The Road Ahead

Annual Report 2015

Dutch Polymer Institute

Foreword
Bolstering Collaborative Polymer Research

In December 2015, the DPI Supervisory Board gave the green light for the continuation of DPI's pre-competitive polymer research activities. This was the 'moment of truth' we had been waiting for and which we had been working towards for the past few years. Although the industrial participation level for the new DPI programme fell short of the stipulated minimum, the Supervisory Board made this crucial decision in the conviction that DPI's essential role in bolstering industrial collaboration in polymer research deserves to be continued.

We are very pleased that several industrial partners share the Supervisory Board's conviction and have joined forces with DPI and with one another to build and maintain a strong industrially relevant polymer knowledge base. Together, we must demonstrate that even in the absence of structural government funding the DPI collaboration platform, henceforth to be primarily financed by industry, is not only viable but also successful.

A major priority for us now is to secure a substantial number of participations so that a new polymer research programme with sufficient volume can be put in place. Although in the new setup DPI will primarily be funded by its industrial partners, we will continue to make optimal use of all national and international opportunities of securing additional funding. It would be a great help, for example, if more funding became available from government agencies. This would lower the threshold for companies to participate in a collaborative platform like DPI, which has enabled companies to cost-effectively meet their immediate research needs and the same time to address challenges that extend beyond their individual research and innovation portfolios.

Polymer research: more important than ever

Polymers will continue to play an important role in various realms of human life. Polymeric materials offer a number of unique properties in terms of design, functionality and price – regardless of whether they are fossil-based or bio-based. The solutions to existing and new technical and societal challenges – such as in the fields of energy and the environment – will require innovations to existing materials as well as the development of completely new materials, many of which will be polymer-based. In oil & gas exploration and production, for example, polymeric materials will be needed to replace conventional materials as the physical conditions in which these activities are carried out become increasingly harsher. On the whole, the use of polymeric materials worldwide is expected to grow significantly in the coming years.

This important present and future role of polymeric materials calls for more in-depth research in order to gain a much better understanding of the molecular structure of such materials and the underlying molecular interactions. Compared to scientific knowledge in some other areas, our understanding of polymeric materials is still in its infancy. This at any rate means that there is tremendous scope – as well as a great need – for new research. Collaborative pre-competitive programmes, driving joint industrial and academic research efforts, will lead to a better understanding of fundamental aspects of existing materials while at the same time laying the basis for the development of new materials. This is where DPI has a pivotal role to play.

DPI: the road ahead

DPI's excellent track record in terms of industrial relevance and scientific quality is based on a combination of several unique elements: industry-defined research topics, pooling of resources, involvement of top-level academic research groups, a virtual setup, quality control by leading international experts and the international dimension. In the new setup, these elements will continue to form the backbone of the DPI model. Also, the DPI programme will continue to fulfil its essential role in supplying the competently trained polymer scientists that the polymer sector needs.

However, we are now also vigorously pursuing a strategic direction that will enhance the scope and impact of our research programme. We are working to broaden our partner base to represent a broad cross-section of the polymer value chain. This will enable us to gear the research programme to the challenges

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

faced not only by polymer producers but also by their customers and other stakeholders further downstream across the value chain. Fundamental knowledge gained in one area may thus lead to new insights in others, thereby accelerating innovation and possibly reducing costs. This, we believe, will lead to smarter and more efficient routes to solutions that are needed in the short as well as the longer term in the end-markets we intend to focus on: oil & gas, building construction, packaging, electrics & electronics and automotive.

The Supervisory Board's decision and the support and commitment of our industrial partners gives us the strength and encouragement to identify and engage new partners and establish a viable and sustainable research programme. We are committed to once again demonstrating our added value by making DPI a thriving international collaboration platform that drives excellent polymer research and leads to new insights and breakthroughs in polymer science.

Jacques Joosten – Managing Director

Sybrand van der Zwaag – Scientific Director

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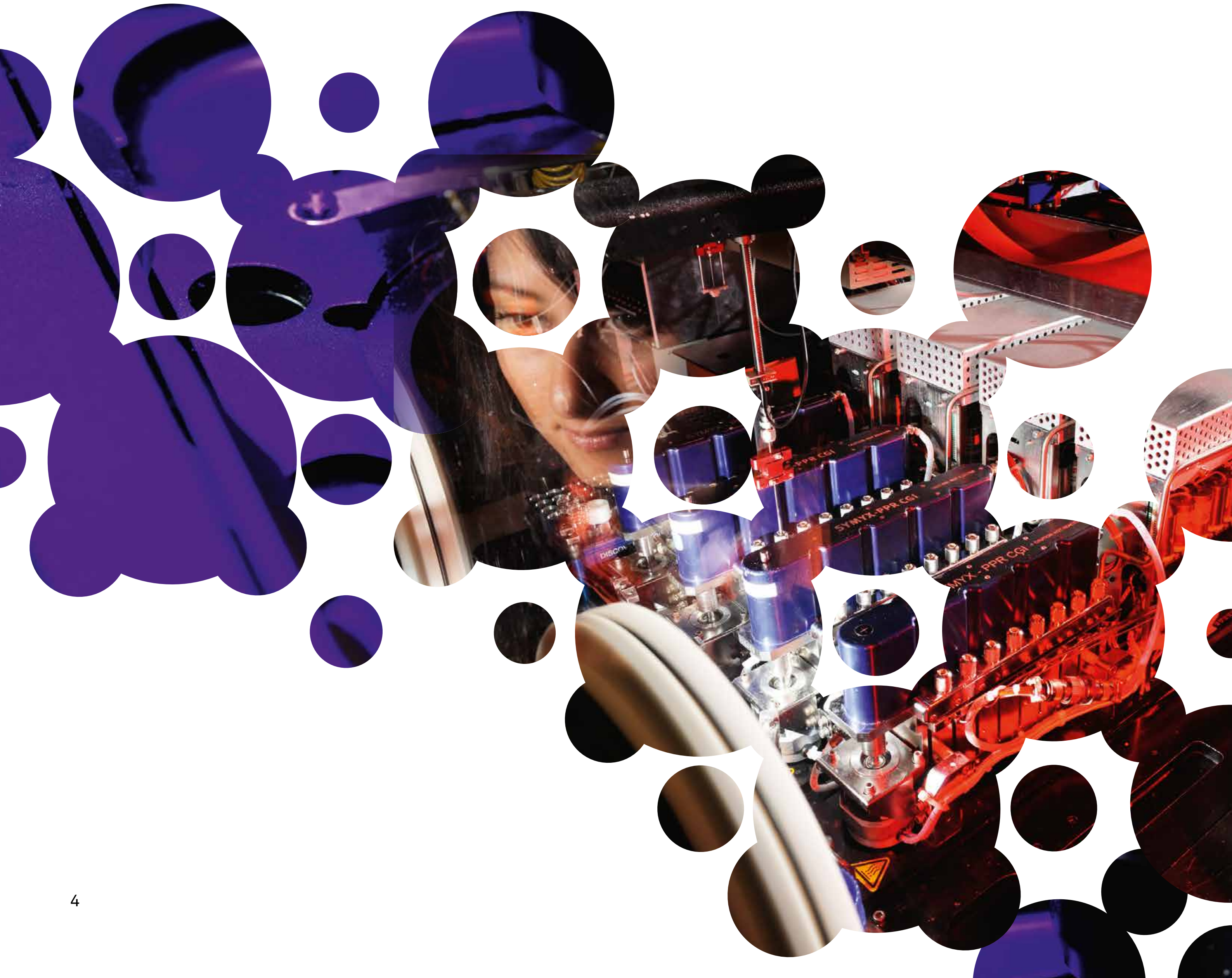


Organisation 2015

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

Council of Participants
- **Dr. L. Hviid**, *Shell, Chair*

Scientific Reference Committee
- **Prof.dr. A.J. Schouten**, *University of Groningen, Chair*
- **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*

Scientific Programme Chairs
- **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 (left in 2015)
- **Prof.dr. G. Eggink**
  Bio-Inspired Polymers (left in 2015)
- **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*
- **R.P.F. Hoogers-Valken** - *Secretariat*
- **P.J.J. Kuppens, AA** - *Controlling*
- **A.C.M. Looymans** - *Project Administration (left in 2015)*
- **L. de Wit** - *Project Administration*

Staff European projects
- **A. Brouwer, MSc**
  Project Manager SEAFRONT
- **Dr. J.A.E.H. van Haare**
  Project Manager SEAFRONT (left in 2015)
- **R.J. Korstanje, MSc**
  Project Manager SHINE
- **A.C.M. Looymans**
  EU project Office (left in 2015)
- **L. de Wit**
  EU Project Office

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

Programme Area Coordinators
- **Dr. M.J. Bruining**
  Coatings Technology and Corporate Research
- **Dr. J.A.E.H. van Haare**
  Functional Polymer Systems, Large-Area Thin-Film Electronics (left in 2015)
- **Dr. D.G. Hristova-Bogaerds**
  Performance Polymers
- **R.J. Korstanje, MSc**
  Performance Polymers
- **Dr. P.M.M. Nossin**
  Bio-Inspired Polymers (left in 2015)
- **Dr. J.E. Stamhuis**
  Polyolefins, Polymers for Enhanced Oil Recovery and Emerging Technologies

PERSONNEL CHANGES AT DPI

In 2015, two of our Scientific Programme Chairs left DPI. Prof. Frans de Schryver, Scientific Programme Chair for Functional Polymer Systems and Large-Area Thin-Film Electronics, left DPI in connection with his retirement. Prof. Gerrit Eggink, Scientific Programme Chair for Bio-Inspired Polymers, left DPI as this programme area was discontinued and merged with the Performance Polymers programme area.

Dr. John van Haare, Programme Area Coordinator for Functional Polymer Systems and Large-Area Thin-Film Electronics, and Dr. Peter Nossin, Programme Area Coordinator for Bio-Inspired Polymers, left DPI to pursue careers elsewhere.

Angela Looymans, responsible for Project Administration, left DPI to pursue a career elsewhere.

The Scientific Reference Committee was dissolved due to the completion of the current DPI programme.

DPI: International Centre of Excellence in Polymers

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

PRE-COMPETITIVE PROGRAMME

DPI Rules & regulations apply to all projects

Polyolefins		Performance Polymers	Functional Polymer Systems	Coatings Technology
11 projects		**18 projects**	**10 projects**	**5 projects**
Industry • Borealis • Braskem • Dow Benelux • DSM • ExxonMobil • Freeslate • Lanxess Elastomers • LyondellBasell • Michelin • SABIC • SCG Chemicals • Sinopec • Teijin Aramid	**Academia** • Eindhoven University of Technology • ESCPI-Lyon • Fraunhofer Institute for Structural Durability and System Reliability LBF • Johannes Kepler University Linz • Lomonosov Moscow State University • Loughborough University • Martin-Luther University of Halle-Wittenberg • National Council for Scientific and Technological Development (CNPq) • National Interuniversity Consortium of Materials Science and Technology (INSTM) • Radboud University • UFRGS Universidade Federal do Rio Grande do Sul • Universidade Federal do Rio de Janeiro • University of Erlangen-Nürnberg (FAU) • University of Manitoba • University of Naples Federico II • University of Perugia • University of Turin • University of Udine	**Industry** • AkzoNobel • BASF • Bayer • Bekaert • DSM • Food & Biobased Research Wageningen UR • FrieslandCampina • Petrobras • SABIC • SKF • Teijin Aramid **Academia** • CNRS Strasbourg • Delft University of Technology • DWI an der RWTH Aachen • Eindhoven University of Technology • Food and Biobased Research, Wageningen UR • National Council for Scientific and Technological Development (CNPq) • National Technical University of Athens • Tsinghua University • Universidade Católica de Brasilia • Universidade Federal do Rio de Janeiro • University of Groningen • University of Twente	**Industry** • BASF • DSM • ECN • Industrial Technology Research Institute Taiwan • Philips • Rolic Technologies • SABIC • TNO **Academia** • Delft University of Technology • Eindhoven University of Technology • Imperial College London • Max Planck Institute for Polymer Research • University of Groningen • University of Twente • Wageningen University & Research	**Industry** • AkzoNobel • Altana • DSM • Lawter • Saint-Gobain **Academia** • Changchun Institute of Applied Chemistry • Eindhoven University of Technology • University of Groningen • University of Haute-Alsace • Wageningen University & Research
Expenditure € 1.28 million FTEs 16.0 (19 researchers)		Expenditure € 1.47 million) FTEs 23.0 (35 researchers)	Expenditure € 0.51 million FTEs 11.2 (13 researchers)	Expenditure € 0.32 million FTEs 7.4 (9 researchers)

Pre-competitive research programme

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

DPI Rules & regulations apply to all projects

Large-Area Thin-Film Electronics	Polymers for Enhanced Oil Recovery	Emerging Technologies	Corporate Research
6 projects	**2 projects**	**1 project**	**6 projects**
Industry • DSM • Philips • TNO	**Industry** • Shell • SNF Floerger	**Industry** • DPI partners	**Industry** • All DPI partners take part in Corporate Research
Academia • Eindhoven University of Technology • Imperial College London • Max Planck Institute for Polymer Research • University of Groningen • University of Twente	**Academia** • Delft University of Technology • University of Groningen	**Academia** • Delft University of Technology	**Academia** • Delft University of Technology • Eindhoven University of Technology • ESRF, Grenoble • Foundation for fundamental research on matter (FOM) • TI Food and Nutrition (TIFN) • University of Groningen
Expenditure € 0.18 million FTEs 7.1 (9 researchers)	Expenditure € 0.10 million FTEs 2.0 (2 researchers)		Expenditure € 0.66 million FTEs 3.8 (4 researchers)

Industrial pre-commercial programme

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

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

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

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

PRE-COMMERCIAL PROGRAMME

Model framework for collaboration	
Rules and regulations set by involved partners	**Rules and regulations set by involved partners**
SHINE (1-2-2013/31-7-2016)	**SEAFRONT** (1-1-2014/31-12-2017)
Partners • Acciona Infraestructuras • Arkema • BIWI • Cidetec • Critical Materials • Delft University of Technology • ESPCI ParisTech • Forschungszentrum Jülich • Fraunhofer UMSICHT • MTA-TTK • SKF Engineering & Research Centre • Teijin Aramid • DPI	**Partners** • AkzoNobel / International Paint • BioLog • Bio-On • Biotrend • Bluewater Energy Services • Delft University of Technology • Eindhoven University of Technology • Fraunhofer IFAM • Hapag Lloyd • I-Tech • Minesto • Smartcom Software • Solintel • Solvay Specialty Polymers • University of Bristol • University of Gothenburg • University of Newcastle upon Tyne • Val FoU • DPI
Budget € 6.4 million (€ 4.0 million EU subsidy)	Budget € 11.2 million (€ 8.0 million EU subsidy)

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 CO2 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 CO2 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 has been 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 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: **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.

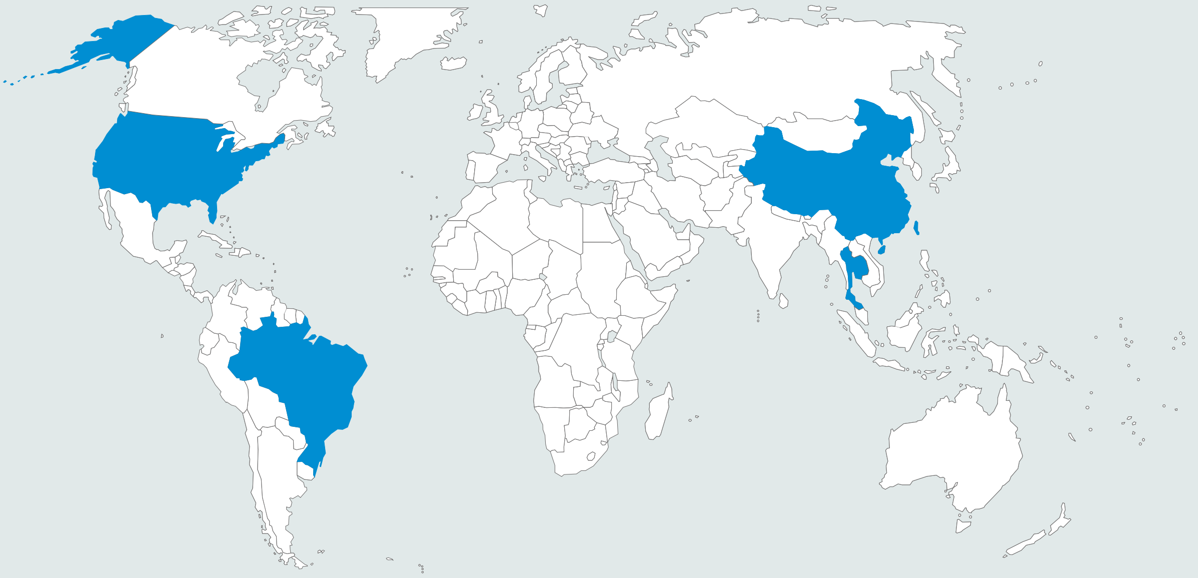
The project started on 1 February 2013 with a total budged of 6.4 M€, with a 4 M€ contribution from the EU. It will end on 31 July 2016.Dissemination has taken place, in the form of publications and posters on various conferences, related to the development of new polyurethane materials with very efficient self-healing properties. Applied results are being generated as well as new methodologies to successfully access self-healing properties.

More information about this project can be found on the website:
https://cordis.europa.eu/project/rcn/106538/

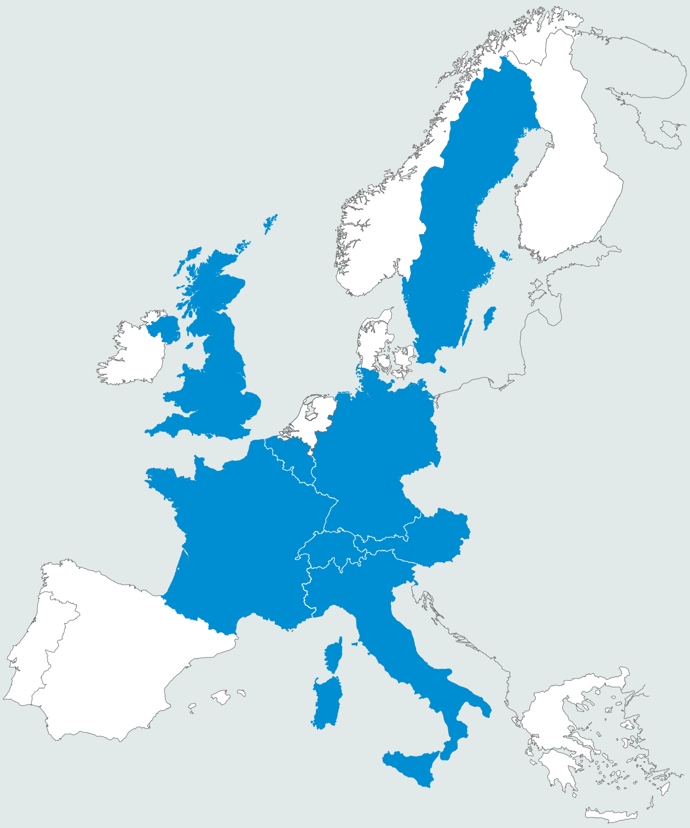
SEVENTH FRAMEWORK PROGRAMME

Partners Industry 2015

North and South America, Asia



Europe



ALTANA	Altana
BASF The Chemical Company	BASF
Bayer	Bayer
BEKAERT better together	Bekaert - Left in 2015
BOREALIS SHAPING the FUTURE with PLASTICS	Borealis
EVONIK INDUSTRIES	Evonik - Left in 2015

- Braskem
- ExxonMobil
- Freeslate - Left in 2015
- Industrial Technology Research Institute Taiwan - Left in 2015
- Petrobras
- SCG Chemicals
- Sinopec

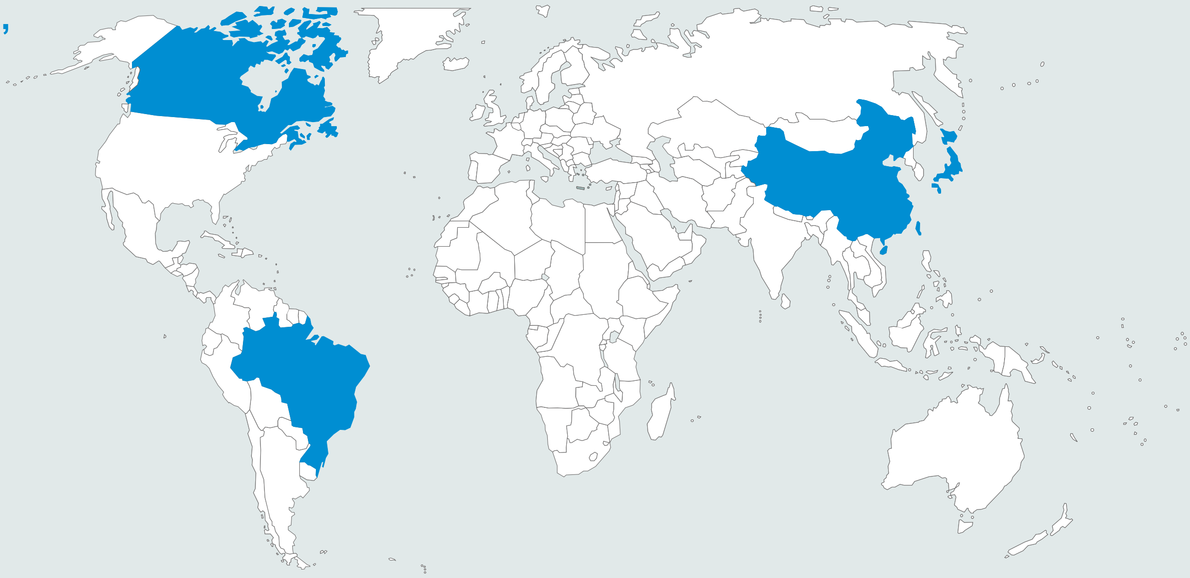
- LyondellBasell - Left in 2015
- Michelin
- Rolic Technologies - Left in 2015
- Saint-Gobain
- SKF
- SNF Floerger

The Netherlands

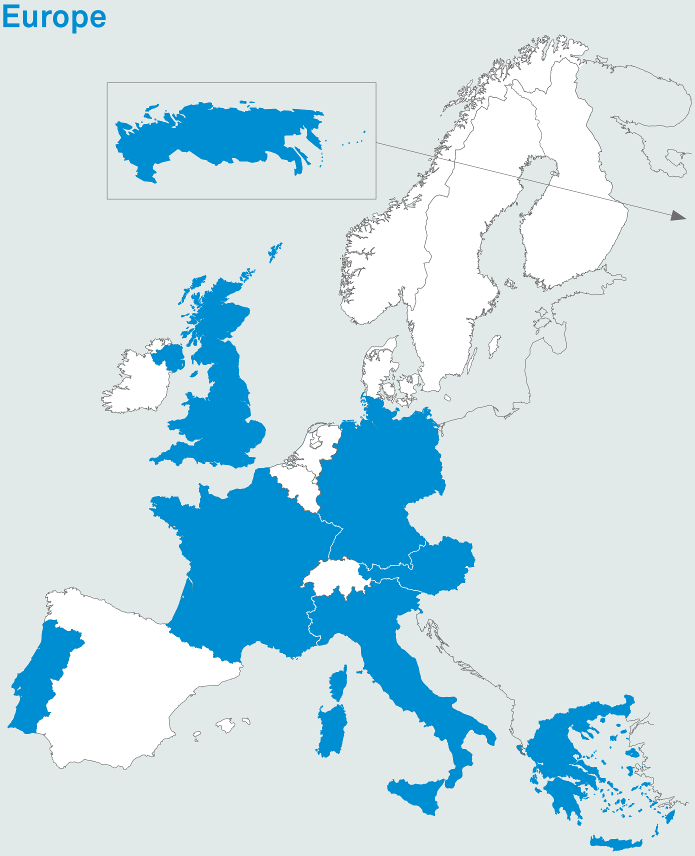
- AkzoNobel
- Dow Benelux
- DSM
- ECN - Left in 2015
- Food and Biobased Research Wageningen UR
- FrieslandCampina
- Lanxess Elastomers
- Lawter
- Philips - Left in 2015
- SABIC
- Shell
- Teijin Aramid
- TNO - Left in 2015

Partners Knowledge institutes 2015

North and South America, Asia



Europe



- CNRS Strasbourg
- National Interuniversity Consortium of Materials Science & Technology (INSTM)
- DWI an der RWTH Aachen
- ESCPE-Lyon
- ESRF, Grenoble
- Fraunhofer Institute for Structural Durability and System Reliability LBF
- Friedrich-Schiller-University, Jena (No research projects in 2015)
- Imperial College London
- Johannes Kepler University Linz
- Karlsruhe Institute of Technology (No research projects in 2015)
- Loughborough University
- Martin-Luther-University Halle-Wittenberg

- Changchun Institute of Applied Chemistry
- Japan Advanced Institute of Science and Technology (No research projects in 2015)
- National Council for Scientific and Technological Development
- 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 (No research projects in 2015)

- Max-Planck Institute for Polymer Research
- National Technical University of Athens
- Lomonosov Moscow State University
- University of Algarve (No research projects in 2015)
- University of Erlangen-Nürnberg (FAU)
- University of Haute-Alsace
- University of Naples Federico II
- University of Perugia
- University of Turin
- University of Udine
- University of Wuppertal (No research projects in 2015)

The Netherlands

- Delft University of Technology
- ECN (No research projects in 2015)
- Eindhoven University of Technology
- Foundation for fundamental research on matter (FOM)
- Food and Biobased Research Wageningen UR
- NWO
- Polymer Technology Group Eindhoven (No research projects in 2015)
- Radboud University
- University of Amsterdam (No research projects in 2015)
- University of Groningen
- University of Twente
- Wageningen University and Research

Summary of financial data 2015

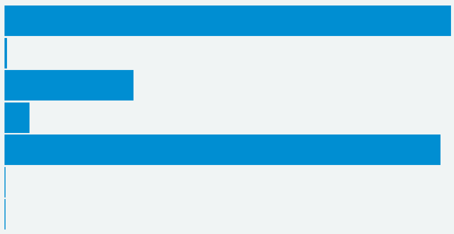
Income

Income	(x EUR million)	%
Contributions from industrial partners	3.75	35.3
In-kind contributions from industrial partners	0.16	1.5
Revenue Patents	0.04	0.4
Revenue DPI Value Centre	0.41	3.9
Contributions from knowledge institutes	1.11	10.5
Contributions from Ministry of EA	0.00	0.0
Revenue TKI SPM	0.57	5.4
EU FP7 projects	4.58	43.1
Industrial pre-commercial research programme Value Chain	0.00	0.0
Solving societal themes and challenges	0.00	0.0
Total income	**10.62**	**100**

Expenditure

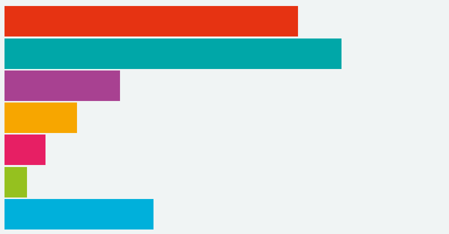
By nature

	(x EUR million)	%
Personnel costs	4.92	43.0
Depreciation	0.02	0.2
Other costs	1.42	12.4
In-kind contribution	0.27	2.4
EU FP7 projects	4.8	42.0
Industrial pre-commercial research programme Value Chain	0	0.0
Solving societal themes and challenges	0	0.0
Total expenditure	**11.43**	**100**



By Technology Area

	(x EUR million)	%
Polyolefins	1.28	28.3
Performance Polymers	1.47	32.5
Functional Polymer Systems	0.51	11.3
Coatings Technology	0.32	7.1
Large-Area Thin-Film Electronics	0.18	4.0
Polymers for Enhanced Oil Recovery	0.10	2.2
Corporate Research	0.66	14.6
Sub total	**4.52**	**100**



Knowledge Workers Scheme	0.00
Knowledge Transfer	0.11
Organisation and support	1.12
Support to DPI Value Centre	0.42
In-kind contribution	0.27
Provision	0.19
EU FP7 projects	4.80
Industrial pre-commercial research programme Value Chain	0.00
Solving societal themes and challenges plus geographical outreach	0.00
Total expenditure	**11.43**

Key Performance Indicators 2015

Number of industrial partners

2014	37
2015	32

European governmental funding (% of total funding)

2014	45%
2015	43%

Number of partner knowledge institutes
(universities, etc.)

2014	45
2015	35

Participation of foreign knowledge institutes
as % of total expenditure

2014	18%
2015	25%

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

End 2014	35%
End 2015	37%

Overhead costs
as % of total expenditure

2014	10%
2015	10%

Contribution Ministry of Economic Affairs
as % of total income

End 2014	0%
End 2015	0%

Expenditure for knowledge transfer
x EUR million

2014	0.16
2015	0.11

Number of patents filed by DPI

2014	2
2015	0

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

2014	6
2015	1

Track record DPI researchers

Left in total	28
Employed by partner knowledge institute	16
Employed by non-partner knowledge institute	3
Employed by partner industrial company	2
Employed by non-partner industrial company or start-up	2
Unknown	5

Research output	2014	2015
Scientific publications	111	93
PhD theses	20	10

DPI Value Centre
Innovation in polymers: more important than ever

Polymer-based materials are widely used in daily life. The demand for polymers is driven by growth in end-use markets, such as packaging, building & construction, automotive, electronics and consumer goods. Solutions to existing and new technical and societal challenges – such as in the fields of energy and the environment – will require innovations to existing materials as well as the development of completely new materials, many of which will be polymer-based. Every reason for DPI Value Centre to continue to support entrepreneurs in the polymer sector in their pursuit of innovation and business success.

Helping to achieve a circular economy of plastics

An important element in the pursuit of a circular economy of plastics is recycling. The recycling percentage of plastics is still low compared to other materials. Whereas for glass and metal a percentage of 80 per cent is achieved, for plastics this is just under 40 per cent. Moreover, plastics recycling primarily consists of mechanical recycling of packaging materials and the reuse of other plastics lags behind. The increasing demand for circularity and action plans at the European level for a more circular economy require greater reuse of valuable plastic materials from, for example, the construction or electronics industry. The recycling percentage of this plastic waste is low, partly because it consists of a wide variety of plastics, making sorting and mechanical recycling technically demanding and therefore economically unattractive.

Startup of the Year 2015

Onora was elected Startup of the Year 2015. DPI VC grants this award to a startup company with an innovative product or service with the best growth profile in a particular year. Onora was honoured for her breakthrough achievement in developing an innovative product as well as producing a prototype series and securing financing for this trial production.

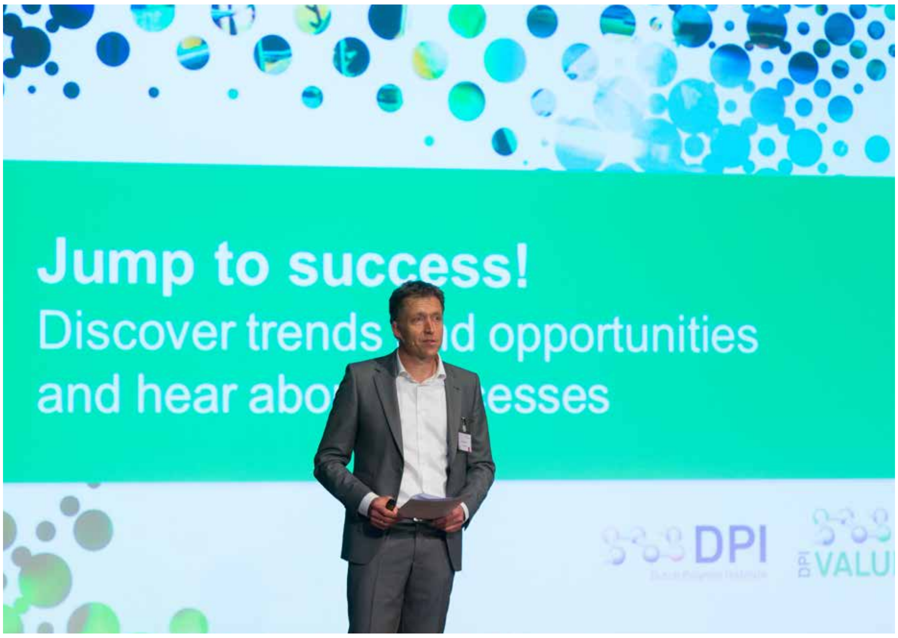
Onora has developed an innovative and stylish coffin made from 100% organic material that is fully biodegradable, releasing no harmful substances to the soil or air (after a cremation). Material use is reduced by 45% and the overall environmental impact is less than half that of a standard coffin. Nowhere in the world has a product of such a large size ever been produced from this kind of biopolymer. In addition to being an innovation within the funeral industry, this is also an innovation for the (bio) plastics processing industry.

Arie Brouwer, Managing Director DPI Value Centre: "In 2015 we contributed to several events and (co-)organised a number of workshops with topics such as sustainable renovation of houses, increasing the reuse of plastics and the viability of chemical recycling in the Netherlands. The logistic, technological and business aspects of plastics recycling, and defining further steps, were also important topics. The meetings of our 2CE network (2CE stands for Towards a Circular Economy) concentrated on issues such as circular (product)design and the use of residuals of a production process".

Within the framework of the Plastic Value Chain Agreement, based on the study of the knowledge and innovation needs of the plastic and rubber processing industry carried out by DPI VC, a plan was made to set up in 2016 a consortium of companies active in the field of recycling.

More and more opportunities for thermoplastic composites

Thermoplastic composites (TPC) can be used for making lightweight but strong products that are competitive and suitable for various product-market combinations



Discovering trends and opportunities and hearing about successes

The overall theme of the Polymer Innovation Day 2015 was '*Jump to success!*'. The theme, referring to an innovation jump, a business jump or a physical jump, was a recurring feature of all presentations. One of the speakers in the main programme was Jeroen de Vries of KVE Composites Group, who spoke about developments in the use of composites in the aerospace industry. Marieke Havermans shared her inspiring success story about setting up her company Onora that develops and produces biodegradable coffins. Dutch athlete Marlou van Rhijn, Paralympic World and European champion and known as the world's fastest woman on blades, and her technical partner Frank Jol told the story of Marlou's athletic achievements with the help of her custom-made carbon fibre blades. Kamiel Maase of NOC*NSF Topsport energised the audience by posing some innovation challenges.

Participants were able to continue the discussions in five parallel workshops on 1) the innovative use of polymers in sports, 2) opportunities for innovation in the building construction sector, 3) polymer recycling in a circular economy, 4) DPI project nanoporous materials and 5) startups and new business activities. With a lively business market with startups, innovative companies and knowledge centres, the event attracted a large number of participants, who made the most of the opportunity for networking and meeting new people.

while also offering sustainability advantages. The TPC workshop in March 2015 where more than 70 OEMs and plastics processing companies discussed the applications, processing and business opportunities of TPC, resulted in an initiative to establish collaboration and form joint innovation projects. Here DPI VC teams up with NRK PVT Kunststofverwerkers (the Federation of Plastics and Rubber Industry in the Netherlands).

New business, networking and knowledge transfer

Arie Brouwer: "DPI Value Centre has a strong track record of setting up high-quality innovation projects, supporting and accelerating new businesses and stimulating networking and knowledge transfer." The close cooperation with DPI and connections with organisations such as NRK (the Federation of the Rubber and Plastics Industry in the Netherlands), VNCI (Association of the Dutch Chemical Industry) and Modint (Trade association of manufacturers, importers, agents and wholesalers of clothing, fashion accessories, carpet and (interior) textiles), enables DPI VC to have access to special expertise and knowledge in different areas.

In 2015 DPI VC provided support to 30 new companies and 80 innovation projects were launched. Arie Brouwer: "The companies acknowledge the benefits of the innovation dynamic that characterises the network of DPI Value Centre. They are very pleased by the customer-oriented and hands-on approach of the experienced entrepreneurs in our network." Chemical startups looking for funding are brought together with investors at matching events organised by the Business Angels Network • Smart & Biobased (BAN•SB). The two matching events held in 2015 resulted in a first investment and future developments look promising.

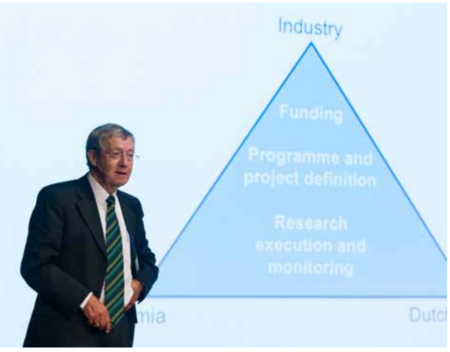
Directly at the start of 2015, the Startupbootcamp Smart Materials (an accelerator programme led by the founders of the Startupbootcamp HighTechXL) was launched at Brightlands Chemelot Campus in Geleen, the Netherlands. As one of the partners, DPI VC was actively involved in the so-called 'team hunt and selection' phase of the programme scheduled for the first quarter of 2015.

DPI VC was one of the initiators of the Brightlands Materials Center at Brightlands Chemelot Campus.
In this new international development center that opened mid-March, top scientists and industry professionals will work together to develop sustainable, breakthrough polymeric materials and application technologies. DPI VC's SME business innovation experts will coordinate on-site the entrepreneurship activities within the new centre.

DPI VC supported and participated in regional innovation initiatives in the field of plastics and polymers in, for example, Groningen, Zwolle, Nijmegen, Wageningen and Emmen. The last-named is now ready to once again take up plastic fibre activities.

DPI VALUECENTRE

DPI Annual Meeting 2015



DPI POSTER AWARD 2015
Winners of the DPI poster prizes
Zizi Li (third prize), Hanne van der Kooij (first prize) and Oana Barsan (second prize)

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 2015 totalled € 1.28 million. The total number of FTEs allocated at year-end 2015 was 16.0 (19 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 twenty reviewed papers and two theses.

FACTS AND FIGURES

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

Partners from the research world
- Eindhoven University of Technology
- ESCPI-Lyon
- Fraunhofer Institute for Structural Durability and System Reliability LBF
- Johannes Kepler University Linz
- Lomonosov Moscow State University
- Loughborough University
- Martin-Luther University of Halle-Wittenberg
- National Council for Scientific and Technological Development (CNPq)
- National University Consortium of Materials Science and Technology INSTM)
- Radboud University
- UFRGS Universidade Federal do Rio Grande do Sul
- Universidade Federal do Rio de Janeiro
- University of Erlangen-Nürnberg (FAU)
- University of Manitoba
- University of Naples Federico II
- University of Perugia
- University of Turin
- University of Udine

For details, see page 28

PERFORMANCE POLYMERS

Bio-Inspired Polymers merged with Performance Polymers in 2015.

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
- Food & Biobased Research Wageningen UR
- FrieslandCampina
- 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
- Food and Biobased Research, Wageningen UR
- National Council for Scientific and Technological Development (CNPq)
- National Technical University of Athens
- Tsinghua University
- Universidade Católica de Brasilia
- Universidade Federal do Rio de Janeiro
- University of Groningen
- University of Twente

Budget and organisation
Expenditure in 2015 totalled € 1.47 million. The total number of FTEs allocated at year-end 2015 was 23.0 (35 researchers). Prof.dr. Costantino Creton acted as Scientific Chairman and Ronald Korstanje and Dr. Denka Hristova-Bogaerds acted as Programme Area Coordinator of the Performance Polymers programme.

Before the merge of Bio-Inspired Polymers with Performance Polymers, 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 twelve reviewed papers and one thesis.

For details, see page 29

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, switchable surfaces and antireflective coatings.

FACTS AND FIGURES

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

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

Budget and organisation
Expenditure in 2015 totalled € 0.51 million. The total number of FTEs allocated at year-end 2015 was 11.2 (13 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 fourteen reviewed papers and two theses.

For details, see page 30

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 Groningen
- University of Haute-Alsace
- Wageningen University & Research

Budget and organisation
Expenditure in 2015 totalled € 0.32 million. The total number of FTEs allocated at year-end 2015 was 7.4 (9 researchers). 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 twelve reviewed papers, three theses and one reported invention.

For details, see page 30

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
- TNO

Partners from the research world
- Eindhoven University of Technology
- Imperial College London
- Max Planck Institute for Polymer Research
- University of Groningen
- University of Twente

Budget and organisation
Expenditure in 2015 totalled € 0.18 million. The total number of FTEs allocated at year-end 2015 was 7.1 (9 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 thirteen reviewed papers.

For details, see page 31

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 2015 totalled € 0.10 million. The total number of FTEs allocated at year-end 2015 was 2.0 (2 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.

For details see page 32

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, all of DPI's partners have first right of refusal for the intellectual property (IP) generated in the first two years, but, after two years, if a project is continued, the IP is treated in the same way as in other technology areas.

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

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 generated no reviewed papers in 2015.

For details, see page 32

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)
- TI Food and Nutrition (TIFN)
- University of Groningen

Budget and organisation

Expenditure in 2015 totalled € 0.66 million. The total number of FTEs allocated at year-end 2015 was 3.8 (4 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 eleven reviewed papers and one thesis.

For details, see page 32

Output 2015

POLYOLEFINS

Projects

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

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

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

#787: In situ X-ray measurements

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

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

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

Theses

Nazila Yaghini
Towards the architectures of macromolecules

Cristian Grazioli
Determination of the thermodynamic parameters of interaction between the components of heterogeneous ziegler natta pre-catalyst

Scientific publications

M. Banaei, M. V. Annaland, J. A. M. Kuipers and N. G. Deen
On the accuracy of landweber and tikhonov reconstruction techniques in gas-solid fluidized bed applications
Aiche Journal 61(12) 4102-4113

E. Morra, E. Giamello, S. Van Doorslaer, G. Antinucci, M. D'Amore, V. Busico and M. Chiesa
Probing the coordinative unsaturation and local environment of ti3+ sites in an activated high-yield ziegler-natta catalyst
Angewandte Chemie-International Edition 54(16) 4857-4860

I. Kryven and P. D. Iedema
Transition into the gel regime for crosslinking radical polymerisation in a continuously stirred tank reactor
Chemical Engineering Science 126(296-308

N. Yaghini and P. D. Iedema
New models of radical polymerization with branching and scission predicting molecular weight distribution in tubular and series of continuous stirred tank reactors allowing for multiradicals and gelation
Chemical Engineering Science 130(301-309

N. Yaghini and P. D. Iedema
Predicting molecular weight distribution by deterministic modeling and monte carlo simulations of radical polymerization with branching and scission allowing for multiradicals and gelation in various reactor configurations
Chemical Engineering Science 130(310-318

N. Yaghini and P. D. Iedema
Population balance modeling of full two-dimensional molecular weight and branching distributions for ldpe with topological scission in continuous stirred tank reactor
Chemical Engineering Science 137(556-571

H. S. Zijlstra and S. Harder
Methylalumoxane - history, production, properties, and applications
European Journal of Inorganic Chemistry 1) 19-43

C. Boulho, H. S. Zijlstra and S. Harder
Oxide-bridged heterobimetallic aluminum/zirconium catalysts for ethylene polymerization
European Journal of Inorganic Chemistry 12) 2132-2138

D. W. van der Meer, J. Varga and G. J. Vancso
The influence of chain defects on the crystallisation behaviour of isotactic polypropylene
Express Polymer Letters 9(3) 233-254

C. Ehm, P. H. M. Budzelaar and V. Busico
Calculating accurate barriers for olefin insertion and related reactions
Journal of Organometallic Chemistry 775(39-49

E. Morra, A. Cuko, S. Maurelli, G. Berlier, P. Ugliengo and M. Chiesa
Electronic structure of ti3+-ethylene complexes in microporous aluminophosphate materials. A combined epr and dft study elucidating the role of somo orbitals in metal-olefin pi complexes
Journal of Physical Chemistry C 119(46) 26046-26055

M. A. Bashir, V. Monteil, V. Kanellopoulos, M. A. Ali and T. McKenna
Partial molar volumes and thermal expansion coefficients as an explanation for co-solvent effect of penetrants in multicomponent polymer mixtures
Macromolecular Chemistry and Physics 216(21) 2129-2140

K. S. Liu, S. Ronca, E. Andablo-Reyes, G. Forte and S. Rastogi
Unique rheological response of ultrahigh molecular weight polyethylenes in the presence of reduced graphene oxide
Macromolecules 48(1) 131-139

H. S. Zijlstra, M. C. A. Stuart and S. Harder
Structural investigation of methylalumoxane using transmission electron microscopy
Macromolecules 48(15) 5116-5119

E. M. Troisi, G. Portale, Z. Ma, M. van Drongelen, D. Hermida-Merino and G. W. M. Peters
Unusual melting behavior in flow induced crystallization of lldpe: Effect of pressure
Macromolecules 48(8) 2551-2560

I. Guerrero-Rios, E. Novarino, B. Hessen and M. W. Bouwkamp
Quantification of activated single-site olefin polymerization catalysts on a solid support
Organometallics 34(23) 5589-5596

E. Morra, S. Maurelli, M. Chiesa and S. Van Doorslaer
Probing the coordination environment of ti3+ ions coordinated to nitrogen-containing lewis bases
Physical Chemistry Chemical Physics 17(32) 20853-20860

N. Yaghini and P. D. Iedema
Branching determination from radius of gyration contraction factor in radical polymerization
Polymer 59(166-179

K. C. H. Tijssen, E. S. Blaakmeer and A. P. M. Kentgens
Solid-state nmr studies of ziegler-natta and metallocene catalysts
Solid State Nuclear Magnetic Resonance 68-69(37-56

E. Morra, S. Maurelli, M. Chiesa and E. Giamello
Rational design of engineered multifunctional heterogeneous catalysts. The role of advanced epr techniques
Topics in Catalysis 58(12-13) 783-795

PERFORMANCE POLYMERS

Projects

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

#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

#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

#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

#796: REFINE

Thesis

Karel Wilsens
Exploring the application of 2,5-furandicarboxylic acid as a monomer in high performance polymers

Scientific publications

G. M. Bogels, H. P. C. van Kuringen, I. K. Shishmanova, I. K. Voets, A. P. H. J. Schenning and R. P. Sijbesma
Selective absorption of hydrophobic cations in nanostructured porous materials from crosslinked hydrogen-bonded columnar liquid crystals
Advanced Materials Interfaces 2(7)

J. Wu, P. Eduard, S. Thiyagarajan, B. A. J. Noordover, D. S. van Es and C. E. Koning
Semi-aromatic polyesters based on a carbohydrate-derived rigid diol for engineering plastics
Chemsuschem 8(1) 67-72

N. O. Jaensson, M. A. Hulsen and P. D. Anderson
Stokes-cahn-hilliard formulations and simulations of two-phase flows with suspended rigid particles
Computers & Fluids 111(1-17

E. Miloskovska, D. Hristova-Bogaerds, M. van Duin and G. de With
In situ silica-epdm nanocomposites obtained via reactive processing
European Polymer Journal 69(260-272

Y. L. Zhao, Z. Chen, X. M. Zhu and M. Moller
Silica nanoparticles catalyse the formation of silica nanocapsules in a surfactant-free emulsion system
Journal of Materials Chemistry A 3(48) 24428-24436

N. O. Jaensson, M. A. Hulsen and P. D. Anderson
Simulations of the start-up of shear flow of 2d particle suspensions in viscoelastic fluids: Structure formation and rheology
Journal of Non-Newtonian Fluid Mechanics 225(70-85

H. P. C. van Kuringen, J. W. A. Leijten, A. H. Gelebart, D. J. Mulder, G. Portale, D. J. Broer and A. P. H. J. Schenning
Photoresponsive nanoporous smectic liquid crystalline polymer networks: Changing the number of binding sites and pore dimensions in polymer adsorbents by light
Macromolecules 48(12) 4073-4080

L. M. Polgar, M. van Duin, A. A. Broekhuis and F. Picchioni
Use of diels-alder chemistry for thermo-reversible cross-linking of rubbers: The next step toward recycling of rubber products?
Macromolecules 48(19) 7096-7105

E. Miloskovska, C. Friedrichs, D. Hristova-Bogaerds, O. Persenair, M. van Duin, M. R. Hansen and G. de With
Chemical mapping of silica prepared via sol-gel reaction in rubber nanocomposites
Macromolecules 48(4) 1093-1103

C. H. R. M. Wilsens, Y. S. Deshmukh, W. Q. Liu, B. A. J. Noordover, Y. F. Yao, H. E. H. Meijer and S. Rastogi
Processing and performance of aromatic-aliphatic thermotropic polyesters based on vanillic acid
Polymer 60(198-206

C. H. R. M. Wilsens, N. J. M. Wullems, E. Gubbels, Y. F. Yao, S. Rastogi and B. A. J. Noordover
Synthesis, kinetics, and characterization of bio-based thermosets obtained through polymerization of a 2,5-furandicarboxylic acid-based bis(2-oxazoline) with sebacic acid
Polymer Chemistry 6(14) 2707-2716

Y. Wang, Y. Gao, H. M. Wyss, P. D. Anderson and J. M. J. den Toonder
Artificial cilia fabricated using magnetic fiber drawing generate substantial fluid flow
Microfluidics and Nanofluidics 18(2) 167-174

FUNCTIONAL POLYMER SYSTEMS

Projects

#762: Solution-Processed Small-Molecule Tandem OPV

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

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

#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

#792: Particle Stability and Mobility in Silicones

Theses

Umesh Chinnaswarmy Panchataram
Ordering Properties of Oligomeric Columnar Discotic Liquid Crystals

Isabelle Monnaie
Structure creation of P3HT in solution

Scientific publications

J. J. van Franeker, S. Kouijzer, X. W. Lou, M. Turbiez, M. M. Wienk and R. A. J. Janssen
Depositing fullerenes in swollen polymer layers via sequential processing of organic solar cells
Advanced Energy Materials 5(14)

J. J. van Franeker, D. Westhoff, M. Turbiez, M. M. Wienk, V. Schmidt and R. A. J. Janssen
Controlling the dominant length scale of liquid-liquid phase separation in spin-coated organic semiconductor films
Advanced Functional Materials 25(6) 855-863

A. Micoli, M. Nieuwenhuizen, M. Koenigs, M. Quintana, R. Sijbesma and M. Prato
Supramolecular macrostructures of upy-functionalized carbon nanotubes
Chemistry-a European Journal 21(40) 1 4179-14185

A. O. F. Jones, P. Knauer, R. Resel, A. Ringk, P. Strohriegl, O. Werzer and M. Sferrazza
Thermal stability and molecular ordering of organic semiconductor monolayers: Effect of an anchor group
Chemphyschem 16(8) 1712-1718

I. Stengel, G. Gotz, M. Weil and P. Bauerle
A dinuclear (bpy)pt-ii-decorated crownophane
European Journal of Organic Chemistry 18) 3887-3893

M. J. M. Wirix, P. H. H. Bomans, M. M. R. M. Hendrix, H. Friedrich, N. A. J. M. Sommerdijk and G. De With
Visualizing order in dispersions and solid state morphology with cryo-tem and electron tomography: P3ht: Pcbm organic solar cells
Journal of Materials Chemistry A 3(9) 5031-5040

H. H. Feng, M. Bohmer, R. Fokkink, J. Sprakel and F. Leermakers
Reentrant stabilization of grafted nanoparticles in polymer solutions
Journal of Physical Chemistry B 119(40) 12938-12946

J. J. van Franeker, G. H. L. Heintges, C. Schaefer, G. Portale, W. W. Li, M. M. Wienk, P. van der Schoot and R. A. J. Janssen
Polymer solar cells: Solubility controls fiber network formation
Journal of the American Chemical Society 137(36) 11783-11794

H. H. Feng, D. Ershov, T. Krebs, K. Schroen, M. A. C. Stuart, J. van der Gucht and J. Sprakel
Manipulating and quantifying temperature-triggered coalescence with microcentrifugation
Lab on a Chip 15(1) 188-194

C. P. Umesh, A. T. M. Marcelis and H. Zuilhof
Ordering properties of columnar discotic triazines containing three pendant triphenylenes with four or five fluorinated tails
Liquid Crystals 42(10) 1450-1459

C. P. Umesh, A. T. M. Marcelis and H. Zuilhof
Columnar ordering properties of fluorinated and non-fluorinated tris(hexaalkoxytriphenylene) tristriazolotriazines
Liquid Crystals 42(9) 1269-1279

J. J. van Franeker, M. Turbiez, W. W. Li, M. M. Wienk and R. A. J. Janssen
A real-time study of the benefits of co-solvents in polymer solar cell processing
Nature Communications 6(

H. H. Feng, J. Sprakel and J. van der Gucht
Hydrodynamic model for drying emulsions
Physical Review E 92(2)

H. Khandelwal, R. C. G. M. Loonen, J. L. M. Hensen, M. G. Debije and A. P. H. J. Schenning
Electrically switchable polymer stabilised broadband infrared reflectors and their potential as smart windows for energy saving in buildings
Scientific Reports 5:11773

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

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

#781: Film Formation in Complex Colloidal Coatings

Theses

Koen Adema
Photodegradation of polyester-urethane coatings

Hesam Makki
Modeling and physical study of weathering of a polyesterurethane coatings

Caroline Rocco
Polymérisation sous rayonnement UV et lumière naturelle de réseaux de polymères interpénétrés pour des revêtements auto-régénérants

Scientific publications

G. Kacar, E. A. J. F. Peters and G. de With
Multi-scale simulations for predicting material properties of a cross-linked polymer
Computational Materials Science 102(68-77

N. Zheng, Z. Y. Yi, Z. Z. Li, R. Chen, Y. Q. Lai and Y. F. Men
Achieving grazing-incidence ultra-small-angle x-ray scattering in a laboratory setup
Journal of Applied Crystallography 48(608-612

X. Allonas, A. Ibrahim, V. Charlot, M. Retailleau, F. Karasu and C. Croutxe-Barghorn
Development of new photoinitiating systems for depth curing of thick materials
Journal of Photopolymer Science and Technology 28(1) 25-29

S. Q. Shi, F. Karasu, C. Rocco, X. Allonas and C. Croutxe-Barghorn
Photoinitiating systems for led-cured interpenetrating polymer networks
Journal of Photopolymer Science and Technology 28(1) 31-35

H. M. van der Kooij, M. de Kool, J. van der Gucht and J. Sprakel
Coalescence, cracking, and crack healing in drying dispersion droplets
Langmuir 31(15) 4419-4428

G. Kacar, E. A. J. F. Peters, L. G. J. van der Ven and G. de With
Hierarchical multi-scale simulations of adhesion at polymer-metal interfaces: Dry and wet conditions
Physical Chemistry Chemical Physics 17(14) 8935-8944

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
Kinetic monte carlo simulation of the photodegradation process of polyester-urethane coatings
Physical Chemistry Chemical Physics 17(30) 19962-19976

Y. Zhang, C. Rocco, F. Karasu, L. G. J. van der Ven, R. A. T. M. van Benthem, X. Allonas, C. Croutxe-Barghorn, A. C. C. Esteves and G. de With
Uv-cured self-replenishing hydrophobic polymer films
Polymer 69(384-393

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
Quantitative spectroscopic analysis of weathering of polyester-urethane coatings
Polymer Degradation and Stability 121(280-291

H. Makki, K. N. S. Adema, M. M. R. M. Hendrix, E. A. J. F. Peters, J. Laven, L. G. J. van der Ven, R. A. T. M. van Benthem and G. de With
Weathering of a polyester-urethane clearcoat: Lateral inhomogeneities
Polymer Degradation and Stability 122(180-186

Y. Y. Li, B. A. J. Noordover, R. A. T. M. van Benthem and C. E. Koning
Bio-based poly(urethane urea) dispersions with low internal stabilizing agent contents and tunable thermal properties
Progress in Organic Coatings 86(134-142

H. M. van der Kooij and J. Sprakel
Watching paint dry; more exciting than it seems
Soft Matter 11(32) 6353-6359

HIGH-THROUGHPUT EXPERIMENTATION

Thesis

Aleksandra Chojnacka
Quantitative pyrolysis - gas chromatography - mass spectrometry to study polymer dissolution and solubility

Scientific publications

N. Kuhl, S. Bode, R. K. Bose, J. Vitz, A. Seifert, S. Hoeppener, S. J. Garcia, S. Spange, S. van der Zwaag, M. D. Hager and U. S. Schubert
Acylhydrazones as reversible covalent crosslinkers for self-healing polymers
Advanced Functional Materials 25(22) 3295-3301

C. von der Ehe, F. Kretschmer, C. Weber, S. Crotty, S. Stumpf, S. Hoeppener, M. Gottschaldt and U. S. Schubert
Raft copolymerization of thioglycosidic glycomonomers with nipam and subsequent immobilization onto gold nanoparticles
Controlled Radical Polymerization, Vol 2: Materials 1188(221-256

E. van Bracht, R. Raave, I. Y. Perevyazko, E. M. Versteeg, T. G. Hafmans, U. S. Schubert, E. Oosterwijk, T. H. van Kuppevelt and W. F. Daamen
Biodistribution of size-selected lyophilisomes in mice
European Journal of Pharmaceutics and Biopharmaceutics 94(141-151

A. Can, Q. L. Zhang, T. Rudolph, F. H. Schacher, J. F. Gohy, U. S. Schubert and R. Hoogenboom
Schizophrenic thermoresponsive block copolymer micelles based on lcst and ucst behavior in ethanol-water mixtures
European Polymer Journal 69(460-471

M. E. Favretto, A. Krieg, S. Schubert, U. S. Schubert and R. Brock
Multifunctional poly(methacrylate) polyplex libraries: A platform for gene delivery inspired by nature
Journal of Controlled Release 209(1-11

G. M. E. Pozza, S. Crotty, M. Rawiso, U. S. Schubert and P. J. Lutz
Molecular and structural characterization of hybrid poly(ethylene oxide) polyhedral oligomeric silesquioxanes star-shaped macromolecules
ournal of Physical Chemistry B 119(4) 1669-1680

J. A. Czaplewska, T. C. Majdanski, M. J. Barthel, M. Gottschaldt and U. S. Schubert
Functionalized peg-b-page-b-plga triblock terpolymers as materials for nanoparticle preparation
Journal of Polymer Science Part a-Polymer Chemistry 53(18) 2163-2174

B. Sandmann, B. Happ, S. Kupfer, F. H. Schacher, M. D. Hager and U. S. Schubert
The self-healing potential of triazole-pyridine-based metallopolymers
Macromolecular Rapid Communications 36(7) 604-609

M. M. Bloksma, M. M. R. M. Hendrix, S. Rathgeber, U. S. Schubert and R. Hoogenboom
Main-chain chiral poly(2-oxazoline)s: Influence of alkyl side-chain on secondary structure formation in the solid state
Macromolecular Symposia 350(1) 43-54

LARGE-AREA THIN FILM ELECTRONICS

Projects

#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 multi-layer barriers

Scientific publications

E. H. Huisman, A. G. Shulga, P. J. Zomer, N. Tombros, D. Bartesaghi, S. Z. Bisri, M. A. Loi, L. J. A. Koster and B. J. van Wees
High gain hybrid graphene-organic semiconductor phototransistors
Acs Applied Materials & Interfaces 7(21) 11083-11088

A. Perrotta, S. J. Garcia, J. J. Michels, A. M. Andringa and M. Creatore
Analysis of nanoporosity in moisture permeation barrier layers by electrochemical impedance spectroscopy
Acs Applied Materials & Interfaces 7(29) 15968-15977

A. M. Andringa, A. Perrotta, K. de Peuter, H. C. M. Knoops, W. M. M. Kessels and M. Creatore
Low-temperature plasma-assisted atomic layer deposition of silicon nitride moisture permeation barrier layers
Acs Applied Materials & Interfaces 7(40) 22525-22532

G. E. Eperon, S. N. Habisreutinger, T. Leijtens, B. J. Bruijnaers, J. J. van Franeker, D. W. Dequilettes, S. Pathak, R. J. Sutton, G. Grancini, D. S. Ginger, R. A. J. Janssen, A. Petrozza and H. J. Snaith
The importance of moisture in hybrid lead halide perovskite thin film fabrication
Acs Nano 9(9) 9380-9393

J. G. Labram, Y. H. Lin, K. Zhao, R. P. Li, S. R. Thomas, J. Semple, M. Androulidaki, L. Sygellou, M. McLachlan, E. Stratakis, A. Amassian and T. D. Anthopoulos
Signatures of quantized energy states in solution-processed ultrathin layers of metal-oxide semiconductors and their devices
Advanced Functional Materials 25(11) 1727-1736

D. Bartesaghi and L. J. A. Koster
The effect of large compositional inhomogeneities on the performance of organic solar cells: A numerical study
Advanced Functional Materials 25(13) 2013-2023

T. P. Voortman, D. Bartesaghi, L. J. A. Koster and R. C. Chiechi
Cross-conjugated n-dopable aromatic polyketone
Macromolecules 48(19) 7007-7014

D. Westhoff, J. J. Van Franeker, T. Brereton, D. P. Kroese, R. A. J. Janssen and V. Schmidt
Stochastic modeling and predictive simulations for the microstructure of organic semiconductor films processed with different spin coating velocities
Modelling and Simulation in Materials Science and Engineering 23(4)

D. Bartesaghi, I. D. Perez, J. Kniepert, S. Roland, M. Turbiez, D. Neher and L. J. A. Koster
Competition between recombination and extraction of free charges determines the fill factor of organic solar cells
Nature Communications 6(

D. Bartesaghi, M. Turbiez and L. J. A. Koster
Charge transport and recombination in pdpp5t:[70]pcbm organic solar cells: The influence of morphology (vol 15, pg 3191, 2014)
Organic Electronics 24(330-330

C. Schaefer, P. van der Schoot and J. J. Michels
Structuring of polymer solutions upon solvent evaporation
Physical Review E 91(2)

A. Perrotta, S. J. Garcia and M. Creatore
Ellipsometric porosimetry and electrochemical impedance spectroscopy characterization for moisture permeation barrier layers
Plasma Processes and Polymers 12(9) 968-979

A. Perrotta, G. Aresta, E. R. J. van Beekum, J. Palmans, P. van de Weijer, M. C. M. R. van de Sanden, W. M. M. E. Kessels and M. Creatore
The impact of the nano-pore filling on the performance of organosilicon-based moisture barriers
Thin Solid Films 595(251-257

POLYMERS FOR ENHANCED OIL RECOVERY

Projects

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

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

Scientific publications

P. Raffa, D. A. Z. Wever, F. Picchioni and A. A. Broekhuis
Polymeric surfactants: Synthesis, properties, and links to applications
Chemical Reviews 115(16) 8504-8563

D. Kawale, A. T. van Nimwegen, L. M. Portela, M. A. van Dijk and R. A. W. M. Henkes
The relation between the dynamic surface tension and the foaming behaviour in a sparger setup
Colloids and Surfaces a-Physicochemical and Engineering Aspects 481(328-336

EMERGING TECHNOLOGIES

Project

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

CORPORATE RESEARCH

Projects

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

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

#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

Thesis

Marianna Manca
Unraveling structure and dynamics by confocal microscopy

Scientific publications

M. L. Petrus, T. Bein, T. J. Dingemans and P. Docampo
A low cost azomethine-based hole transporting material for perovskite photovoltaics
Journal of Materials Chemistry A 3(23) 12159-12162

M. L. Petrus, T. Bein, T. J. Dingemans and P. Docampo
A low cost azomethine-based hole transporting material for perovskite photovoltaics (vol 3, pg 12159, 2015)
Journal of Materials Chemistry A 3(32) 16874-16874

P. C. Roozemond, M. van Drongelen, Z. Ma, A. B. Spoelstra, D. Hermida-Merino and G. W. M. Peters
Self-regulation in flow-induced structure formation of polypropylene
Macromolecular Rapid Communications 36(4) 385-390

L. R. Hutchings, S. Agostini, I. W. Hamley and D. Hermida-Merino
Chain architecture as an orthogonal parameter to influence block copolymer morphology. Synthesis and characterization of hyperbranched block copolymers: Hyperblocks
Macromolecules 48(24) 8806-8822

G. E. Newby, E. B. Watkins, D. H. Merino, P. A. Staniec and O. Bikondoa
In situ rheo-gisans of triblock copolymers: Gelation and shear effects on quasi-crystalline structures at interfaces
Rsc Advances 5(126) 104164-104171

D. Hermida-Merino, G. E. Newby, I. W. Hamley, W. Hayes and A. Slark
Microphase separation induced in the melt of pluronic copolymers by blending with a hydrogen bonding urea-urethane end-capped supramolecular polymer
Soft Matter 11(29) 5799-5803

A. Cumurcu, J. Diaz, I. D. Lindsay, S. de Beer, J. Duvigneau, P. Schon and G. J. Vancso
Optical imaging beyond the diffraction limit by snem: Effects of afm tip modifications with thiol monolayers on imaging quality
Ultramicroscopy 150(79-87

Y. Jiang, D. Maniar, A. J. J. Woortman, G. O. R. A. van Ekenstein and K. Loos
Enzymatic polymerization of furan-2,5-dicarboxylic acid-based furanic-aliphatic polyamides as sustainable alternatives to polyphthalamides
Biomacromolecules 16(11) 3674-3685

M. L. Petrus, F. S. F. Morgenstern, A. Sadhanala, R. H. Friend, N. C. Greenham and T. J. Dingemans
Device performance of small-molecule azomethine-based bulk heterojunction solar cells
Chemistry of Materials 27(8) 2990-2997

Y. Jiang, A. J. J. Woortman, G. O. R. A. van Ekenstein and K. Loos
A biocatalytic approach towards sustainable furanic-aliphatic polyesters
Polymer Chemistry 6(29) 5198-5211

Y. Jiang, A. J. J. Woortman, G. O. R. A. van Ekenstein and K. Loos
Environmentally benign synthesis of saturated and unsaturated aliphatic polyesters via enzymatic polymerization of biobased monomers derived from renewable resources
Polymer Chemistry 6(30) 5451-5463

EXCHANGE PROGRAMME BRAZIL

Projects

#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

#779: Preparation and Characterization of Model Waterborne Clearcoats

#794: Microbial Synthesis of Functional Polyhydroxyalkanoates (PHA)

Reported invention

#779: Y. Men, Z. Li and Z. Yi
Preparation of Pickering stabilized polymeric latex dispersion using Laponite as stabilizing particle

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

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