



SENBIS
GROUP

Solving polymer challenges

Company presentation Senbis Polymer Innovations B.V.

Emmen, Jan 2024

What we do



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Senbis
helps companies
innovate



Our technologies focus on
reducing
microplastic pollution
& carbon emissions from plastics



“We solve polymer challenges and provide sustainable polymer solutions!”



How we do this



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R&D service provider

- Solving polymer challenges -



3rd party research

- Contract research for international customers in the field of high-end applications of (bio)polymers

Small scale production

- Asset investments
- Provision of pilot plant to market
- Production of speciality and niche products



Supplier of sustainable polymer products

- Providing sustainable polymer solutions -



Own developments

- Own investment & subsidies
- Focus on sustainable alternatives to polymer applications

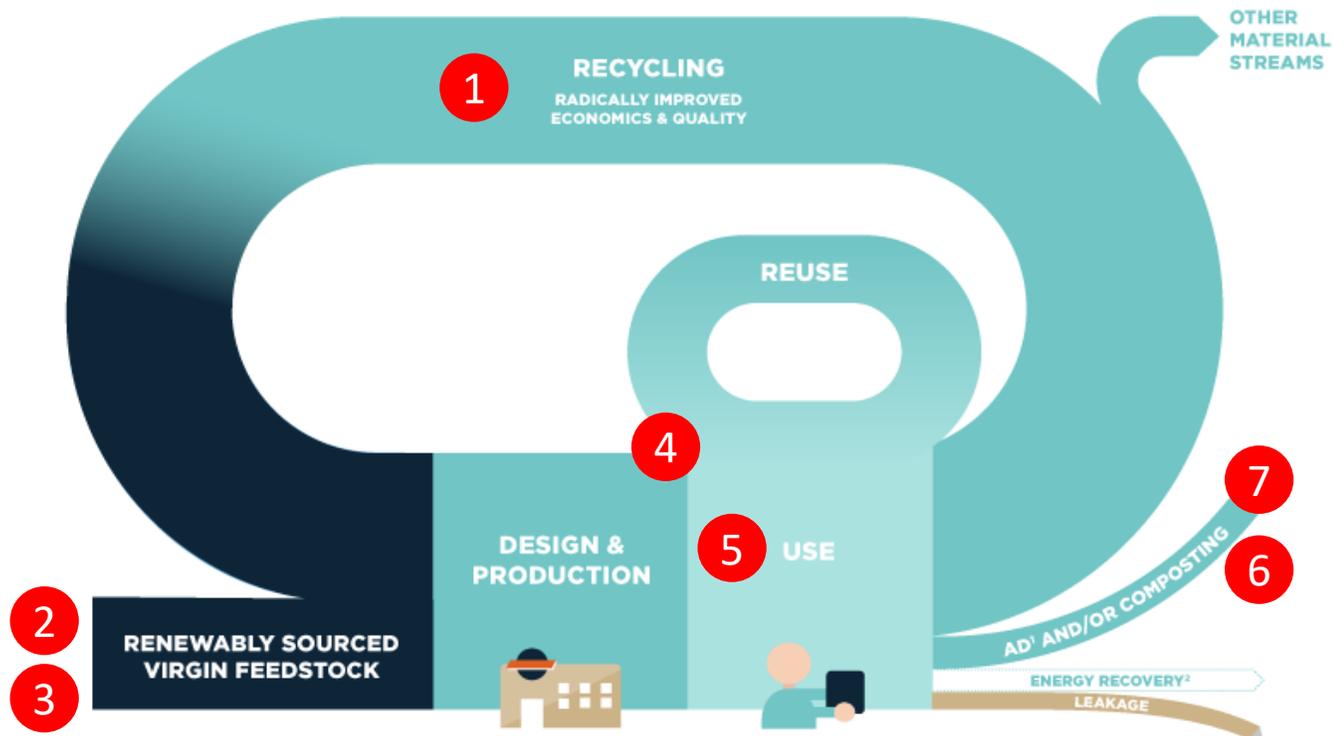


How Senbis works towards a new plastic economy



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THE NEW PLASTIC ECONOMY



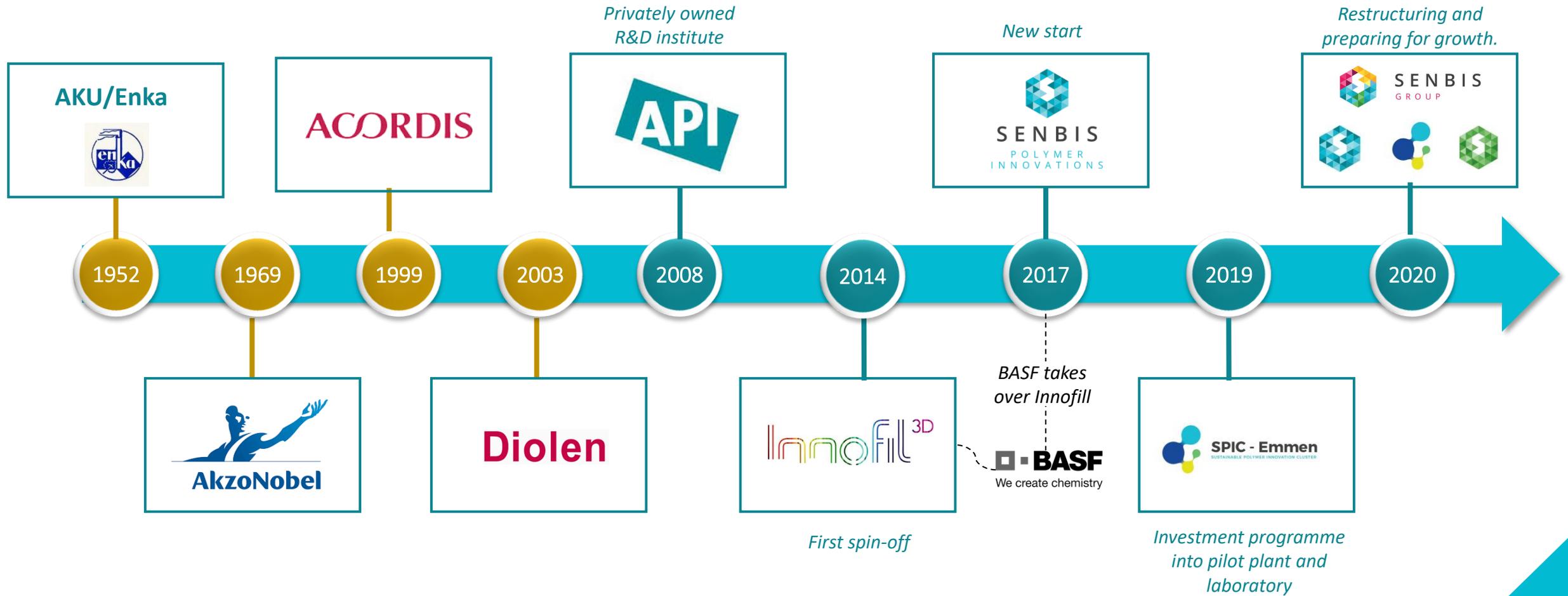
Source: Ellen Macarthur Foundation

- 1 Develop products from recycled polymers
- 2 Develop products from known biobased polymers
- 3 Develop new polymers
- 4 Develop and design recyclable products
- 5 Improve product performance to avoid or reduce microplastic pollution and increase life time
- 6 Develop a new biodegradable polymer with high mechanical and thermal properties
- 7 Develop biodegradable and compostable products to avoid landfill and microplastic pollution

Our history



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Location: Emmtec Industry Park in the Netherlands



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At Senbis we are driven by our values

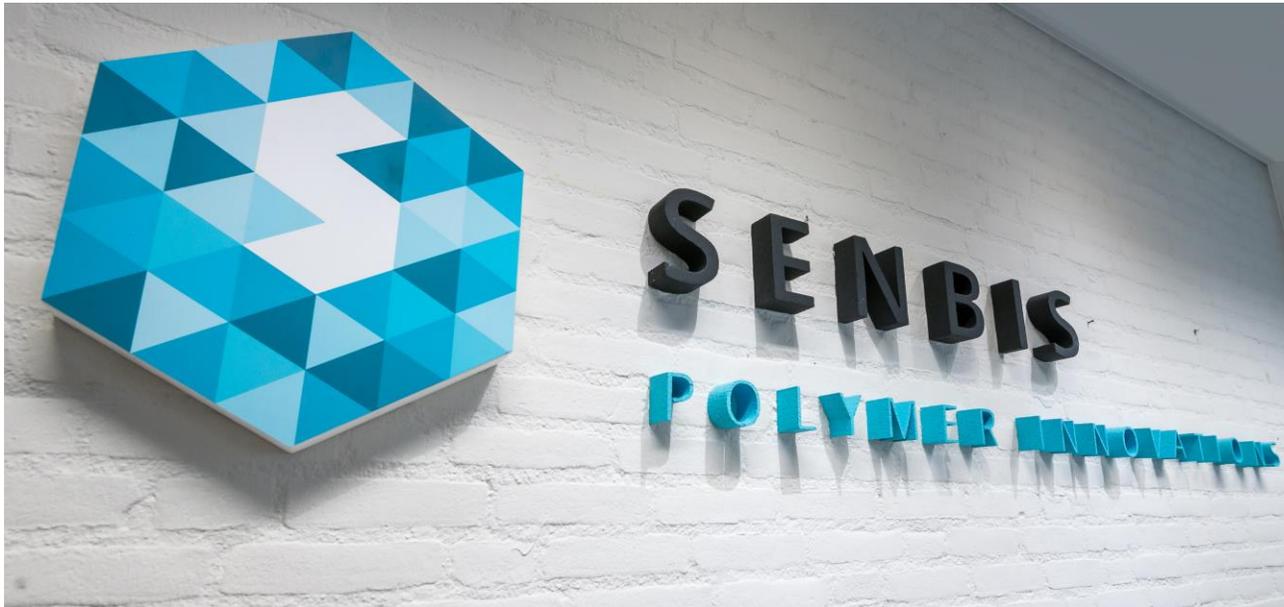


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- 1 WE ARE DRIVEN BY LOGIC AND DETERMINATION.
- 2 WE PROVIDE TANGIBLE AND TRUE SOLUTIONS TO PROBLEMS.
- 3 WE CARE ABOUT THE ENVIRONMENT AND FUTURE GENERATIONS.
- 4 WE IMPROVE THE LIVELIHOOD OF OUR LOCAL SOCIETY THROUGH BUSINESS ACTIVITY.
- 5 WE WILL ALWAYS INNOVATE.
- 6 INNOVATION IS TEAMWORK.

We don't make concessions on our values. Never. That may mean to go against the mainstream, to make unpolitical decisions and maybe even to let go a good business opportunity.





Solving polymer challenges

Senbis polymer innovations offers 3 service pillars



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Consultancy & Research

Our experienced team helps you solve any of your polymer challenges.

- On-site assistance
- Material selection
- Optimization of polymers
- 3D printing

Analyses & Equipment

We have a fully equipped polymer laboratory at our (and your!) disposal.

- Mechanical analysis
- Rheological investigations
- Thermal analysis
- Microscopy

Pilot Plant & Specialty Products

We offer facilities for producing specialty products and up-scaling research

- Compounding
- Extrusion - Spinning
- Polymerization
- Solid State Post-condensation

Senbis offers several cooperation options to other companies with polymeric products



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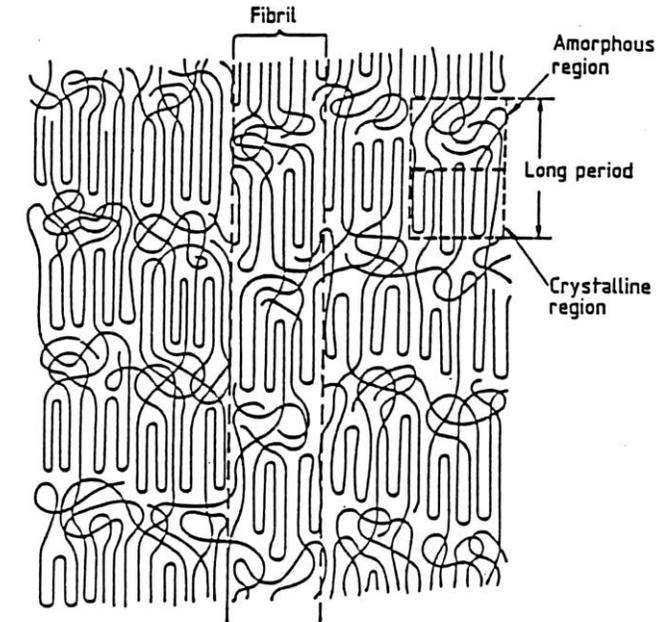
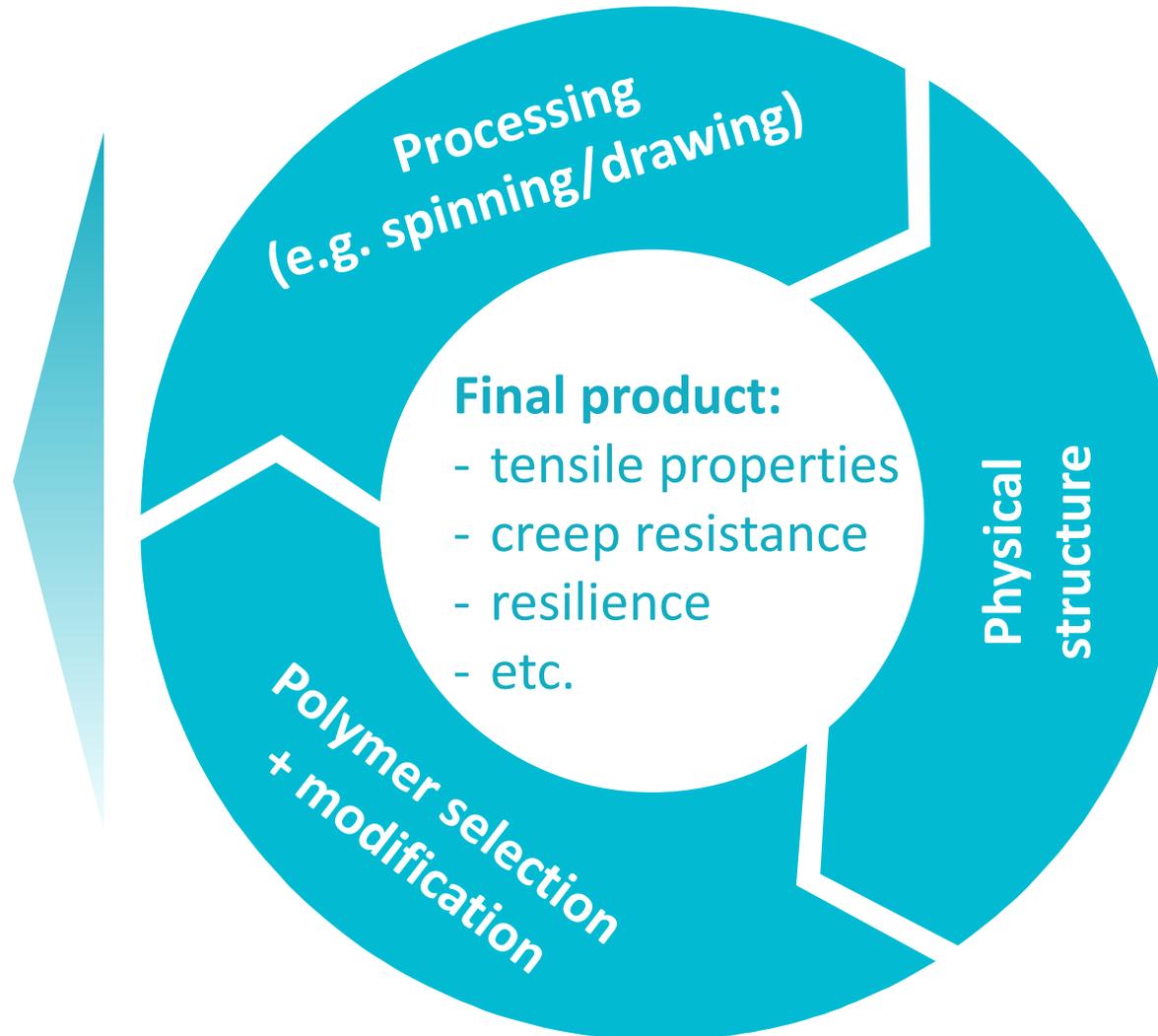


- **Contract research**, we develop IP for our customers
- **Mutual development of products** e.g. in shared ownership
- Production of **dedicated specialty products** for our customers/ partners
- **Dedicated R&D partnerships**. We can be your long-term partner that understands your technology and organization
- **Co-investments** into new laboratory and pilot plant infrastructure
- **Support of educational institutions** with the valorization and with the practical part of education programs



We do this with a **golden combination** of:

- Experienced **R&D personnel**
- Fully equipped **R&D polymer laboratory**
- Unique **pilot plant facilities**



Analysis & Equipment (1/2)



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Physical structure analyses

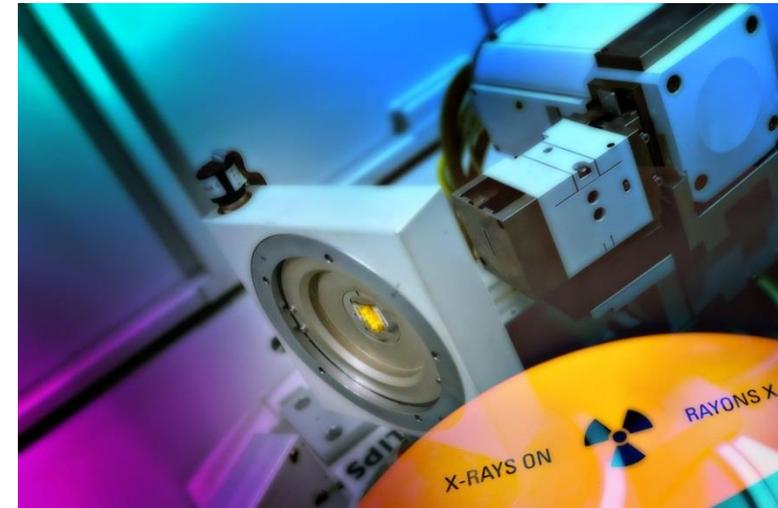
- Sonic modulus
- Density (Davenport column or immersion)
- X-ray diffraction
- FTIR spectroscopy
- Solution viscosity
- Microscopic imaging (e.g. visible and polarised light-, interference-, and fluorescence techniques)

Yarn analyses

- Linear density
- Breaking force, tenacity, modulus, elongation, etc.
- Hot Air Shrinkage, shrinkage force
- Rothshild entanglement testing
- (Ir)regularity testing

Moulded part analyses

- Breaking force, tenacity, modulus, elongation, etc.
- Impact resistance (IZOD, Charpy)



Analysis & Equipment (2/2)



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Rheologic measurements

- Haake extrusion rheometer (realistic conditions)
 - Apparent shear viscosity vs. apparent shear rate
 - Master curves for rheological calculations
 - Elongational viscosity
 - (Rheotens) melt strength curve
- Göttfert capillary rheometer
- Rheometrics controlled strain torsion rheometer
- Melt Flow Rate (MFR)
- Evaluation creep behavior of yarns or films

Thermal analyses

- (Hyper) Differential Scanning Calorimetry (DSC)
- Thermo Gravimetric Analysis (TGA)
- Thermo Mechanical Analysis (TMA)
- Dynamic Vapour Sorption (DVS)
- Dynamic Mechanical Analysis (DMA)
- Thermo Stress Analysis (TSA)



Analysis & Equipment for quality control



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Yarns

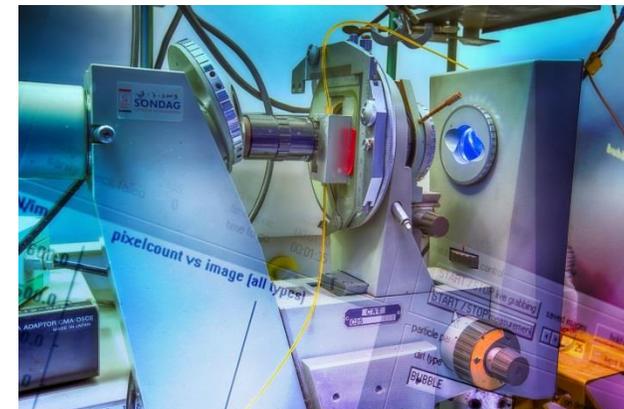
- Tensile properties determination
- Off-line measurement of finish distribution on (running) yarn
- Finish content on yarns (Soxhlet)
- Evaporation rate of finish (components)
- Friction (yarn-to-metal and yarn-to-yarn) properties
- Flory test equipment for mooring ropes applications

Resins - granulate

- Measurement of impurities (Particles In Solution)
- Standard Filtration Test (SFT), including SEM analysis of the resulting filter
- Measurement of water-repellent properties
- Image processing of both microscopic and macroscopic images

Powder

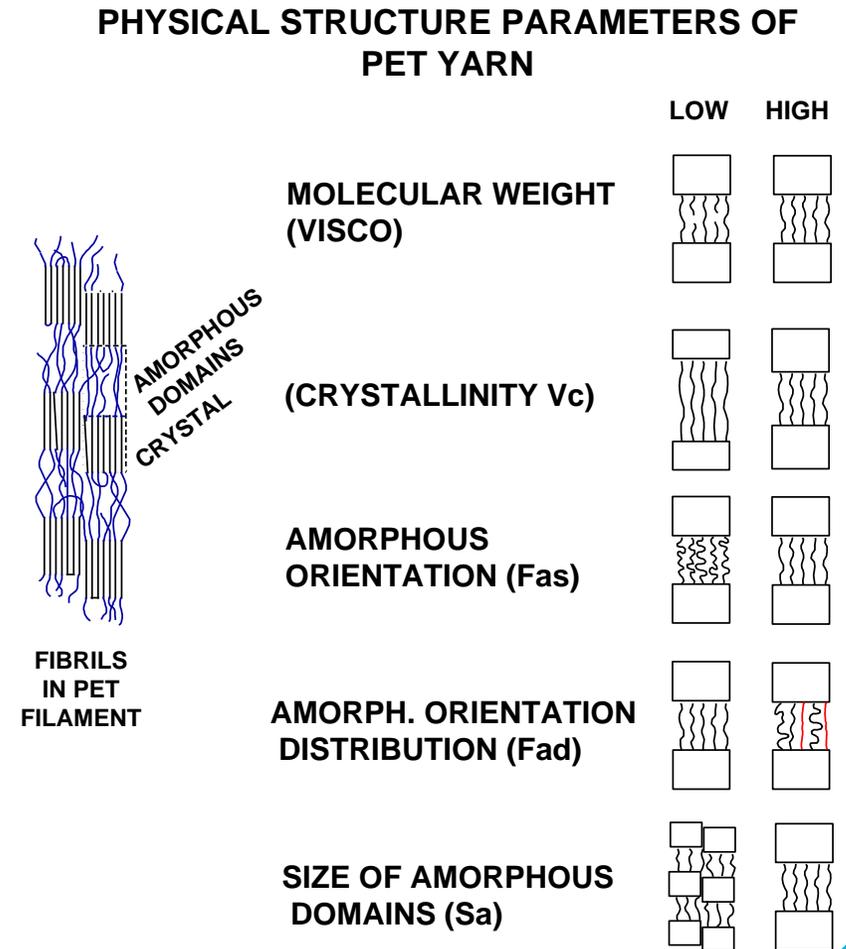
- Particle size (Mastersizer, sieves)
- Angle of repose
- Bulk density
- Tap density



Physical structure analyses: BEREK



- Combining different analyses techniques, in order to elucidate the physical structure parameters: BEREK
- X-ray diffraction (XRD), density, sonic modulus, birefringence
- Correlate the physical structure parameters to the mechanical properties
- Adjust processing parameters in order to optimize mechanical properties
- Applicable on PET-, PA6- and PA66 yarns and more types on request (biopolymers for example)





Spinning

- Small-scale research machine
Extrusion 400 °C, 2 kg/hr, 50 – 500 m/min
- Technical yarn spin-draw-winding (SDW)
Extrusion 350 °C, 50 kg/hr, 5000 m/min, drawing 250 °C
- Pilot scale research machine
Bico, textile yarn (quench cabinet) or technical yarn (quench cabinet and chimney)
Extrusion 450 °C, 50 kg/hr, 2500 m/min, drawing 240 °C

Drying – SSP - polymerization

- Drying masterbatches up to 60 kg
- Solid State Polymerization (SSP) from a few grams to a few kg up to 120 kg per batch
- Polymerization of polyesters and ‘polyesters like’ materials up to 0,5 kg. We have access to a 20 kg facility and are considering investing in such a facility ourselves.

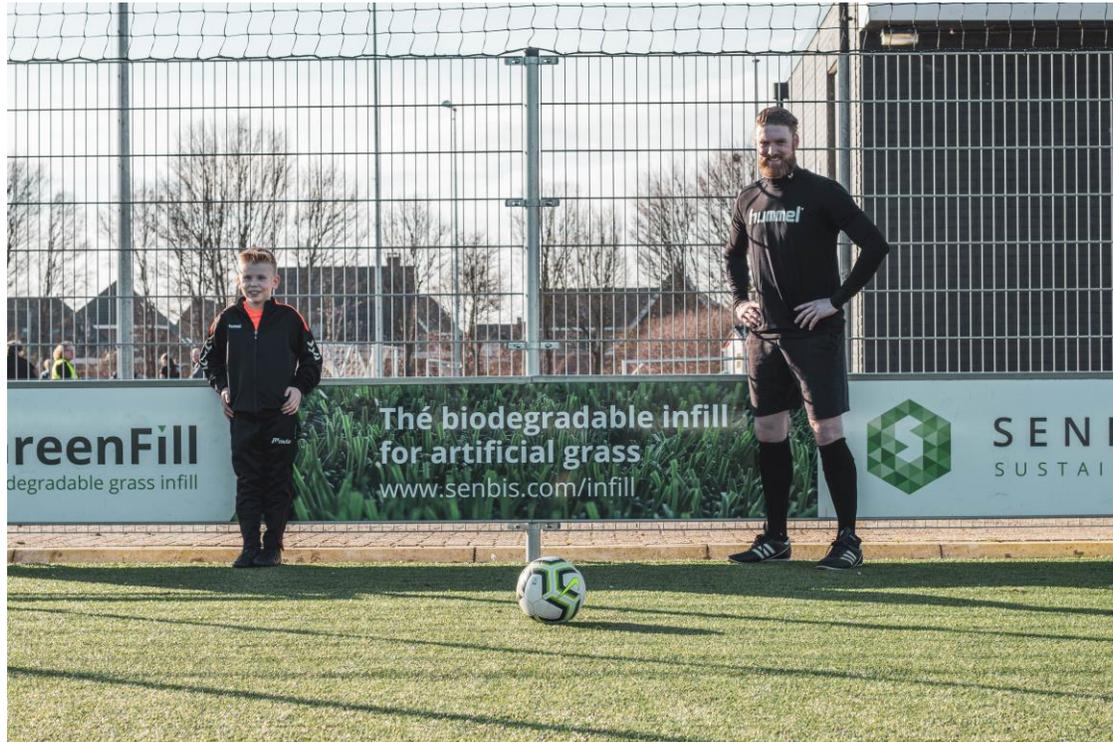
Extrusion - compounding

- Different small-scale processing techniques available: Monofilaments (3d printing), film casting, film blowing, kneader, rheological measurements and more.
- Monofilament spin-draw-winding machine, 450 °C, 1 - 50 kg/hr, feeding with bico or twin screw extruder, 3-stage drawing (hot water, hot air), 100 m/min (note: twin screw extruder can be equipped with spinning pump)

Compounding

- Small-scale twin screw extruders (400 °C, 5 kg/hr) with water bath and cutter
- Pilot twin screw extruder (450 °C, 50 kg/hr) with water bath and cutter



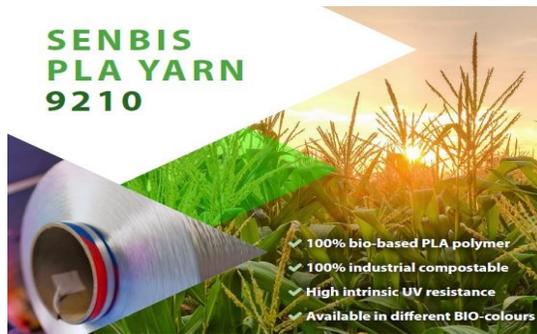


Providing
sustainable
polymer solutions

We have a proven track record in developing and launching biodegradable solutions



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SUSTAINABLE PRODUCTS



2018: industrial compostable Senbis PLA yarn



2018: compostable twine for horticulture (Royal Brinkman)



2020: in-soil biodegradable infill for artificial grass (GreenFill)



2021: In-soil biodegradable trimmerline up-scaling



2019/20: large scale test marine degradable dolly rope



2021: first field test of fully compostable artificial grass



Test stage: Marine degradable mussel socks



Development stage: Biodegradable Baler twine

More information at: <https://senbis.com/products> , www.lplaygreen.com , www.bio-greenline.nl

Senbis invested into new compound and fiber spinning equipment through its subsidiary SPIC



SPIC - Emmen
SUSTAINABLE POLYMER INNOVATION CLUSTER



<https://www.senbis.com/innovations/news/multi-million-investment-in-r-d-infrastructure>

An overview of all our directly accessible R&D equipment can be found at:

<https://www.senbis.com/innovations/analyses-equipment> and <https://www.spic-emmen.com/technology-overview/yarn-spinning/>

Co-founded by:



provincie Drenthe



European Union
European Regional
Development Fund



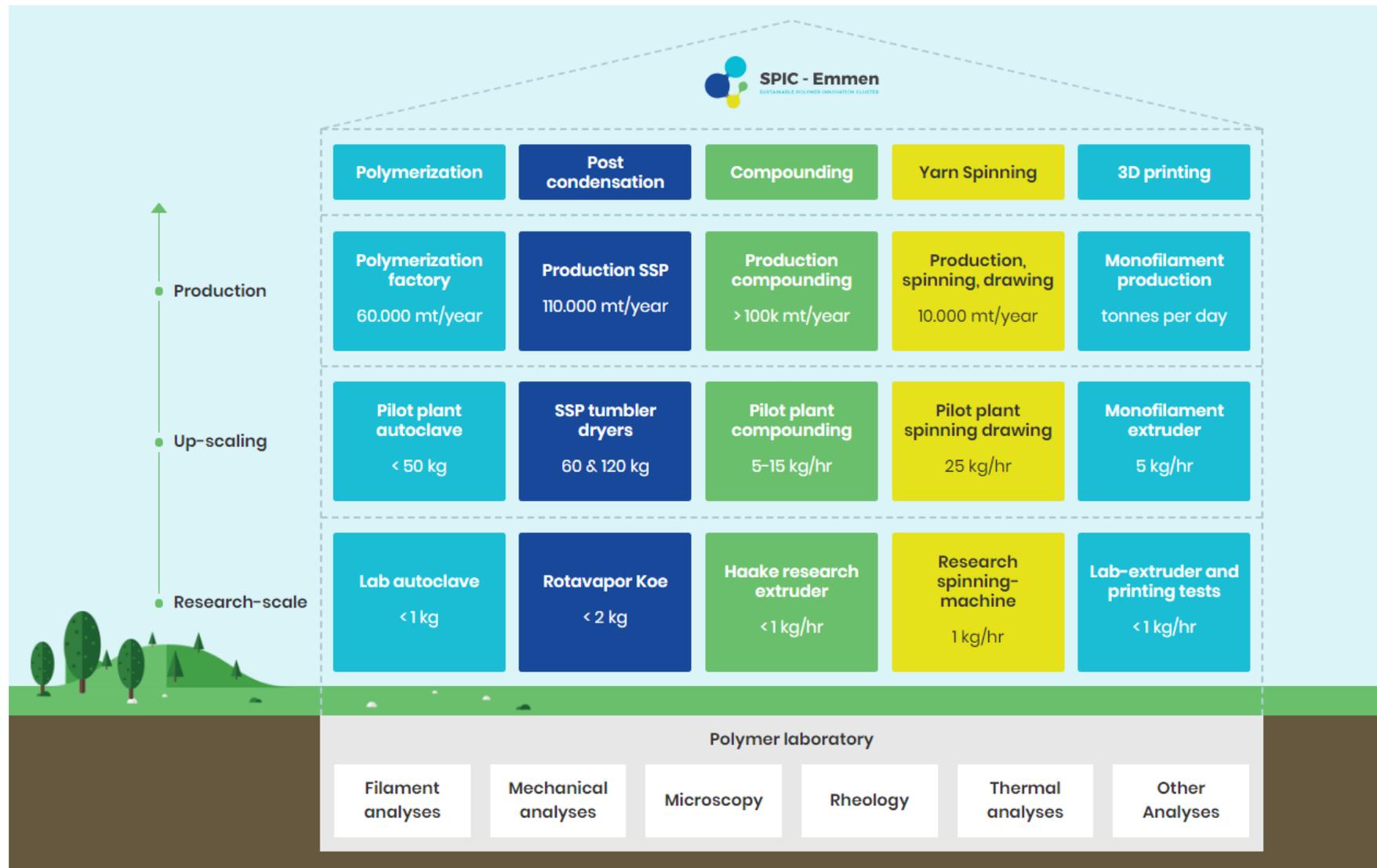
**Gemeente
Emmen**

Cooperation | Sustainable Polymer Innovations Cluster

Key technologies of all scales under one roof!



SPIC - Emmen
SUSTAINABLE POLYMER INNOVATION CLUSTER



More info at:
www.SPIC-Emmen.com

- New R&D infrastructure:
 - Polycondensation
 - Biopolymers
 - Chemical recycling
 - Fiber spinning
 - 3D printing
- **5.8 M€ investments** planned in 3 years
- **3 M€ grant** from EU and NL governments



Contact the team at Senbis Polymer Innovations



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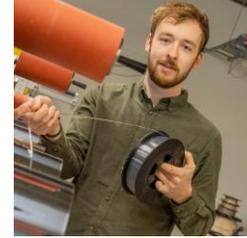
G. Nijhoving
Managing
Director



B. Krins
Technical
Director



B. Bischoff
Polymer Application
Developer



T. Heijnen
Polymer Application
Developer



Dr. M. Bozorg
Project Manager
R&D



M. Veltrop
Bookkeeper



Dr. J. v.d. Vlist
Project manager
R&D



Dr. M. Naeimirad
Project manager
R&D



E. Flohr
Advisor and Business
Developer



J.W. Slijkoord
Business Developer



R. Jongboom
Business Developer



R. v. Bremen
Business Developer
Greenfill & GreenBlade



Telephone/ Email

T: +31 591 308 100
E: info@senbis.com



Postal address

1^e Bokslootweg 17
7821 AT Emmen, NL



Delivery address

Nijbracht 8, Losplaats 230
7821 CA Emmen, NL

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Also, our several partners around the world!