Petrochemical industry trends: sustainability and circular economy

Presentation for Partners
Dynamics of global chemical industry and global GDP growth (1980-2017), %
Positive effect from the use of petrochemicals significantly outweighs a negative effect from their production.

Petrochemical products have a two-way impact on the environment: production certainly results in the release of greenhouse gases, however the use of petrochemicals in different industries contributes to reducing such emissions by more than 2 times compared to the produced asset, which generally has a positive effect not only on the environment but also on the economy.

Production of polymers and other petrochemicals is more environmentally friendly than production of comparable materials including metal and paper.

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<thead>
<tr>
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<tbody>
<tr>
<td>Energy consumption for production of 1 item 355 ml</td>
<td>0.9 W*h</td>
<td>0.63 W*h</td>
<td>0.58 W*h</td>
</tr>
<tr>
<td>Recycling potential</td>
<td>100%</td>
<td>Up to 80%</td>
<td>100%</td>
</tr>
<tr>
<td>Decomposition time</td>
<td>500 years</td>
<td>&gt;1,000 years</td>
<td>300 years</td>
</tr>
<tr>
<td>Air emissions CO₂ equivalent</td>
<td>1.2 kg</td>
<td>2.2 kg</td>
<td>0.5 kg</td>
</tr>
</tbody>
</table>

Source: Table D-1, Franklin Associates, Green Lifestyle Magazine, The Container Recycling Institute, Columbia University Fu Foundation School of Engineering and Applied Science
However, recently, regulators impose limitations and bans on some plastics

<table>
<thead>
<tr>
<th>Products</th>
<th>Regulations</th>
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</table>
| **Plastic bags**       | - 83 ban on free-of-charge distribution  
- 61 bans on manufacturing and imports  
- 51 recycling targets  
- 43 elements of extended producer responsibility  
- 41 requirements to the content of material: biodegradable, compostable and/or recycled  
- 38 regulating the thickness of plastic bags  
- 27 production taxes/fees  |

*127 countries* adopted various forms of plastic bags regulation

| **Single-use plastics** | - 63 elements of extended producer responsibility  
- 51 circulation/ recycling regulation (such as requirements to separate collection, etc.)  
- 29 various forms of taxes  
- 26 recycling targets  
- 23 deposit return schemes of sales (primarily bottles)  
- 16 specific polymers bans (primarily PS and EPS) |

Such regulation may concern certain products (dishware, packaging, etc.), materials (PS) or volume/format of production

| **Plastic microgranules** | - 8 ban on using (Canada, France, South Korea, Sweden, the UK, the US, etc.)  
- 7 control over use and/or production (including cleaning agents)  
- 4 Belgium, Brazil, India, Ireland, EU intend to introduce a ban |

A number of large companies voluntarily refuse using microplastics.

*Source: UNEP*
Regulators are driving change

**EU Plastic Strategy 2030:**
- 55% of recycled material in plastic packaging
- More than 50% of plastic waste are to be recycled
- Plastic packaging is 100% recyclable and/or suitable for reuse
- Growth of capacities for waste separation and recycling for 4 time (compared to 2015)
- Biodegradable plastic ban

**Asian legislation:**
- > 60% of states enacted bans and restrictions in regards of single-use plastic
- Ban on plastic waste import in China
- India is to ban 100% single-use plastic by 2022
- Indonesia to reduce plastic waste by 70% by 2025

**Secondary plastic content in EU by 2025**
- Bottles, PET (25%)
- PET in packaging (25%)
- Bottle caps (30%)
- Pallets, PETF (50%)
- Shrink wrap, PE (50%)

**Germany:**
Consumers pay obligatory utilization fee (22ct) for each single-use plastic bag; distributors and vendors are responsible for waste collection and recycling

**Kenia:**
Penalty at a rate of $19-38k or 4 years of imprisonment for import, use or production of polybag
Primary driver of such regulation is concern about the increasing amount of plastic waste in the World Ocean

95% of plastic waste gets into the World Ocean from 10 rivers

Source of microplastics in the World Ocean:

- Tyres: 28%
- Polymer granules: 4%
- Plastic-based textile: 8%
- Paintings of buildings: 14%
- Road markings: 20%
- Cosmetics and hygiene products: 24%
- Marine coating (PWM): 2%

Source: C. Schmidt, “Export of Plastic Debris by Rivers into the Sea”, 2017
Global FMCG companies make voluntary commitments that are more stringent than the regulator has established.

### Global goals of manufacturers of consumer goods

<table>
<thead>
<tr>
<th>Company</th>
<th>Commitment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nestlé</td>
<td>100% recyclable or reusable packaging by 2025</td>
</tr>
<tr>
<td>PepsiCo</td>
<td>100% recyclable or biodegradable packaging by 2025</td>
</tr>
<tr>
<td>P&amp;G</td>
<td>100% reusable or recyclable packaging by 2030</td>
</tr>
<tr>
<td>Coca-Cola</td>
<td>100% recyclable packaging, bottles are 50% made of recyclables, 100% bottles collected and recycled by 2030</td>
</tr>
<tr>
<td>Danone</td>
<td>100% recyclable, reusable or biodegradable packaging by 2025</td>
</tr>
<tr>
<td>Evian</td>
<td>Evian bottles of 100% recyclables</td>
</tr>
<tr>
<td>Unilever</td>
<td>100% recyclable, reusable or biodegradable packaging by 2025</td>
</tr>
<tr>
<td>Unilever</td>
<td>over 25% content of recyclables</td>
</tr>
<tr>
<td>Henkel</td>
<td>100% recyclable or biodegradable packaging by 2025</td>
</tr>
<tr>
<td>Amcor</td>
<td>100% reusable or recyclable packaging by 2030</td>
</tr>
<tr>
<td>Tesco</td>
<td>100% recyclable packaging by 2019</td>
</tr>
</tbody>
</table>
Ensuring sustainability is a global task (UN Sustainable Development Goals)

Investors take non-financial (i.e. environmental) risks into consideration

Regulators toughen up environmental laws

Increasing demand to recycling and recycled materials use in B2B

Shift from linear to circular model of consumption in B2C

Consumers pay attention to ecological properties of goods and packaging

Capital markets tend towards “green” industries rather than “polluting” ones

Sustainability trend is strengthening
The share of investors considering climate risks & sustainability is steadily growing

According to PwC 2018 Private Equity Funds Survey,

- 76% of investors consider waste management practices
- 77% of investors notice the significance of carbon footprint

According to Barclays Survey,

- 68% of investors prefer to invest in companies producing eco packaging

Source: EY 2018; PWC Private Equity Responsible Investment Survey 2019; «Tackling the challenge of plastic pollution. What can investors do?» Barclays, 2018
Companies that integrate sustainability in corporate strategy have higher business valuation and higher profits

<table>
<thead>
<tr>
<th>Oil &amp; Gas</th>
<th>Pharmaceuticals</th>
<th>FMCG</th>
<th>Banking &amp; Finance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health &amp; Safety</td>
<td>Expand access to drugs</td>
<td>Responsible procurement</td>
<td>Expand access to financial services</td>
</tr>
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According to Boston Consulting Group research

<table>
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<tr>
<th>Business valuation growth</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>+19</td>
<td>+12</td>
<td>+11</td>
<td>+3</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Profits grow</th>
<th></th>
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<tbody>
<tr>
<td>+3.4 p.p. EBITDA</td>
<td>+8.2 p.p. EBITDA</td>
<td>+4.8</td>
<td>+0.5</td>
</tr>
</tbody>
</table>

Source: MSCI ESG Research LLC, OEKOM research AG, BCG
Circular economy as a key paradigm of sustainability becomes a key to companies’ success in the future

According to the results of business leaders survey, BCG and WBCSD, 2018:

- 97% of respondents said that the circular economy drives innovation to help make the company more efficient and competitive
- 96% of respondents believe that the circular economy is important for their company’s future success
- 84% of respondents expect to increase their investments in circular economy projects in the future
- 51% of respondents state that circular economy activities already add to company profits

Source: The New Big Cycle, by WBCSD and BCG, 2018
Thanks to their unique properties, plastics are logically built into the circular economy

- **Plastics conserve resources**
  
  Lower weight of polymer package helps to save fuel during operation and energy during production.

- **Plastics decrease the amount of rubbish**
  
  Polymer packaging protects products from the effects of many external factors allowing consumers to receive fresh products and significantly extending a shelf life of such products by 2-4 times, thus ensuring a positive economic effect for producers and consumers.

- **Recycling of polymers into useful products**
  
  Plastics can be 100% recycled.

**Sources:** British Plastic Federation, Plasticsnews, NewChemistry,
Case: a typical plastic bottle can be processed into a sport T-shirt

NGL\(^1\) and LPG\(^2\) are extracted from APG\(^3\) being a by-product of oil production\(^1\)

Ethylene monomers are produced from LPG cracking

PET\(^4\) is produced by polymerisation of MEG\(^5\) recovered from ethylene and TA\(^6\)

Chemical bonds in the polymer chain determine the plasticity of the material: thermoplastics (T) and duroplastics (D)

Polymer granules are melt into a viscous substance, which is then blown out and stretched into a specific mold. The mold is then cooled to produce PET containers of a specific shape.

PET bottle

Primary election of PET bottles

Optoelectronic separation of bottles by color

Cutting into flakes

Washing

Material separation by density and drying

Automatic separation of flakes by color for further processing

Optoelectronic separation of flakes by color

Extruder converts flakes into granules\(^**\)

Production of PET-fibers

Recycled PET is used for clothing (e.g., sport T-shirts)

Recycled PET is added to the primary material for production of new bottles

Thermal film

Recycled PET is used for clothing (e.g., sport T-shirts)

Extruder converts flakes into granules\(^**\)

Automatic separation of flakes by color for further processing

Optoelectronic separation of flakes by color

Material separation by density and drying

PET bottle

Primary election of PET bottles

Optoelectronic separation of bottles by color

Cutting into flakes

Washing

Recycled PET is added to the primary material for production of new bottles

PET bottle

Note: *PET can also be produced from other feedstocks such as naphta.

** Depending on the area of application different equipment should be installed with corresponding CAPEX and OPEX.

Source: Plastics Europe

1 NGL – natural gas liquids
2 LPG – liquefied petroleum gas
3 APG – associated petroleum gas
4 PET – polyethyleneterephthalate
5 MEG – monoethyleneglycol
6 TA - terephthalic acid
Petrochemical companies’ transition towards the circular economy will increase the recycling volume.

Circular Economy is striving to close the loop of production-consumption-disposal by more efficient and sustainable use of resources across the whole value chain.

Despite a significant increase in demand for secondary polymers, the bulk of demand is driven by virgin polymers.
<table>
<thead>
<tr>
<th>Company</th>
<th>Recyclable Material</th>
<th>Recycling Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SABIC</td>
<td>Plastics</td>
<td>Chemical recycling</td>
<td>Signed a Memorandum of Understanding (MoU) with Plastic Energy Ltd, a UK based chemical recycling company, to supply raw materials for SABIC petrochemical activities in the EU</td>
</tr>
</tbody>
</table>
| Dow              | Plastics                     | Collection / recycling        | • New business models and growth strategies that monetize plastics waste recycling streams  
• New product offerings via technologies that will be used to transform plastic waste into valuable resources in North America and EMEA  
• New recycling, collection and infrastructure platforms for local value chain partners |
| Dupont           | Plastics                     | Chemical recycling            | Joint venture with Loop Industries Inc., a leading technology innovator in sustainable plastic resin; partnership plan to begin production in Q1 2020                                                        |
| Indorama Ventures| PET resin / polyester fiber  | Chemical recycling            |                                                                                                                                                                                                            |
| LyondellBasell   | Polypropylene / HDPE         | Chemical recycling            | • Plastics recycling joint venture with Suez in the Netherlands  
• Agreement with Karlsruhe Institute of Technology (KIT), Germany                                                                                                                                           |
| Borealis         | LDPE / HDPE                  | Mechanical recycling          | Acquisition of Ecoplast (Austria) that processes approximately 35 thousand tons of industrial and household plastic waste                                                                               |
SUSTAINABILITY IN SIBUR
SIBUR is a global player of petrochemical market

Legend
- gas processing & infrastructure
- infrastructure facilities
- R&D centers
- investment project
- investment projects under consideration
* total production capacity

- plastics, elastomers and intermediates
- olefins and polyolefins
- business support
- loading racks
- project engineering centers
- corporate health center

* Joint ventures
  - LLC RusVinyl (Kstovo) – JV with SolVin
  - LLC Yuzhno-Priobskiy GPP (Khanty-Mansiysk) – JV with Gazprom Neft Group
  - LLC NPP Neftekhimiya (Moscow) – JV with Gazprom Neft Group
  - LLC POLIDM (Omsk) – JV with Gazprom Neft Group and Titan Group
  - Reliance Sibur Elastomers Private Limited (Jamnagar) – JV with Reliance Industries Limited

** LPG and light oils transshipment terminal. The terminal operator
SIBUR effectively reprocesses by-products purchased from oil and gas companies into high value-added products

(1) Associated petroleum gas (APG) is a by-product of oil production
(2) Liquified hydrocarbon crude (LHCC) including natural gas liquids (NGL), liquified petroleum gas (LPG) and naftha is by-product of gas production
SIBUR produces a wide range of petrochemical products

<table>
<thead>
<tr>
<th>FUEL AND FEEDSTOCK PRODUCTS</th>
<th>POLYOLEFINS</th>
<th>BOPP FILMS</th>
<th>RUBBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORGANIC SYNTHESIS</td>
<td>POLYETHYLENE TEREPHTHALATE</td>
<td>EXPANDED POLYSTYRENE ALPHAPOR</td>
<td>THERMOPLASTIC ELASTOMERS</td>
</tr>
</tbody>
</table>
Launch of ZapSibNefteKhim will sufficiently increase range of product solutions.
SIBUR is the member of CEFIC…

All products exported by SIBUR Group to the EU were registered in 2010 under the EU REACH Regulation (Registration, Evaluation and Authorisation of Chemicals).

In 2017 SIBUR became a member of the European Chemical Industry Council (Cefic) and joined the European Ethylene Producers Committee (EEPC).

… and active participant of Operation Clean Sweep

In January 2018, SIBUR joined Operation Clean Sweep – a PlasticsEurope initiative that aims to prevent the loss of polymer particles during production and logistics processes.

During 2018 prevented the loss of 186 tons of plastic pellets into the environment, with 86% going back to the production cycle and the rest being disposed of as required or sold.
SIBUR takes care of possible social and environmental consequences of its activity and follows the principles of sustainable development.

Social responsibility
Charity activity of PJSC SIBUR Holding is performed within the scope of "Good deeds formula" programme. In 2017, 130 projects from 17 SIBUR's presence cities became winners of Regional Socially Important Projects Competition.

Total amount invested in implementation of these projects numbered ₽91 316 283 rubles.

Responsible approach
SIBUR has implemented an integrated management system (IMS) and got it certified to the requirements of the following international standards:
- OHSAS 18001
- ISO 9001
- ISO 14001
- ISO 50001
In 2014, SIBUR joined Responsible Care Programme.

SIBUR’s ecological mission
In 2017, SIBUR processed 22,8 bln m³ APG, preventing atmospherical emission of ≈7 mln tons of polluting substances.
It is comparable with annual emissions of such countries as Malta, Cyprus, Iceland, Albania, Moldova, and Estonia.

Participation in international ratings of sustainable development (CDP, EcoVadis, Sustainalytics). SIBUR took the 14th place in the first ECO-rating of the largest Russia’s Implementation.

Implementation of the “green office” concept (separate collection of garbage in public areas, installation of motion sensors in public areas in order to save electricity, office of recycled materials etc.)
SIBUR is also elaborating recycling projects

**Mechanical recycling**

1. Flex-to-resin (FTR) production at production facilities
2. Integration of print removal, metallization from BOPP films and obtaining secondary feedstock
3. Development of a special HDPE grade for manufacturing polymer pellets
4. Obtaining secondary feedstock such as granules and using it to produce FFS film

**Chemical recycling**

1. Chemical recycling of secondary plastics – thermolysis of secondary plastics into a mixture of hydrocarbons that is subsequently converted into olefins, whereupon new polymers are produced
2. Gasification of the municipal solid waste left after sorting producing synthesis gas and subsequent production of ethanol.
3. Chemical recycling of PETE – depolymerization of low-quality feedstock (dirty colored flake, cloth, carpets, etc.) with polymer cleanup and subsequent production of clean virgin PET.
SIBUR actively supports the transition of Russia towards the circular economy model

**Basketbottle and Hockeybottle** – projects aimed at collection of plastic bottles in and around national sports arenas

15 t collected during 2 years of the project implementation

Jointly with Wilson, a global manufacturer of equipment for tennis and team sports, SIBUR presented the first eco-friendly **basketball made from recycled plastic bottles**. It’s the official ball of the VTB United League.

SIBUR supported the “**Separating the Right Way**” initiative of the Ministry of Natural Resources and Ecology of Russia designed to pursue a complex of activities and campaigns in the area of separate collection and disposal of municipal waste.
R&D IN SIBUR: INNOVATIVE & SUSTAINABLE
On top of operational excellence focus, we are also looking for specialty chemistry opportunities in multiple industries.

Focus on production technology

- Innovative technologies
  - Alternative feedstock
    - Methane to olefins and aromatics (BTX fraction)
  - Technology
    - Heat exchange
    - Mass transfer
    - Dynamic equipment
    - New reactor types
  - Technological optimization
  - Product
    - Brand assortment expansion

Focus on new products

- New product
  - Long term R&D focus
    - New chemical solutions based on current – and future – company product portfolio
  - Specialty chemistry for:
    - Heavy machinery
    - Oil & Gas
    - Agriculture
    - FMCG
    - Robotics
    - Mobility

... and our R&D projects are carried out throughout the value chain - from raw materials to new products.
Our R&D expertise goes from development of new grades and compounds to processing technologies and testing of end products

NIOST

Developing and testing of new polymers
- Assessment of material properties
- Analysis of competitive samples
- Development and optimization of materials formulations

Technical Center for Development and Processing of Polyolefins

Processing of new polymers
- Processing of raw materials on pilot production lines into end products across various segments:
  - Compounds
  - Packaging
  - Consumer goods
  - Piping
  - Fibers

Testing of end products
- Testing of formulated grades and end products on a state-of-the-art equipment in accordance to requirements of the industry

Sibur
NIOST in Tomsk is in the avant-garde of SIBUR’s R&D activities

NIOST laboratories are equipped with state-of-the-art analytical facilities of global leading manufacturers and workplaces of employees are compliant with global standards.

Key objectives:

- R&D projects implementation in the priority scientific and technical areas of the company
- Development of innovative ideas and proposals to be implemented by the Company
- Concentration and advanced training of scientific staff
To expand our R&D capabilities we employ Scientific Advisory Board (SAB) with the world’s leading experts from Business and Academia

The SAB’s role is to

- Review and advise on the proposals and plans prepared by SIBUR;
- Identify new areas of research where SIBUR can reap the benefits of cutting edge science and build the foundation for enterprise and industry growth;
- Highlight critical issues and emerging global trends where SIBUR could fill a gap or meet a need;
- Assist and advise on the management of R&D.

Some of 11 members of SAB in 2018:

- **Timothy Diephouse**
  - University of Michigan
  - Ph.D. Organic Chemistry
  - 32 year career in R&D at Dow Chemical

- **Krzysztof Matyjaszewski**
  - Carnegie Mellon University
  - University Professor
  - Over 150 patents

- **Geoffrey Coates**
  - Stanford University
  - Ph.D. in Organic Chemistry
  - Tisch University Professor

- **Brian Goodall**
  - Advisor to Fortune 100 Chemical Company (polymerization catalysts)
  - 100 US patents
In 2019, SIBUR opened PolyLab – a collaborative R&D center for the development and application of polyolefins

**Location**
on the territory of Skolkovo Innovation Center

**Building area**
5350 m²

**Main objectives of the center**
- Development of new grades
- Technical support, promotion of developed grades
- Optimization of developed grades
- Quality improvement of manufactured grades
- Platform for industry events and promotion of plastics consumption
- Complaint management

**Processing equipment**
- Injection moulding
- Extrusion blowing
- Pipes extrusion
- Production of films
- Multifilament production line
- Thermoforming

**Laboratory equipment**
- Physical and mechanical, analytical, reological, thermophysical, physical and chemical testing
- Testing of manufactured goods:
  - moulding goods
  - films
  - canisters
  - pipes
PolyLab – technical center for development and processing of polyolefins

Polymer processing and application development block

**COMPOUNDING**
Production of compounds and premixes:
- Laboratory batches for processing on the R&D center equipment
- Pilot batches for testing at clients site (1 – 3 ton)
- Testing of new polymers in model compounds

**MOLDING & FORMING**
Production of articles by:
- Injection molding
- Extrusion blow molding
- Thermoforming

**FILMS**
Production of films:
- Blown films
- Cast films
- Biaxial oriented films

**PIPES AND FIBERS**
Production of pipes and fibers:
- Extrusion of 32 mm and 110 mm pipes
- Multifilament fibers production

Analytical testing laboratory

**ANALYTICAL TESTS**
- GPC, HPLC, GC
- DCS, DMA, TG
- FT-IR
- Optical & Electron Microscopy

**BASIC TESTS**
- Mechanical testing
- Optical testing
- Rheological testing
- Thermal testing

**APPLICATION TESTS**
- Top load
- Drop tests
- Shrinkage, warpage
- Films properties
- Pipes tests (MRS, FNCT, ESCR)
- Barrier and sealing properties
We are intensively looking into Technology Platforms to focus on the most promising mid- to long-term R&D projects

<table>
<thead>
<tr>
<th>Technology platform</th>
<th>Key applications</th>
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<tbody>
<tr>
<td>Polymers with controlled decomposition</td>
<td>• Biodegradable polymer coatings for fertilizers</td>
</tr>
<tr>
<td></td>
<td>• Biodegradable agricultural films</td>
</tr>
<tr>
<td></td>
<td>• Super-absorbing polymers</td>
</tr>
<tr>
<td>Encapsulation for various polymer applications</td>
<td>• Self-healing polymers</td>
</tr>
<tr>
<td></td>
<td>• Self-lubricating polymers</td>
</tr>
<tr>
<td>Stimuli sensitive materials/polymers</td>
<td>• Artificial muscles</td>
</tr>
<tr>
<td></td>
<td>• Shape-memory polymers</td>
</tr>
<tr>
<td></td>
<td>• Innovative packaging</td>
</tr>
<tr>
<td></td>
<td>• New polymers for tires</td>
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<tr>
<td>New polymers for 3D-printing</td>
<td>• New generation of filaments</td>
</tr>
<tr>
<td></td>
<td>• 3D-printing for industrial use and construction</td>
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</tbody>
</table>
Creation and filling of Technology Platforms is based on global trends and industries’ demand

**Major trends**
- Sharing economy
- New business & production models
- Digitization
- Electric cars
- Autonomous cars
- Sustainability

**Areas for joint R&D activities**
- Transparent plastics
- Stimuli-responsive polymers
- Bio-degradable plastics
- Engineering polymers
- Polymers for 3D-printing
- Functional polymer coatings
- Recycled plastics
- Materials with zero emission release
- Materials for autonomous drive infrastructure
- Light weight composites
- Polyolefins
- Rubbers
- Synthetic rubbers for more durable tires
- Synthetic rubbers for connected tires
- Synthetic rubbers for interior elements
- Synthetic rubbers for self repairing tires
- Functional rubber coatings
- Self restoring materials
- Super hydrophobic coatings
- Shape memory polymers
- Synthetic rubbers for connected tires

**XXXX** - SIBUR competences, either developed or in development