokinetics of polymers for drug delivery - A high-throughput approach to polymers with optimum targeting characteristics

Scientific publications

A. C. Crecelius, J. Vitz and U. S. Schubert
Mass spectrometric imaging of synthetic polymers
Analytica Chimica Acta 808(10-17

A. Chojnacka, H. G. Janssen and P. Schoenmakers
Detailed study of polystyrene solubility using pyrolysis-gas chromatography-mass spectrometry and combination with size-exclusion chromatography
Analytical and Bioanalytical Chemistry 406(2) 459-465

A. M. Breul, I. R. de Moraes, R. Menzel, M. Pfeffer, A. Winter, M. D. Hager, S. Rau, B. Dietzek, R. Beckert and U. S. Schubert
Light-harvesting of polymerizable 4-hydroxy-1,3-thiazole monomers by energy transfer toward photoactive os(ii) metal complexes in linear polymers
Polymer Chemistry 5(8) 2715-2724

A. M. Breul, J. Kubel, B. Haupler, C. Friebe, M. D. Hager, A. Winter, B. Dietzek and U. S. Schubert
Synthesis and characterization of poly(phenylacetylene)s with ru(ii) bis-terpyridine complexes in the side-chain
Macromolecular Rapid Communications 35(7) 747-751

B. Haupler, A. Ignaszak, T. Janoschka, T. Jahnert, M. D. Hager and U. S. Schubert
Poly(methacrylates) with pendant benzoquinone units - monomer synthesis, polymerization, and electrochemical behavior: Potential new polymer systems for organic batteries
Macromolecular Chemistry and Physics 215(12) 1250-1256

B. Haupler, R. Burges, C. Friebe, T. Janoschka, D. Schmidt, A. Wild and U. S. Schubert
Poly(exttf): A novel redox-active polymer as active material for li-organic batteries
Macromolecular Rapid Communications 35(15) 1367-1371

B. Sandmann, B. Happ, J. Vitz, R. M. Paulus, M. D. Hager, P. Burtscher, N. Moszner and U. S. Schubert
Metal-free cycloaddition of internal alkynes and multifunctional azides under solvent-free conditions
Macromolecular Chemistry and Physics 215(17) 1603-1608

B. Sandmann, B. Happ, M. D. Hager, J. Vitz, E. Rettler, P. Burtscher, N. Moszner and U. S. Schubert
Efficient cu(i) acetate-catalyzed cycloaddition of multifunctional alkynes and azides: From solution to bulk polymerization
Journal of Polymer Science Part a-Polymer Chemistry 52(2) 239-247

D. Holscher, S. Dhakshinamoorthy, T. Alexandrov, M. Becker, T. Bretschneider, A. Buerkert, A. C. Crecelius, D. De Waele, A. Elsen, D. G. Heckel, H. Heklau, C. Hertweck, M. Kai, K. Knop, C. Krafft, R. K. Maddula, C. Matthaus, J. Popp, B. Schneider, U. S. Schubert, R. A. Sikora, A. Svatos and R. L. Swennen
Phenalenone-type phytoalexins mediate resistance of banana plants (musa spp.) to the burrowing nematode radopholus similis
Proceedings of the National Academy of Sciences of the United States of America 111(1) 105-110

E. Altuntas and U. S. Schubert
Polymeromics: Mass spectrometry based strategies in polymer science toward complete sequencing approaches: A review
Analytica Chimica Acta 808(56-69

F. Kretschmer, U. Mansfeld, S. Hoeppener, M. D. Hager and U. S. Schubert
Tunable synthesis of poly(ethylene imine)-gold nanoparticle clusters
Chemical Communications 50(1) 88-90

G. M. E. Pozza, M. J. Barthel, S. Crotty, J. Vitz, F. H. Schacher, P. J. Lutz and U. S. Schubert
Precise synthesis of undecenyl poly(ethylene oxide) macromonomers as heterofunctional building blocks for the synthesis of linear diblocks or of branched materials
European Polymer Journal 57(221-236

L. Tauhardt, D. Pretzel, K. Kempe, M. Gottschaldt, D. Pohlers and U. S. Schubert
Zwitterionic poly(2-oxazoline)s as promising candidates for blood contacting applications
Polymer Chemistry 5(19) 5751-5764

L. Tauhardt, D. Pretzel, S. Bode, J. A. Czaplewska, K. Kempe, M. Gottschaldt and U. S. Schubert
Synthesis and in vitro activity of platinum containing 2-oxazoline-based glycopolymers
Journal of Polymer Science Part a-Polymer Chemistry 52(18) 2703-2714

L. Tauhardt, M. Frant, D. Pretzel, M. Hartlieb, C. Bucher, G. Hildebrand, B. Schroter, C. Weber, K. Kempe, M. Gottschaldt, K. Liefeith and U. S. Schubert
Amine end-functionalized poly(2-ethyl-2-oxazoline) as promising coating material for antifouling applications
Journal of Materials Chemistry B 2(30) 4883-4893

M. J. Barthel, A. C. Rinkenauer, M. Wagner, U. Mansfeld, S. Hoeppener, J. A. Czaplewska, M. Gottschaldt, A. Trager, F. H. Schacher and U. S. Schubert
Small but powerful: Co-assembly of polyether-based triblock terpolymers into sub-30 nm micelles and synergistic effects on cellular interactions
Biomacromolecules 15(7) 2426-2439

M. J. Barthel, F. H. Schacher and U. S. Schubert
Poly(ethylene oxide) (peo)-based abc triblock terpolymers - synthetic complexity vs. Application benefits
Polymer Chemistry 5(8) 2647-2662

M. Wagner, M. J. Barthel, R. R. A. Freund, S. Hoeppener, A. Traeger, F. H. Schacher and U. S. Schubert
Solution self-assembly of poly(ethylene oxide)-block-poly(furfuryl glycidyl ether)-block-poly(allyl glycidyl ether) based triblock terpolymers: A field-flow fractionation study
Polymer Chemistry 5(24) 6943-6956

M. Zille, A. Stolle, A. Wild and U. S. Schubert
Znbr2-mediated synthesis of indoles in a ball mill by intramolecular hydroamination of 2-alkynylanilines
Rsc Advances 4(25) 13126-13133

R. Edam, E. P. C. Mes, D. M. Meunier, F. A. Van Damme and P. J. Schoenmakers
Branched polymers characterized by comprehensive two-dimensional separations with fully orthogonal mechanisms: Molecular-topology fractionation x size-exclusion chromatography
Journal of Chromatography A 1366(54-64

S. Bode, M. Enke, H. Gorls, S. Hoeppener, R. Weberskirch, M. D. Hager and U. S. Schubert
Blocked isocyanates: An efficient tool for post-polymerization modification of polymers
Polymer Chemistry 5(7) 2574-2582

S. Crotty, C. Weber, A. Baumgaertel, N. Fritz, E. Altuntas, K. Kempe and U. S. Schubert
Semi-automated multi-dimensional characterization of synthetic copolymers
European Polymer Journal 60(153-162

S. Wunscher, B. Seise, D. Pretzel, S. Pollok, J. Perelaer, K. Weber, J. Poppde and U. S. Schubert
Chip-on-foil devices for DNA analysis based on inkjet-printed silver electrodes
Lab on a Chip 14(2) 392-401

S. Wunscher, R. Abbel, J. Perelaer and U. S. Schubert
Progress of alternative sintering approaches of inkjet-printed metal inks and their application for manufacturing of flexible electronic devices
Journal of Materials Chemistry C 2(48) 10232-10261

S. Wunscher, S. Stumpf, J. Perelaer and U. S. Schubert
Towards single-pass plasma sintering: Temperature influence of atmospheric pressure plasma sintering of silver nano-particle ink
Journal of Materials Chemistry C 2(9) 1642-1649

S. Wunscher, T. Rasp, M. Grouchko, A. Kamyshny, R. M. Paulus, J. Perelaer, T. Kraft, S. Magdassi and U. S. Schubert
Simulation and prediction of the thermal sintering behavior for a silver nanoparticle ink based on experimental input
Journal of Materials Chemistry C 2(31) 6342-6352

T. Jahnert, B. Haupler, T. Janoschka, M. D. Hager and U. S. Schubert
Polymers based on stable phenoxyl radicals for the use in organic radical batteries
Macromolecular Rapid Communications 35(9) 882-887

T. Jahnert, M. D. Hager and U. S. Schubert
Application of phenolic radicals for anti-oxidants, as active materials in batteries, magnetic materials and ligands for metal-complexes
Journal of Materials Chemistry A 2(37) 15234-15251

T. Rudolph, M. J. Barthel, F. Kretschmer, U. Mansfeld, S. Hoeppener, M. D. Hager, U. S. Schubert and F. H. Schacher
Poly(2-vinyl pyridine)-block-poly(ethylene oxide) featuring a furan group at the block junction-synthesis and functionalization
Macromolecular Rapid Communications 35(9) 916-921

Y. Jiang, G. O. R. A. van Ekenstein, A. J. J. Woortman and K. Loos
Fully biobased unsaturated aliphatic poly-esters from renewable resources: Enzymatic synthesis, characterization, and properties
Macromolecular Chemistry and Physics 215(22) 2185-2197

Filed patent application

#730: A. Schallon, A. C. Rinkenauer, L. Tauhardt, K. Kempe and U. S. Schubert
2-oxazolines based amphiphilic, cationic poly-mers for efficient and non-toxic gene delivery

BIO-INSPIRED POLYMERS

Projects

#686: Thermal Catch and Release

#689: Bio-inspired hairy surfaces for actuation or sensing, produced with roll-to-roll technology

#737: Exploring novel biobased poly-mers comprising furandicarboxylic acids, 2,2,4,4-tetramethyl 1,3-cyclobutanediol (CDBO) derivatives and substituted hydroxy benzoic acids as biobased rigid monomers

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

#739: Melt processable Bio-based Aromatic Polymers

#740: Enzymatic catalysis for the production of biobased monomers and polymers based upon them

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

#770: Antimicrobial recombinant polymers for treatment of nosocomial infections

#772: Emergent properties of biomolecular systems: structural/dynamic characteriza-tion and development of new functionalities

#794: Microbial Synthesis of Functional Polyhydroxyalkanoates (PHA)

Thesis

Vladimir Dmitrović
Bio-inspired poly(amino acid) directed mine-ralization

Scientific publications

C. H. R. M. Wilsens, B. A. J. Noordover and S. Rastogi
Aromatic thermotropic polyesters based on 2,5-furandicarboxylic acid and vanillic acid
Polymer 55(10) 2432-2439

C. H. R. M. Wilsens, J. M. G. A. Verhoeven, B. A. J. Noordover, M. R. Hansen, D. Auhl and S. Rastogi
Thermotropic polyesters from 2,5-furandi-carboxylic acid and vanillic acid: Synthesis, thermal properties, melt behavior, and mechanical performance
Macromolecules 47(10) 3306-3316

C. H. R. M. Wilsens, Y. S. Deshmukh, B. A. J. Noordover and S. Rastogi
Influence of the 2,5-furandicarboxamide moiety on hydrogen bonding in aliphatic-aromatic poly(ester amide)s
Macromolecules 47(18) 6196-6206

C. von der Ehe, C. Weber, M. Wagner, J. A. Czaplewska, M. Gottschaldt and U. S. Schubert
Synthesis of thermoresponsive glycopolymers combining raft polymerization, thiol-ene reaction, and subsequent immobilization onto solid supports
Macromolecular Chemistry and Physics 215(13) 1306-1318

S. E. H. J. van Kempen, H. A. Schols, E. van der Linden and L. M. C. Sagis
Molecular assembly, interfacial rheology and foaming properties of oligofructose fatty acid esters
Food & Function 5(1) 111-122

S. E. H. J. van Kempen, H. A. Schols, E. van der Linden and L. M. C. Sagis
Effect of variations in the fatty acid chain of oligofructose fatty acid esters on their foaming functionality
Food Biophysics 9(2) 114-124

S. E. H. J. van Kempen, H. A. Schols, E. van Der Linden and L. M. C. Sagis
Effect of variations in the fatty acid chain on functional properties of oligofructose fatty acid esters
Food Hydrocolloids 40(22-29

S. Thiyagarajan, J. Wu, R. J. I. Knoop, J. van Haveren, M. Lutz and D. S. van Es
Isohexide hydroxy esters: Synthesis and application of a new class of biobased ab-type building blocks
Rsc Advances 4(89) 47937-47950

S. Thiyagarajan, W. Vogelzang, R. J. I. Knoop, A. E. Frissen, J. van Haveren and D. S. van Es
Biobased furandicarboxylic acids (fdcas): Effects of isomeric substitution on polyester synthesis and properties

Green Chemistry 16(4) 1957-1966

V. Dmitrovic, J. J. M. Lenders, H. R. Zope, G. de With, A. Kros and N. A. J. M. Sommerdijk
Library of random copolypeptides by solid phase synthesis
Biomacromolecules 15(10) 3687-3695

Filed patent applications

#739: C.H.R.M. Wilsens, E. Gubbels, N.J.M. Wullems, B.A.J. Noordover and S. Rastogi
Fully bio-based coatings using oxazoline ring-opening chemistry

#737: Shanmugam Thiyagarajan, W. Vogelzang, R.J.I. Knoop, J. van Haveren and D.S. van Es
Exploring novel biobased polymers comprising furandicarboxylic acids, 2,2,4,4-tetramethyl-1,3-cyclobutanediol derivatives and substituted hydroxyl benzoic acids as biobased/rigid monomers

#737: Shanmugam Thiyagarajan, M.A. Meijlink, W. Vogelzang, R.J.I. Knoop, J. van Haveren and D.S. van Es
Exploring novel biobased polymers comprising furandicarboxylic acids, 2,2,4,4-tetramethyl-1,3-cyclobutanediol derivatives and substituted hydroxyl benzoic acids as biobased/rigid monomers

LARGE-AREA THIN-FILM ELECTRONICS

Projects

#659: Crosslinkable Semiconductors for Robust Polymer Electronics

#704: Forming processes in metal oxide organic light-emitting diodes

#733: Solution processed multilayer polymeric light-emitting diodes

#734: Predictive processing of polymer: fullerene solar cells

#735: Solution-processable low-temperature oxide semiconductors for large-area electronics

#741: Inkjet Printing of Suspensions

#748: Organic semiconductors blended into a crosslinkable insulator: Separating processability from optoelectronic functionality

#752: Looking down the rabbit hole: impact of porosity in the (in)organic layers on the perfomance of moisture permeation multilayer barriers

Theses

Benjamin Bory
Electroforming and switching of organic-inorganic resistive memories

Paulo Roberto Ferreira da Rocha
Electrical characterization of metal-oxide-polymer devices for non-volatile memory applications

Scientific publications

A. Perrotta, E. R. J. van Beekum, G. Aresta, A. Jagia, W. Keuning, R. M. C. M. van de Sanden, E. W. M. M. Kessels and M. Creatore
On the role of nanoporosity in controlling the performance of moisture permeation barrier layers
Microporous and Mesoporous Materials 188(163-171

B. F. Bory, J. X. Wang, H. L. Gomes, R. A. J. Janssen, D. M. De Leeuw and S. C. J. Meskers
Relation between the electroforming voltage in alkali halide-polymer diodes and the bandgap of the alkali halide
Applied Physics Letters 105 (23) 3502

B. F. Bory, P. R. F. Rocha, R. A. J. Janssen, H. L. Gomes, D. M. De Leeuw and S. C. J. Meskers
Lithium fluoride injection layers can form quasi-ohmic contacts for both holes and electrons
Applied Physics Letters 105 (12) 3302

D. Abbaszadeh, G. A. H. Wetzelaer, H. T. Nicolai and P. W. M. Blom
Exciton quenching at pedot:Pss anode in polymer blue-light-emitting diodes
Journal of Applied Physics 116 (22) 4508

D. Abbaszadeh, H. T. Nicolai, N. I. Craciun and P. W. M. Blom
Effect of arylamine hole-transport units on the performance of blue polyspirobifulorene light-emitting diodes
Physical Review B 90 (20) 5204

D. Bartesaghi, M. Turbiez and L. J. A. Koster
Charge transport and recombination in pdpp5t:[70]pcbm organic solar cells: The influence of morphology
Organic Electronics 15(11) 3191-3202

S. R. Thomas, G. Adamopoulos, Y. H. Lin, H. Faber, L. Sygellou, E. Stratakis, N. Pliatsikas, P. A. Patsalas and T. D. Anthopoulos
High electron mobility thin-film transistors based on ga2o3 grown by atmospheric ultrasonic spray pyrolysis at low temperatures
Applied Physics Letters 105(9)2105

Filed patent application

#735: Yen-Hung Lin and T. Anthopoulos
Improved metal oxide thin-film transistors

ENHANCED OIL RECOVERY

Projects

#716: Design of new chemical products (polymers and amphiphilics) for EOR

#736: Relating Polymer Rheology to Apparent Viscosity in Poreus Media

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

Scientific publications

D. A. Z. Wever, G. Ramalho, F. Picchioni and A. A. Broekhuis
Acrylamide-b-n-isopropylacrylamide block copolymers: Synthesis by atomic transfer radical polymerization in water and the effect of the hydrophilic-hydrophobic ratio on the solution properties
Journal of Applied Polymer Science 131(2)

P. Raffa, M. C. A. Stuart, A. A. Broekhuis and F. Picchioni
The effect of hydrophilic and hydrophobic block length on the rheology of amphiphilic diblock polystyrene-b-poly(sodium methacrylate) copolymers prepared by atrp
Journal of Colloid and Interface Science 428(152-161

Reported invention

#716: A.A. Broekhuis, P. Raffa and F. Picchioni
Amphiplilic block copolymers for enhanced oil recovery

EMERGING TECHNOLOGIES

Project

#761: Reactive Liquid Crystal Oligomers as Precursors Towards Composite Resins

Projects

#598: Application of time resolved X-ray diffraction techniques for study on structural and morphological changes during polymerization and processing

#693: Elastin-Functionalized Silica Particles

#695: Optical microscopy for nanoscale imaging

#698: Designer Polypeptides for Self-Assembled Delivery Vehicles

#715: Novel Polyimide Architectures: Towards Membranes with Tunable Transport Properties

#717: All-aromatic heterocyclic liquid crystal polymers for photovoltaic applications

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

#727: Improved characterization techniques for branched polymers

#727: (Oligo)cellulose by enzymatic polymerisation

#727: Polymers go even greener

#VEC-001: Understanding the visco-elasticity of elastomer-based nanocomposites

Theses

Michiel L. Petrus
Azomethine-based Donor Materials for Organic Solar Cells

Sandeep Namdeo
Flagellar hydrodynamics of biological and biomimetic micro-swimmers

Armando Hernández García
Protein-based Polymers that Bind to DNA - Design of Virus-like Particles and Supramolecular Nanostructures

Mark van Eldijk
Elastin-like polypeptides in protein nanotechnology

Delei Chen
Smart 3D Imaging Strategies for Nanostructured Soft Matter

Jelena Ćirić
Improved Characterization Techniques for Branched Polysaccharides

Aysegul Cumurcu
Ellipsometry Based Imaging Techniques for Nanoscale Characterization of Heterogeneous Polymer Films

Scientific publications

A. Hernandez-Garcia, D. J. Kraft, A. F. J. Janssen, P. H. H. Bomans, N. A. J. M. Sommerdijk, D. M. E. Thies-Weesie, M. E. Favretto, R. Brock, F. A. de Wolf, M. W. T. Werten, P. van der Schoot, M. C. Stuart and R. de Vries
Design and self-assembly of simple coat proteins for artificial viruses
Nature Nanotechnology 9(9) 698-702

C. Batistakis and A. V. Lyulin
Simulated glass transition in thin polymer films: Influence of truncating the non-bonded interaction potentials
Computer Physics Communications 185(4) 1223-1229

C. Batistakis, M. A. J. Michels and A. V. Lyulin
Confinement-induced stiffening of thin elastomer films: Linear and nonlinear mechanics vs local dynamics
Macromolecules 47(14) 4690-4703

C. van der Walt, M. A. Hulsen, A. C. B. Bogaerds and P. D. Anderson
Transient modeling of fiber spinning with filament pull-out
Journal of Non-Newtonian Fluid Mechanics 208(72-87

D. L. Chen, B. Goris, F. Bleichrodt, H. H. Mezerji, S. Bals, K. J. Batenburg, G. de With and H. Friedrich
The properties of sirt, tvm, and dart for 3d imaging of tubular domains in nanocomposite thin-films and sections
Ultramicroscopy 147(137-148

D. L. Chen, H. Friedrich and G. de With
On resolution in electron tomography of beam sensitive materials
Journal of Physical Chemistry C 118(2) 1248-1257

E. Gubbels, L. Jasinska-Walc, D. Hermida-Merino, M. R. Hansen, B. Noordover, A. Spoelstra, H. Goossens and C. Koning
Phase separation in poly(butylene terephthalate)-based materials prepared by solid-state modification
Polymer 55(16) 3801-3810

J. Ciric, A. J. Woortman and K. Loos
Analysis of isoamylase debranched starches with size exclusion chromatography utilizing pfg columns
Carbohydrate Polymers 112(458-461

J. Ciric, A. Rolland-Sabate, S. Guilois and K. Loos
Characterization of enzymatically synthesized amylopectin analogs via asymmetrical flow field flow fractionation
Polymer 55(24) 6271-6277

J. Razzokov, S. Naderi and P. van der Schoot
Prediction of the structure of a silk-like protein in oligomeric states using explicit and implicit solvent models
Soft Matter 10(29) 5362-5374

M. B. van Eldijk, F. C. M. Smits, J. C. Thies, J. Mecinovic and J. C. M. van Hest
Thermodynamic investigation of z(33)-antibody interaction leads to selective purification of human antibodies
Journal of Biotechnology 179(32-41

M. B. van Eldijk, F. C. M. Smits, N. Vermue, M. F. Debets, S. Schoffelen and J. C. M. van Hest
Synthesis and self-assembly of well-defined elastin-like polypeptide-poly(ethylene glycol) conjugates
Biomacromolecules 15(7) 2751-2759

M. E. Mulholland, D. Navarathne, M. L. Petrus, T. J. Dingemans and W. G. Skene
Correlating on-substrate prepared electrochromes with their solution processed counterparts - towards validating polyazomethines as electrochromes in functioning devices
Journal of Materials Chemistry C 2(43) 9099-9108

M. L. Petrus, R. K. M. Bouwer, U. Lafont, S. Athanasopoulos, N. C. Greenham and T. J. Dingemans
Small-molecule azomethines: Organic photovoltaics via schiff base condensation chemistry
Journal of Materials Chemistry A 2(25) 9474-9477

S. Naderi and P. van der Schoot
Effect of bending flexibility on the phase behavior and dynamics of rods
Journal of Chemical Physics 141(12)

Y. Jiang, A. J. J. Woortman, G. O. R. A. van Ekenstein, D. M. Petrovic and K. Loos
Enzymatic synthesis of biobased polyesters using 2,5-bis(hydroxymethyl)furan as the building block
Biomacromolecules 15(7) 2482-2493

BRM
P. Salice, E. Ronchi, A. Iacchetti, M. Binda, D. Natali, W. Gomulya, M. Manca, M. A. Loi, M. Iurlo, F. Paolucci, M. Maggini, G. A. Pagani, L. Beverina and E. Menna
A fulleropyrrolidine-squaraine blue dyad: Synthesis and application as an organic light detector

Journal of Materials Chemistry C 2(8)
1396-1399

Y. Saricay, P. A. Wierenga and R. de Vries
Changes in protein conformation and surface hydrophobicity upon peroxidase-catalyzed cross-linking of apo-alpha-lactalbumin
Journal of Agricultural and Food Chemistry
62(38) 9345-9352

C. C. van den Akker, J. Nguyen, M. Schleeger, K. P. Velikov, M. Bonn and G. H. Koenderink
Amyloids: Connecting from single fibril mechanics to macroscopic rheology
Biophysical Journal 106(2) 684a-684a

EXCHANGE PROGRAMME BRAZIL

Projects

#768: Silica nanoparticles and graphene nanosheets - a catalysts approach for controlled polyolefin reactor intermixing

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

#770: Antimicrobial recombinant polymers for treatment of nosocomial infections

#771: Silica nanoparticles - a Catalysts Approach for Polyolefin Reactor Intermixed Compounds with Controlled intermixing of polyOlefins

#772: Emergent properties of biomolecular systems: structural/dynamic characterization and development of new functionalities

EXCHANGE PROGRAMME CHINA

Projects

#779a: Preparation and Characterization of Model Waterborne Clearcoats

#794: Microbial Synthesis of Functional Polyhydroxyalkanoates (PHA)

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

Dutch Polymer Institute

Mail address
P.O. Box 902
5600 AX Eindhoven
The Netherlands

Visiting address
Kennispoort
John F. Kennedylaan 2
5612 AB Eindhoven

T   +31 (0) 40 247 56 29
F   +31 (0) 40 247 24 62

info@polymers.nl
www.polymers.nl