Issued by Norner AS
November 2020

NORNER NEWS 20

Sustainable Packaging

Healthcare Innovations

Durability and Protection

Extended Polymer Services

norner™
The Polymer Explorers

3@Norner

Anita Thoner

Hi, I am working as Engineer in Performance Laboratory where I am happy to support customers within the coating area.

Morten Augestad

As a Business Director for Processing Pilot Application Centre, I appreciate when we deliver the best support to clients.

Jorunn Nilsen

Hi, I am a polymer research expert and enjoy working in projects together with our clients.

Towards a New Normal

Dear reader

Norner is created on a vision – a vision to be The global market leader of Industrial R&D services in Polymers by exploring opportunities and discovering Sustainable plastics solutions.

I have enjoyed working with my highly competent colleagues and excellent customers worldwide for almost three years now, and I can assure that this vision is more alive than ever.

In the previous issue, the "Norner News 2019", I wrote about the New Normal, where the shifts in politics, business and the environment, among others, affect the world today and in the future. "The future is much more complex and unpredictable than ever……".

True.

This year we faced the largest and most unpredictable challenge of all means when the Covid-19 Pandemic hit our lives, our businesses, and set the frames for our future perspectives. It has been and still is very serious, too many people have passed away, and businesses have struggled all over the world.

I am then very proud of how the Norner team and our customers have tackled the Covid-19 pandemic, by continuing to be innovative, look ahead and seek sustainable solutions even in difficult times. We cross our fingers for a vaccine to be ready in early 2021, and a fast recovery back to normal.

Meanwhile, we are busy at Norner with a lot of interesting client projects for development of new products and technologies. A common target for most of these is improved sustainability and this is true for customers across our segments from healthcare and packaging to infrastructure, energy and polymer industry.

Several communities and companies have stated that they will go plastic-free. We do not think it is possible to live without plastics. We do not think it is sustainable to live without plastics. Plastics are an important part of the future climate and environmental solutions, and an important part of our daily lives. During the last months of pandemic, plastics have also proven its usefulness in many critical applications. Many healthcare products would be impossible to design and produce without plastic materials. Food hygiene has been more important than ever during the last months and plastic packaging solutions are protecting the food content and protecting people.

We believe there is a great future in plastics, a great sustainable future. However, plastic materials must be used where it makes sense, just like with all the other materials we surround ourselves with. It is all about being Plastic-smart.

We eagerly look forward to cooperating with our customers to explore sustainable solutions, together.

Navigating towards a New Normal. Again.

Enjoy the reading!

- Kjetil

New employees at Norner

Norner had a very good result in 2019 and the good trend continues in 2020 despite difficulties related to the Covid-19 pandemic. This has made it possible and necessary to hire 12 new researchers and engineers so far in 2020.

Everyone brings with them highly relevant knowledge and experiences from exciting companies and disciplines that will contribute to Norner becoming even better at developing new technology and sustainable plastic solutions.

We are happy to welcome our new employees.

Thea Glittum
Engineer

Jan Fredrik Mikkelsen
Engineer

David Gulbrandsen Sanna
Senior Engineer

Asbjørn Noraberg
Senior Engineer

Glenn Marius Thomassen
Senior Engineer

Sara Rund Herum
Senior Engineer

Tanja Radusin
Senior Researcher

Vinh Duy Cao
Senior Researcher

Hany Anwar
Senior Researcher

Cesar Augusto Sales Barbosa
Senior Researcher

Mohammad Shamsuzzoha
Senior Researcher

Siri Stabel Olsen
Principal Business Developer

New Polymer Exploration Centre

The construction of our Polymer Exploration Centre is now in full swing which is a major milestone for us at Norner. This will put us in a position to serve clients and partners worldwide even better with state-of-the-art facilities to develop sustainable products and technologies as well as high quality testing when it opens late 2021.

The centre will see more investments in polymerisation, polymer processing and polymer analysing and testing to ensure that we can continue to focus on the entire value chain of polymers.

The centre will also continue to be part of the Norwegian Future Materials Catapult centre where equipment and competence can be shared based on common needs while confidentiality is professionally handled.

New Laboratory Manager

Ida Marie Wold is our new manager for the Scientific Laboratory from November 1st. She started in Norner as Business Developer two years ago and this will also be part of her new role. The Scientific Laboratory is a very important part of Norner and is in the middle of many interesting and important investments in advanced analytical equipment to better serve our customers.
"I previously worked in the industry with research, project management and business development. I am very happy for my new role in Norner, a company which I am proud to be part of with a strong sustainable profile."

Ida Marie Wold
Laboratory Manager

» *Hinge cycle test: A hinge cycle test was done on recycled materials which perorm excellent and achieved more than 30.000 cycles which is even better that the reference virgin materials.*

LYONDELLBASELL SELECT NORNER

Assessing recycled quality

LyondellBasell select Norner to evaluate their latest recycled PP materials in Caps&Closures.

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The joint venture between LyondellBasell and Suez, established in The Netherlands, has introduced a set of recycled Polypropylene and Polyethylene's to the market. This joint venture – QCP – has teamed up with the innovation/R&D centre of LyondellBasell in Ferrara-Italy for tailoring their recycled materials for important end markets.

Norner has been assigned by LyondellBasell in Ferrara to evaluate the recycled materials in various end applications. One important segment is caps for household chemicals, cosmetics and personal care containers.

RECYCLED PP IN FLIP-TOP CAP END USE

Norner operate a 4 cavity flip-top cap mould with very important features for the market that can be evaluated. This includes:

- Integrated hinge performance (Cyclic test)
- Hinge strength
- Closure dimensions
- Hinge torque
- Response to colour MB

We carried out trials with Moplen QCP300P and Moplen QCP540S and tested them with a Moplen hompolymer mfr 15 as a reference.

Processing of the materials by injection moulding was very good and showed consistent and reliable operation.

Emanuele Burgin - Application Development, Technical Service and Innovation manager PP Europe, Rigid Packaging and Caps and Closures says "Very interesting and positive results for our recycled PP produced by our Joint Venture QCP".

The summary of results are showed in the table and clearly demonstrate that the tested materials process very well and achieve very good mechanical strength. The caps also looks very good and has good dimensional stability.

» *These samples shows the white colour achieved with increased loading of white masterbatch.*

Property vs reference		Comment
Cycle time/productivity	++	Fast
Dimension/shrinkage	+	In the window of PP resins
Colour	0	Different from virgin materials
Hinge cycle test	++	Very good
Torque & strength	0	Reduced, but still good

PLASTICS RECYCLING PILOT CENTRE

When plastic waste is being collected, washed and recycled a key issue is to achieve a high purity and quality. This enable the use of recycled plastics back into the normal production chain of both disposable products like packaging, or durable products.

At Norner we have facilities for grinding, pelletizing, processing and prototyping as well as advanced test and analytical services.

We run several types of projects for circular economy and recycling like:

- Quality assessment and benchmarking of recycled materials in applications.
- Development and establishment of product specifications for recycling.
- Recipe development for incorporation of recycled materials.
- Recyclability evaluations including RecyClass protocol testing
- Quality improvement programs for recycling.
- Stabilising recycled plastics for better quality and durability.
- Investigating and improving odour and migration problems.

Recycling

We have a dedicated extrusion line from Coperion with flexible feeding systems, modern instrumentation and Nordson filtering unit. We have experience with development of degassing, solvent flushing, filtering, additives and stabilisers.

Processing and prototypes

We can process the recycled materials and produce industry relevant prototypes:

- Injection moulding
- Extrusion blow moulding
- Cast film and sheet extrusion
- Blown film extrusion
- Thermoforming

Testing of materials and prototypes

Both standard specimens as well industry relevant prototypes can be further tested and evaluated with a wide range of methods in our laboratories.

New Norner catalyst technology for advanced polyethylene products

Norner has developed a novel multimodal polymerisation technology which enable metallocene catalysts reaching high yields while producing LLDPE and HDPE with improved processing performance. By replacing heterogeneous catalyst with homogeneous catalysts in Continuous Stirred Tank Reactor (CSTR) slurry processes, catalyst cost can be reduced dramatically and a significant reduction in environmental footprint can be reached. Good polymer powder morphology can be obtained and adjusted to meet the requirements given by the polymerisation technology.

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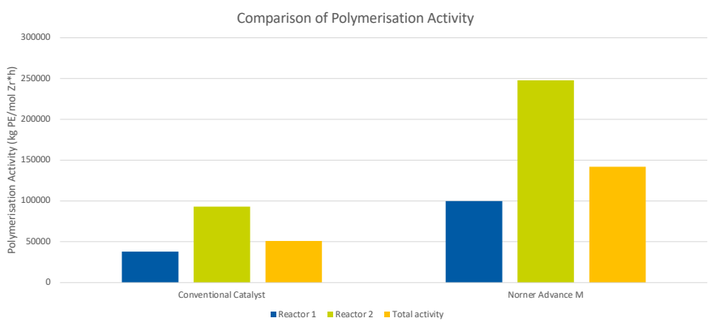
From the start, metallocene catalysts have been well known for producing mPE with very good comonomer distribution and narrow Molecular Weight Distribution (MWD), and for limitations in Molecular Weight (Mw). The poor processing performance from the narrow MWD was for many years a roadblock for exploring the positive aspects with mPE, resulting in a slow market penetration. In the recent years however, new catalysts and bimodal polymerisation technology has enabled production of easy processing mPE grades with capabilities for higher Mw, also giving opportunities for more robust HDPE products at higher densities. The market for mPE is currently growing faster than ever and also in value added segments.

The majority of LLDPE and HDPE is produced using heterogeneous catalysts where SiO_2 and $MgCl_2$ are the most common catalyst supports. Metallocene catalysts are typically impregnated on SiO_2 when used in gas phase and slurry processes. Although the SiO_2 has high surface area and good pore structure, the activity of a heterogeneous metallocene catalyst will be significantly lower than the homogeneous counterpart.



» *Figure 1: Advance M technology – more than double activity vs. conventional catalysts.*

However, heterogeneous catalyst in gas phase and slurry processes is deeply embedded as a "must have" among the mPE producers to avoid fouling and to obtain the required powder morphology.

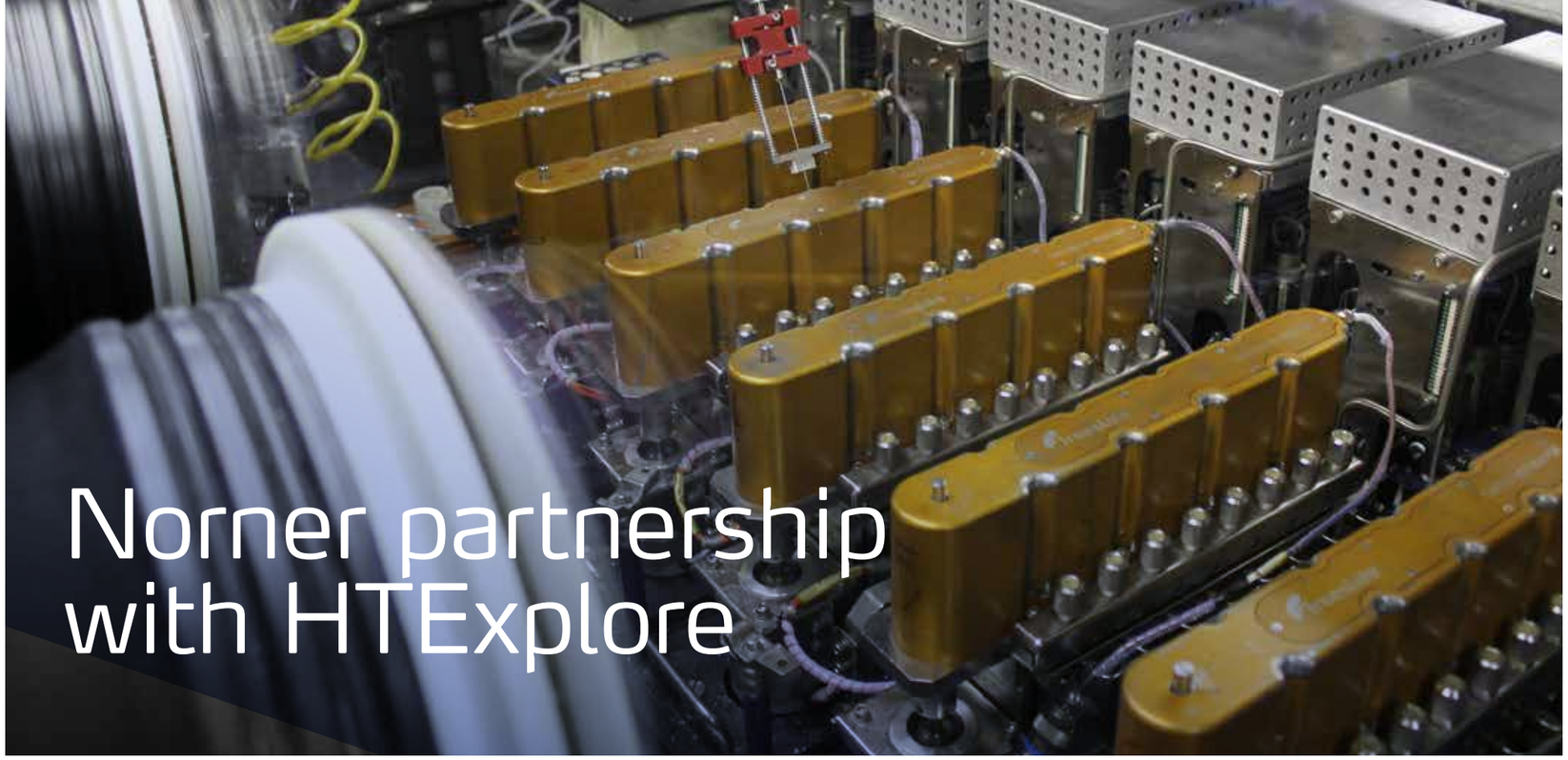
With Norner Advance M technology a range of metallocene complexes and co-catalysts can safely be used in slurry reactors and only minor modifications to the catalyst feeding system would be required to compensate for the lack of catalyst support.

Heterogeneous metallocene catalysts are among the most expensive on the market, while many metallocene complexes and co-catalysts are readily available as commodities to a significantly lower price. With ref to Fig 1, the higher activity will in addition reduce the consumption of catalysts per kg PE significantly. Heterogenization of catalysts requires substantial amounts of energy and consumption of solvents and other chemicals, and the same is the case for production of the SiO_2. All together this adds up to a considerable reduction in environmental footprint through reduced CO_2 emission and waste when converting from traditional catalyst concept to Norner Advance M.

As an example, this opens for a very attractive transformation for a 150kta CSTR 2-reactor plant which normally would be running a fairly traditional product mix where most grades are produced with heterogeneous ZN catalyst. Let us imagine such a plant would be converted only to produce MDPE and HDPE from metallocene catalysts only, utilizing Norner Advance M technology for all products. The product mix opportunities enabled with Norner Advance M technology have no practical limitations in higher Mw and higher densities, and without SiO_2 the products are free from contaminants. This combination will open the door to a broad product mix covering advanced products for extrusion-, blow moulding-, injection moulding-, rotomoulding-, film and membrane applications which would meet or surpass the performance of leading grades in a variety of market areas. We foresee e.g. PE100RC with superior properties from excellent comonomer distribution in the UHMw polymer chains combined with the absence of contaminants from SiO_2, and super-clean products for HV W&C insulation and medical applications.

Savings on catalyst cost alone will be significant and we expect the improved purity will allow for a reduction in additive loading in the LLDPE and HDPE products, giving potentials for further cost reductions. Many mPE products sell already today at a higher price than ZN or Cr based grades and with new specialities on top, a substantially increase in average margin can be achieved.

Norner is already in discussion with potential licensees of the Advance M technology and look forward to welcome other companies to evaluate the benefits of revamping their CSTR plants.



Norner partnership with HTExplore

Norner and HTExplore join forces to bridge the gap between catalyst High Throughput Screening (HTS) and application development of polymers.

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The present and future demands from polymer producers and catalyst manufacturers call for a highly integrated service offer, addressing each step of the polymer value chain with multiscale approaches, ranging from testing of novel catalysts at very small scale to the processing and application testing of real-size polymer prototypes. In this context, Norner and HTExplore have decided to establish a partnership to combine the long-term experience in catalyst and product development at bench and pilot scale of Norner with the HTS technologies mastered and operated by HTExplore.

Finding the right balance between the ingredients in a complex catalyst recipe is demanding and requires an HTS approach to cover the very broad variable space followed by polymer analysis to understand the effect of recipe and parameters. This will provide a theoretical basis to make choices for upscaling of such catalyst systems. On the other hand, the development and implementation of a catalyst system also require testing in more commercially relevant conditions in order to fully understand both the fit to the reactor systems and conditions and how the resulting polymer perform in processing and applications.

Norner has been developing catalysts and polymers along with solving problems by scaling polymerization down to litre and kg scale in bench scale reactors for more than 40 years. At this scale, we can effectively and with low risk operate in a much wider process window than in pilot plants and full-scale production units and mimic a variety of olefin polymerisation technologies. Producing 0,5 to 5 kg polymer per experiment makes it possible to carry out full characterization and application testing of the polymers, giving relevant data for introduction of new grades in commercial scale. For catalyst development however, this scale has its clear limitations in cost and speed.

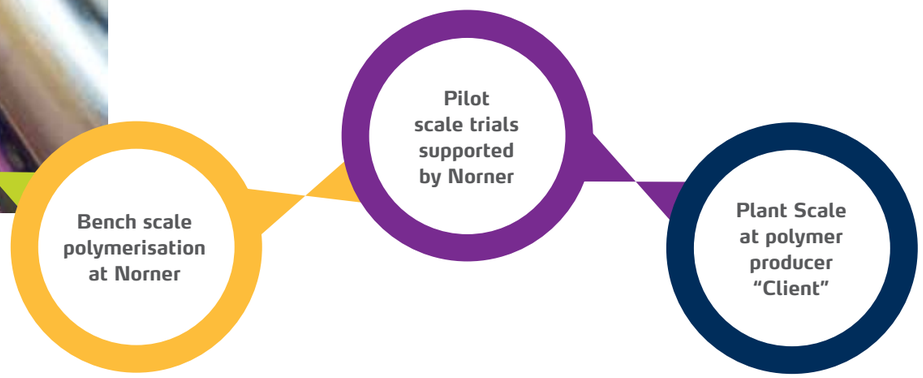
HTExplore operates an HTS polymerisation workflow based on two PPR48 platforms, which allow the parallel production at mL scale of 48 polymer samples per day. This requires very small amount of catalyst and produce between 50 to 400mg polymer per cell. The reactor cells can be operated between 40 and 200°C and between 2 and 30 bar, with up to six different temperature and pressure settings per library. Various types of polyolefin catalysts can be screened in solution or slurry in semi batch fashion with a single monomer gas fed on demand and with gaseous or liquid comonomers. The samples can be analysed and characterised by HTExplore with GPC, CEF and NMR for the accurate assessment of molecular weight-, compositional- and microstructural parameters. This has proven to be a very effective way to map catalyst performance for screening purposes. At the same time, the absence of polymer application data is just as obvious.

We strongly believe that the industrial R&D experience of Norner combined with the scientific expertise of HTExplore will create significant value to our clients. By unifying the two workflows we will provide our clients with the best of two worlds. Using a metaphor from Oil & Gas Exploration, HTS corresponds to the seismic tools used to find the promising oil fields, while bench scale reactors corresponds to the test rigs drilling down to evaluate if the area is commercially viable.

Furthermore, we offer more than the screening of readily made catalysts as we also have both computational and experimental tools for catalyst development in addition to our long experience in the field. In connection with any new catalyst-, process- or product development, the preliminary IP and FTO (Freedom to operate) studies are also offered in cooperation with IP legal experts.

Hence together, Norner and HTExplore will offer a streamlined and highly integrated workflow which will enable efficient, reliable and market relevant catalyst- and polymer development services for catalyst manufacturers and polymer producers.

HTExplore is a young high-tech company established in Naples (Italy) in 2012 by Prof. Busico, which offers HTS services in polyolefin catalysis, leveraging from a long-term academic tradition directly linked to the school of Giulio Natta. HTExplore combines a rigorous scientific approach with state-of-the-art HTS technologies, operated by highly specialized personnel within a stimulating academic environment.



- *Miniature scale experiments of 48 polymerisations per day*
- *Sample size < 1 gram*
- *Advanced polymer analysis*
- *Development of catalyst and optimisation of composition*

- *Small scale experiments of 5-10 polymerisations per day*
- *Sample size 0,5-5kg*
- *Polymer and material testing*
- *Processing trials and testing*
- *Application prototype testing*
- *Select catalyst for upscaling*

- *Medium scale trials with continuous production*
- *Sample size 50-500kg*
- *Industrial scale processing and application testing*
- *Optimising polymer design*
- *Premarketing samples*

- *Full scale trials in commercial operations*
- *Sample size > 50 ton*
- *Verification of application performance*
- *Customer trials and approvals*
- *Commercial launch*

Recyclable Monomaterial Solutions

Sustainable packaging with focus on recyclability is currently a highly relevant topic, both in Europe and globally.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By 2030 all plastic packaging placed on the EU market should be recyclable or reusable. This is according to the European Strategy for Plastics in a Circular Economy made by the European Commission.

Flexible plastic packaging is a growing segment in the packaging industry and flexible packaging made from monomaterials will most likely play a significant role in order to reach the European 2030 goal.

LAMINATED STRUCTURES

Flexible packaging films are often a laminated structure consisting of several materials where each of them fulfils specific property demands. Laminated structures typically comprise a printing layer and a sealing layer. The printing layer in conventional packaging solutions is often a PET film and the sealing layer is often a multilayered polyethylene (PE) film comprising different materials, including polyethylene and barrier polymers. The main benefits of the PET layer are stiffness, thermal stability and transparency as a reverse printed surface layer which is common for various stand up pouch packaging solutions.

RECYCLABILITY

These laminates are however not recyclable and the industry is intensively developing alternatives. One target is to replace the PET layer with a polyethylene layer to provide a monomaterial, full polyethylene, solution.

MDOPE DEVELOPMENT

MDO (Machine Direction-Oriented) technology enables the production of oriented stiff PE films which fulfil much of the PET performance. The MDO line consists of a series of heating, stretching and annealing steps. This additional processing of multilayered PE films introduces property enhancements and allows thickness reductions which are both beneficial for the purpose of sustainability and recycling. The development of such polyethylene layer is challenging with respect to achieving both the processability and target properties. This requires excellent base resins and optimum recipes.

Norner invested in an industrial MDO pilot line from Hosokawa Alpine already in 2009. Numerous projects have been run on this line for raw material bench marking as well as application and recipe development. Several project results have been presented on international conferences including MDOPE for VFFS applications and shrink films. The first experience with laminates was made almost ten years ago. The technology centre in Norway is well equipped with film extrusion lines and test methods for film performance and film analysis.

SCG CHEMICALS

SCG SMX™ TECHNOLOGY

SMX™ Technology is SCGs unique technology for premium polyethylene resin. It offers superior mechanical properties for end products making them more durable and allowing them to use less materials. SMX™ Technology is designed for HDPE into various applications like film, closures, blow moulding and pipe.

Norner is currently involved in a development project together with SCG Chemicals in Thailand where the purpose is to develop solutions for flexible packaging based on the SMX™ Technology. We have been running trials with SMX™ HDPE grades in combination with various LLDPE at the technology centre in Norway where we have blown film and MDO lines.

Norner and SCG have together designed and developed a formulation for a laminated structure for flexible packaging with a very good balance of properties. The monomaterial solution can replace PET// PE laminates and was made possible by applying resins produced with the SMX™ technology.

“The formulation has taken advantage of the excellent processability and stretchability given by the SMX™ technology and made laminates with a very good balance between processing performance, mechanical and optical properties.” Says Niwat Athiwattananont CTO at SCG Chemicals.

New opportunities for clients in Protective Coating

Norner is one of few test laboratories that is accredited in accordance with ISO 17025 when it comes to testing of corrosion protective coatings. Such accreditation proves that our laboratory is a technical leader in quality management and competence and that our test methods are in accordance with the latest version of international standards.

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We are now in a process where we expand our portfolio of ISO 17025 approved methods, with ISO 15711, "determination of resistance to cathodic disbonding of coatings exposed to seawater". This method evaluates the properties of the coatings to resist the effect of cathodic protection of subsea steel structures.

With this method included we will be able to offer a complete list of approved test methods required in the qualification procedure of coating given in Norsok M-501 and other international standards.

MARINE COATING

We work continuously to expand our range of tests. As an example, we are now in the process of establishing test methods for qualification of protective coatings for use within the marine industry. Our goal is to achieve approval within short time for 3rd. party testing of protective coatings for use in cargo oil tanks and seawater ballast tanks in accordance with IMO resolution MSC.288 (87) and MSC.215 (82).

CRUDE OIL CARGO TANKS

This approval includes qualification testing in accordance with annex 1 in resolution MSC.288(87).
The tests in this standard are designed to simulate the two main environmental conditions to which the crude oil cargo tank coating will be exposed, both in the vapour phase and in the liquid phase in a loaded condition.

In the vapour test, test panels with protective coating are exposed in a gas tight chamber. The gas inside of the chamber is a standardized gas composition, based on the vapour phase in a crude oil tank.

The panels are exposed for the gas at fixed temperature and examined for damages after 90 days exposure time.

To test the resistance to crude oil, the test panels applied with protective coatings are immersed in a standardized test liquid. Crude oil is a complex mixture of chemical materials that can vary in composition over time. To overcome this, a standardized liquid is used to simulate crude oil. The formulation is given in the IMO resolution.
The panels are immersed at fixed temperature and examined for damages after 180 days exposure time.

Since both methods involves hazardous materials, such as H_2S, a very high HSE focus is a necessity when performing such tests.

BALLAST TANK

This approval includes qualification testing of protective coatings in accordance to resolution MSC.215 (82), annex 1. The test used in this specification is based on simulation of conditions that occurs inside a ballast tank, filled with seawater. The protective coatings are exposed for different parameters such as temperature cycles, dry-wet conditions and cathodic protection. To achieve this complex environment a wave tank has been constructed. Test panels will, when they are installed in tanks, be exposed for similar conditions that occurs in in a real-life ballast tank, including continuous splashing of seawater.
After 180 days the protective coatings will be examined for corrosion, adhesion and cathodic disbondment properties.
The ballast testing also includes a condense test. Test panels are exposed in a condense chamber, where the panels are exposed for water condense. The panels are visually examined after 180 days.

Norner is very active in various standardization bodies. We want both to influence the standards when it comes to testing and be up front in new demands from relevant markets.

JOLNIR AUTOCLAVE TESTCENTRE

Joint Industry Project Elastomers

Norner has an ongoing Joint Industry Program (JIP) that covers service life prediction of elastomers in oil and gas sealing applications. The service life expectation for such sealing materials is 20-30 years, and the temperature is typically up to 100-120°C with a fluid exposure of hydrocarbon fluid mixtures containing up to 10% H_2S.

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Such applications are not possible to test in real time, so the JIP test program is set up using temperature to accelerate the ageing. Both elastomers and polymers show more rapid degradation at higher temperature, and the typical rule of thumb indicates that a 10°C increase in temperature doubles the degradation of the material.

Polymers and elastomers are used for years without failure in numerous applications throughout many industries. The performance of the materials is well known since the application and conditions the material is exposed to is well known. Furthermore, many applications are such that replacing a material during service is a relatively straight forward exercise. However, this is not always the case. For many applications, across industries, service conditions that polymer and elastomer materials are exposed to coupled with the service life expectation together warrant rigorous testing and qualification efforts.

AGEING THE MATERIAL

When an application requires service life beyond half a year to a year, there is no good way of performing real time testing. It would take too long before the material was fully tested, and this proves too costly and ineffective for most applications and industries.

Arrhenius methodology is quite common for many applications that have issues of long term use of materials. However, many of todays applications do not take advantage of this type of extrapolation methodology, even though it could prove benefitial. The method, in very short terms, involves ageing the material under relevant accelerating conditions (fluid exposure, temperature or other as relevant) untill a clear degradation trend is found. Typically three accelerating conditions with varying degree of acceleration is used. When temperature is used for acceleration, three set temperatures are used, with at least 10°C between them. Same type of approach is relevant for all other accelerants. The key important features of Arrhenius methodology is to ensure that all degradation mechanisms are relevant for the actual application, and that the degradation mechanism(s) form a trend. If competing degradation mechanisms form competing trends, it is very difficult to generate extrapolation curves that have a small standard deviation.

DEGRADATION MECHANISMS

The special nature of the elastomer and polymer materials is that they exhibit time dependent degradation behavior, and very often also exhibit more than one degradation mechanism. These degradation mechanisms are not always causing the same physical effects, and thus one degradation mechanism can for a while mask the effect of another. Examples of these are swelling and crosslinking. Swelling will result in a softer material that will exhibit a lower tensile stress and strain, and increased elongation at break. Whilst crosslinking will cause hardening of the material with increase in tensile stress and strain, and a shortening of elongation at break. If both mechanisms are happening at the same time, it is often difficult to distinguish these and see the true degradation over time unless testing is indeed carried out over a very long time. The current JIP test program covers testing for 2 years, at 3 off different temperatures in order to create sufficient data sets for high accuracy prediction of service life and material degradation.

Both elastomer and thermoplastic materials for use in mixed production fluid are typically high end materials. These types of applications see much use of HNBR, FKM and FFKM type elastomer materials and for thermoplastics, often PTFE, PEEK and PVDF are seen in use. Thus, chemical stability against a variety of chemicals and temperature is a key feature. This is also why such materials are so important to study for a very long time. They are inherently very stable in aggressive chemicals, and so it takes a very long time before chemical degradation is observed.

COMPRESSION

One additional feature is the study of how tensile measurements and compression measurements are able to capture chemical degradation as a function of temperature and time. As the application is sealing, studying compression is the best link to application behavior. However, ISO standards typically call for tensile testing. Tensile behavior is the most common behavior to map in qualification testing. It is easy to perform tensile testing, but tensile behavior is inherently difficult to directly relate to sealing in compression. Establishing acceptance criteria for tensile measurements is therefore difficult. Thus, studying compression directly is very important.

To compare with tensile testing of elastomers, Norner utilizes the technique of compression stress relaxation, where seals are measured in compression mode to capture the sealing force of the seal. It is a non-destructive methodology. Compression stress relaxation is viewed as an excellent test methodology to evaluate both material performance and sealing ability in a generic material setting.

This current JIP covers elastomer sealing materials for oil and gas applications, but the same technical approach can be used for all materials and applications that suffer the same issues of degradation over time where prediction of service life is difficult within current knowledge of chemical degradation of the material.

In addition to this current JIP on elastomer sealing materials for oil and gas, there is an upcoming similar Joint Industry Project for thermoplastic materials. The idea is identical to what is described above, only evaluating the thermoplastic materials instead of the elastomer materials. For this upcoming thermoplastic JIP, compression stress relaxation is not part of the scope, as thermoplastics do not exhibit the same type of sealing force behavior as the elastomers. Instead a different type compression test will be used, more suited to thermoplastic sealing behavior.

AUTOCLAVES

Norner has a large number of autoclaves to perfom long term ageing where chemicals can be used under pressure and temperature in an effective way to age the material. Both temperature and pressure are very effective accelerants for degradation in polymer and elastomer materials, and using the autoclave setup to perform long term testing of materials is a reasonable method to ensure safe and successful service of the material in its application.

TREMM PROJECT

Reaserch in packaging safety

Food and food safety are high on the agenda, and for food packaging more knowledge about migrating chemical substances, both intentionally added (IAS) and non-intentionally added (NIAS) is needed.

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Food and food safety are highly important topics in the society today. The food should be safe, healthy and sustainable in every way. Naturally, this also includes the food packaging, which is important both for food quality and shelf life, reduced food waste and for food safety. When it comes to food safety, it is required that all plastic packaging materials in contact with the food (Food Contact Materials - FCM) must be in accordance with the strict European regulations (EC 1935/2004 and EU 10/2011). Migration of chemical substances from the packaging to the food has to be below the given specified migration limits (SML). Substances classified as carcinogenic, mutagenic or reprotoxic (CMRs) should not be present at all.

There is high focus on food safety in all parts of the food production value chain, and the partners in the TREMM project have identified several challenges that are important for the industry to solve. The regulations are insufficient and difficult to follow, and the risk assessment for food contact materials is inadequate. More knowledge about chemical substances intentionally added to food contact materials and how they migrate into the food is needed. There is a lack of knowledge about chemical substances not intentionally added to the food contact material (NIAS), and how these migrates to the food. There is also a lack of analytical methods for determination of a huge number of chemical substances and NIAS components.

COLLABORATION PROJECT

The TREMM project is a collaboration project where companies from the food and food packaging industry work together with Norner Research and Nofima to solve the mentioned challenges. The partners from the industry represent both packaging producers, filling machine producers and food producers.

The main objective has been to investigate the migration of chemical substances from FCMs such as laminates, printed packaging materials and packaging intended for heating in microwave ovens. In addition to this, migration from food contact machine components, typically e.g in filling machines, classified as FCM have been investigated.

NIAS SAFETY ASSESSMENT

EU 10/2011 require that NIAS should be identified and give guidelines for how potential risk of these NIAS can be assessed. The project has developed a strategy and process for doing this based on Cramer Class classification.

Case study

In a case study 8 different multilayer packaging materials (laminated and/or printed) were investigated, by using the two screening food simulants 95% ethanol and isooctane. The temperatures and migration time were adjusted to the intended packaging use as expected. We have found both IAS and NIAS in all 8 packages. The identified IAS and NIAS are well below the migration limits even at these harsh screening conditions.

Summary of results - IAS

Several IAS were found, all of these were identified and assessed against the SML from EU regulation 10/2011. Even under screening conditions, the migration was below the SML for all substances. Two of the substances found are typically used in adhesives (Iso-cyanates). They were found in three of the packaging samples which were adhesive laminates. Another substance, Tributyl acetylcitrate (ATBC), used as a plasticizer e.g in printing inks, was found in two of the packaging types, one laminate and one three-layer PE film. All other substances were well known polymer additives and monomers.

Summary of results - NIAS

NIAS are the most challenging to identify and there are various sources for NIAS. It can be side products, degradation products or contaminants. In this case study we found NIAS of different categories:

- Identified, known origin
- Identified, unknown origin
- Detected, but not identified

Among those NIAS we identified with a known origin, one groupe is saturated hydrocarbon. These are a natural part of the polymer. Two NIAS were similar to ATBC and were found in the same two packaging materials where ATBC was found. The other 5 NIAS substances were from additives or monomers including caprolactam dimer.

We identified some NIAS components with unknown origin. Possible origins could be adhesives, or printing inks. Analytical artefacts can also be a reason at the harsh conditions used.

Several unidentified substances were found which proves that identification of NIAS is very challenging. Most of these are very small and close to the 10ppb detection limit.

Project highlights

Successful development of analytical strategies for identification of NIAS in plastics packaging and validated methodology for risk assessment which is implemented at the institutes.

The project has analysed about 30 cases and identified many substances. Most substances are well known, allowed and within the migration limits. At harsh migration conditions, some identified substances need further assessment.

The industry partners have significantly improved understanding which can be implemented in own quality systems.

TREMM-PROJECT FACTS AND FIGURES

Safe Packaging Food and Migration (TREMM) is an Innovation Project for the Industrial Sector (IPN).
The project lasts for 31 months (01.06.2018- 31.12.2020)

Project partners:
From the packaging value chain:

- Tommen Gram/Bewi, Producer and distributor of food packaging films
- Elopak AS, Producer of packaging and packaging machines for liquid food
- Orkla Foods Norway, Food producer
- Hoff SA, Food producer
- SCG Chemicals, Thailand, Producer of polymer materials for packaging applications

R&D organisations with expertise in the food packaging value chain:

- Norner Research
- Nofima

- Tommen Gram/Finn Robert Muller is project responsible.
- Norner/Jorunn Nilsen is the project manager.

NORNER BARRIER CALCULATOR

A tool for sustainable packaging development

Sustainability has always been a key aspect of packaging, but the importance has never been higher. Our barrier on-line calculator can be a very useful tool in development and implementation of more sustainable solutions.

Ole Jan Myhre
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Two of the key aspects in packaging sustainability is REDUCE packaging material and the RECYCLABILITY of the packaging. In this article, we will demonstrate how our barrier calculator can be utilized to simulate some realistic scenarios which enable you to achieve that.

Sustainability is not about finding or choosing one single, 'correct' route. We must consider various factors and priorities like recyclability, downgauging, resource efficiency and waste reduction. Damaging a product or food should be prevented because the environmental impact, if wasted, is much higher than the package.

REDUCE

Packaging optimisation and material reduction has been a main topic for the packaging value chain for decades. Changing format or material type can be one way to reduce packaging weight significantly like the change from glass to PET plastic jars or replacement of hermetic tins with retort plastic pouches. Downgauging, i.e. reducing the wall thickness or size of the packaging is another. This can still be achieved in both rigid and flexible packaging applications.

EXAMPLE 1 - PACKAGING OF FOOD FOR PETS

Packaging of pet food has become a major and advanced packaging segment. It involves several different formats, but we will here consider a 5kg FFS bag for dry dog food pellets.

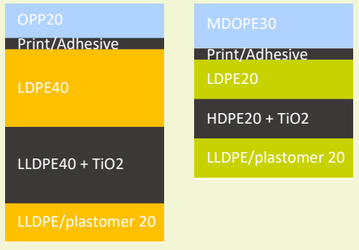
The laminated film was analysed at Norner's microscopy laboratory which revealed the structure to be BOPP // PE illustrated in the left figure. Here the PE film had three different layers of low density PE material including a PE plastomer in the inner layer for excellent sealing performance.

The bag must be tight and since it is a dry food product the key barrier requirement is the moisture barrier.

Let us explore how oriented PE films (MDOPE) can be a technical alternative to the BOPP in the current film.

The new alternative laminate of MDOPE // PE will be monomaterial and can be classified as recyclable. We have designed the PE film with an HDPE core layer and made it 30% thinner, adding to the sustainable profile.

We use the WVTR calculator on www.barrier.norner.no to calculate the transmission of water vapour for a time period of 1 year. The new alternative has 40% better WVTR!



EXAMPLE 2 - FOOD PRODUCT

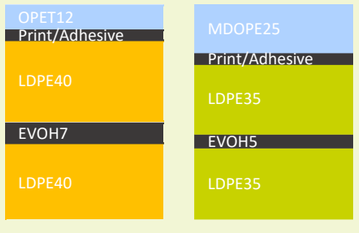
Let's consider another packed food product, a prefabricated pizza dough.

The microscopy analysis revealed that current laminate is OPET // LDPE/EVOH/LLDPE. This is also not a recyclable laminate because the OPET and PE are not compatible.

A possible recyclable alternative is a laminate of MDOPE as the top/printing layer with a similar barrier and sealing layer. PE+EVOH is classified in most recycling streams a recyclable when EVOH < 5% of the total content.

In order to compensate for the thinner EVOH layer in the new laminate we propose to change type of EVOH from a 38% to 32% ethylene content. The new calculated OTR for the recyclable film is better!

We use the OTR calculator on www.barrier.norner.no to calculate the transmission of water vapour for a time period of 25 days for this fresh product.



RECYCLABILITY

The packaging that is most easily recycled is made 100% of the same material and with no addition of colour. The best example of this is PET bottles which is recycled in large volumes. Many other packaging types are coloured with pigments like shampoo bottles or margarine tubs. Even more complex is the film and flexible packaging which often contain many different materials in different functional layers. These laminated films are highly advanced and have really pushed plastics technology to the limits resulting in very light and functional packaging. However, these are not recyclable.

That's why the most important activity in the flexible packaging value chain these days is trying to develop monomaterial, structures that can do the same or similar job.

In the following two examples we will show how both downgauging and recyclability can be assessed and obtained and how the barrier calculator is a useful tool.

CONCLUSION

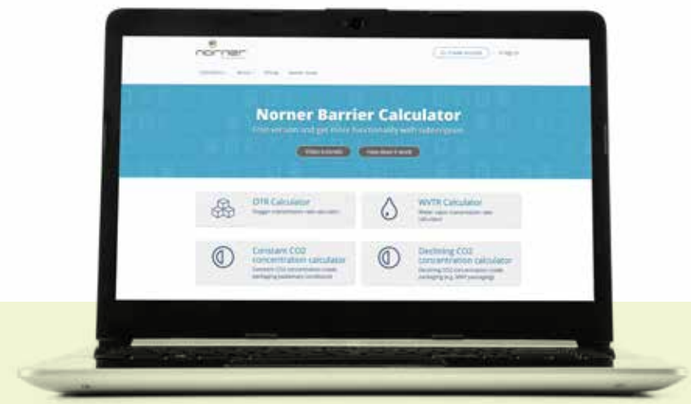
In order to reduce package weight and provide recyclable packaging, the Norner online barrier calculator enables quick simulation of the barrier performance of new packaging solution.

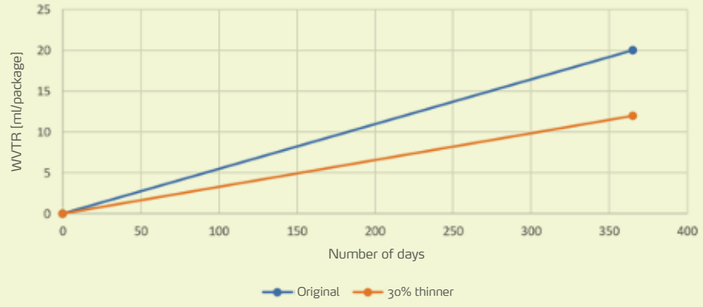
NEW MOCON INSTRUMENTS

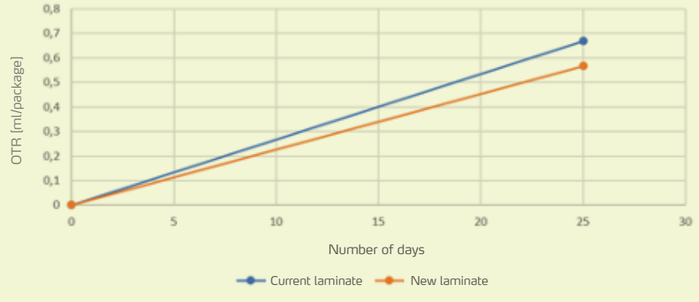
Norner have Mocon instruments for measurement of oxygen (OTR) and water vapour transmission rate (WVTR) which is typically carried out according to ASTM D3985 for OTR and ASTM F1249 for WVTR.

TUTORIALS VIDEOS

Now you can see several tutorials video with the Calculator that show how it can be a very usuful tool.







Focus on the healthcare market

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Norner has historically worked with several companies in the healthcare industry. However, we are now speeding up our efforts to increase our presence in this market. We are doing this by making available the already existing capabilities of Norner as well as adopting to needs specific for this industry. We are strengthening our organization with resources, methods and equipment relevant forhealthcare products and solutions.

The global demographic and digitalization trends feeds innovation in the health ecosystem. For example, in Norway we experience an annual 8-10% revenue growth and the industry is characterized by a proportional large number of start-ups; approx. 10%. Polymer materials is a crucial part of many of these products. However, the core competence and focus for these companies is on the design and function of their product to meet end user needs. Norner fills their competence gap in terms of polymer materials knowledge, test methods and sustainable material choices.

Norner is an active member in relevant clusters such as Norway Health Tech and the Austrian based cluster BioNanoNet.

Norner is also part of the Norwegian Catapult Future Material Centre. Through this infrastructure we work closely with regional incubators, like the health incubator Aleap, and local business gardens across Norway.

Through these clusters we offer Norner polymer expertise to increase value of new innovative products and solutions for continues improvement of healthcare services and peoples lives.

Fortunately, there are both national and European funding schemes available to help drive the development of better healthcare for all. Norner is a trusted development partner and is on a regular basis part of funded projects together with our customers in the healthcare industry.

As an ISO-9001 certified company and GLP routines in place we have the mandatory QMS set-up to meet the regulatory requirements demanded by the health industry. We are also on a regular basis developing and implementing new methods to fulfil the needs from the industry.

Typical services we offer:

- Choice of plastic material to meet intended function and quality
- Make prototype products and evaluate performance of such
- Process development
- Testing of mechanical and chemical strength of medical devices
- Shelf-life and stress testing in requested environment
- Characterize failures and advice on corrective actions
- Ensure sustainable solutions and optimise re-use or recycling of materials in production

Norner works in all relevant sub-segments like medical devices, diagnostics, primary packaging for pharmaceuticals, personal protective equipment and personal aids. In addition to product specific projects we often work with our clients to select materials and processes for functional, economic and sustainable packaging solutions.

We are used to and happy to work with SMB's as well as global brand owners.

Device for patient monitoring

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ShieldMe has developed a device for patient monitoring in nursing homes and health care institutions. The solution will give healthcare professionals increased insight into what happens to patients when they themselves are not physically present and enable faster reaction to critical incidents.

The plastic parts in the sensor housing are all to be produced in polymer material. ShieldMe has therefore engaged Future Materials and Norner to evaluate various material alternatives that comply with relevant requirements, as well as assessment and recommendations to possible suppliers to the product.

A lot of regulations and standards have to be met, both in relation to electronics, temperature variations, chemical resistance and durability. And of course, like most assignments Norner carries out today, sustainability and environmental impact are an important factors that must be included.

STATEMENT BY SHIELDME:
Through our project with Norner, supported by SIVA, we have been able to find suitable polymer materials that adhere to the requirements for compliance with relevant standards. Trough Norner's comprehensive knowledge in materials, they have provided truly immens value in identifying the right materials, as well as to provide the documentation required for the following regulatory processes. This has accelerated us on the right path with regards to both the right material but also with regards to having found production partners.

An Emergency Tourniquet that Saves Time & Lives

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Aristeia AS has developed a tourniquet for pre-hospital use, especially targeting the military market and ambulance services, but also meant for other market segments. The first prototype was composed of various metal components in combination with plastic parts.

The product design enables first responders to act quickly within a short critical time window. It's as simple as putting the device on and pulling the string. It is also simple to remove and re-apply the tourniquet.

Before market launch, it was necessary to optimize design for manufacturability and even try to reduce the device weight. On request from Aristeia, with support from Future Materials, Norner performed an evaluation and recommendation on polymer material selection, a design for manufacturability study and advised for eventual possible metal replacement in some of the current metal parts in order to reduce the overall weight.
Norner`s work and recommendations on material and design had to consider a.o. the products intended use under extreme weather conditions, from arctic to tropical climate, in the deserts and at sea. And also, to make sure all details remain in accordance with international regulations and standards.

STATEMENT BY ARISTEIA:
The collaboration with Future Materials and Norner provided Aristeia with useful insight the company will bring into the development process of its 5th generation prototype. Emergency tourniquets are subjected to significant force during application and are required to have the highest degree of reliability in harsh environments. In addition, staying competitive in the market on pricing is key as well. Optimizing manufacturing and material choices ties into both device functionality and the viability of the business case. The project has effectively de-risked these components and provided a solid basis for further development.

FUTURE MATERIALS CATAPULT CENTER

Supporting innovative companies

Norner is one of the owners of Future Materials Norwegian Catapult Centre together with Elkem, ReSiTec and UiA (MIL).

Heidi N. Bryntesen
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The Norwegian Catapult Programme is designed with the idea of accelerating the process from concept to market of a product. The purpose of the Catapult programme is to support small and medium sized enterprises in Norway.

The Catapult projects funding schemes are specially designed for entrepreneurs and SMEs. The grant with up to 75 % support or max NOK 100,000 per project. The application forms are simple and there is a minimum of reporting bureaucracy. Applications are handled continuously with no specific deadline.

During the projects we assist companies in developing prototypes, offer expertise and equipment for testing, visualisation and simulation. We can support you in turning innovative ideas into new products and services in an effective manner at a lower risk. At our facilities you will be able to develop, test and verify your products on an industrial scale.

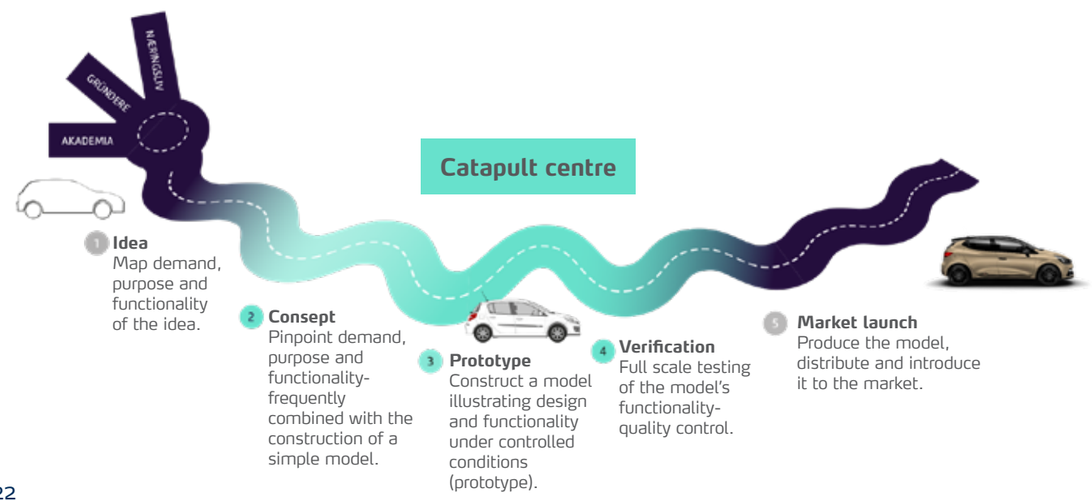
Future Materials' partners hold top-class expertise and are preferred partners for companies all over the world. This is noticed and highly valued by the Norwegian government, who in 2020 awarded NOK 30,000,000 to our Catapult centre for further investments in relevant test and piloting equipment for material analysis and processing.

Future Materials Norwegian Catapult Centre was appointed late 2017 as one of the two very first Catapult centres in Norway. Through a strategic expansion towards the polymer industry, Norner was invited to join as a shareholder and partner in Future Materials in 2019, significantly increasing the Catapult centre's competence and equipment.

The global demand for advanced materials based on micro- and nanoparticles is growing at a rapid rate – and the competition to reach the market is ever increasing. We believe success in development of new materials and products comes through the enhancement of existing products properties. Production of advanced products requires fundamental understanding of the materials' composition and properties. Future Materials excel at the development of new materials.

Future Materials' partners Elkem, ReSiTec and Norner have worked extensively with industrial recycling together with various companies and helped them to use bi and lateral streams in their own production, or to further refine this into new products. We have a wide range of relevant waste processing equipment, for pilot product production based on recycled material, and testing facilities to document the quality of the finished product.

Via Future Materials we can offer a strong competence in powder for Additive Manufacturing (AM), Future Materials has Norway´s only plasma machine for powder production (spheroidization and nanopowder synthesis). Our partner Mechatronics Innovation Lab has a broad range of different 3D-printers for metal, plastic and composite.



» ***PRESERVIA – Preserve world heritage***
When the Vatican Library needed a digital archive to preserve > 80,000 manuscripts for future generations they chose Piql's technology. Piql's innovative approach is to utilise photosensitive film as a digital medium based on high density QR codes. As their R&D partner, Norner has contributed to the development and verification of the durability and lifetime of all elements of this specially developed storage medium including design for a protective packaging. This includes several funded research projects.
This project was supported by The Research Council of Norway.

» ***Materials for extractive media***
The plastic inner liner in the process equipment at the CO_2 capture technology centre at Mongstad did not have enough chemical resistance to the aggressive environment. A combination of extraction of additives, harsh chemicals and high temperature was the root cause of the problems, resulting in a too short lifetime of typically 5-10 years. Norner tested and demonstrated the weakness followed by a development which resulted in a novel additive formulation securing the process equipment an extended lifetime of up to 25 years.

FUTURE MATERIALS
We believe success in development of new materials and products comes through the enhancement of existing products properties. Production of advanced products requires fundamental understanding of the materials' composition and properties. Future Materials excel at the development of new materials. And we aim to get even better!

The global demand for advanced materials based on micro- and nanoparticles is growing at a rapid rate – and the competition to reach the market is ever increasing.

We offer test facilities, competence and a professional network for developing sustainable advanced materials for your company's future products and processes. We focus on the material itself and together we find the solutions of the future!

All Together Global Cleanup

For the 5th year in a row Norner arranged (our) Beach Cleaning Campaign. Previous years we have managed to remove about half a ton of litter during an evening's effort in the spring with our employees, local customers and business partners. This year we wanted to achieve more and at the same time do it safe where necessary Covid-19 measures were taken.

Thor Kamfjord
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Plastics are, and will continue to be, a vital part of modern life and a major contributor towards a circular economy, helping to achieve a more sustainable and resource efficient future for all. But when not properly managed, they may harm our health, biodiversity and ecosystem services. The problem of plastic littering has been growing, and the costs mounting, particularly for the marine environment.

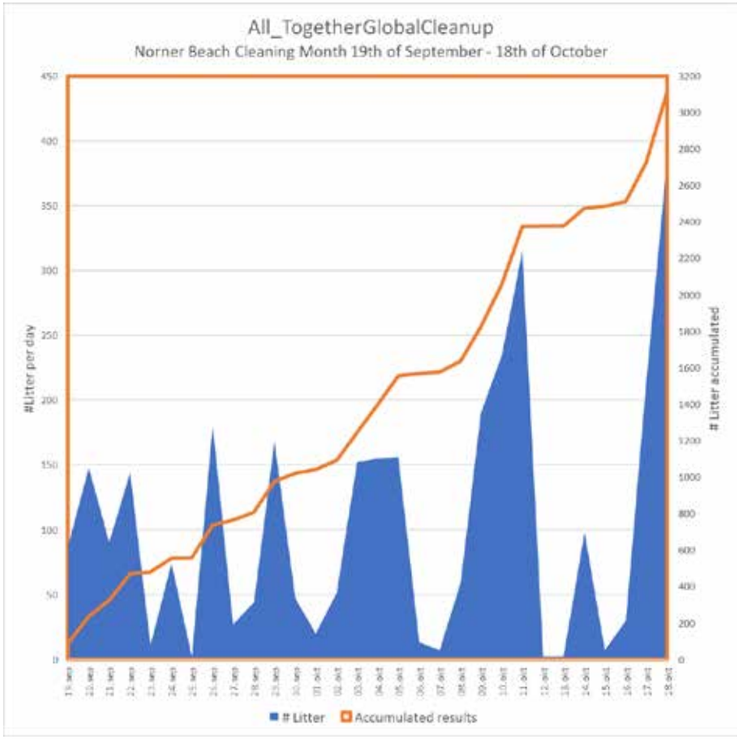
Our common target is a world that is free of plastic waste in the environment and protection of our natural resources and ecosystems which communities everywhere depend on, especially in developing countries. This calls for global cooperation and coordinated actions across all industry sectors to develop solutions that will help solve the plastic waste challenge that we face as a society.

We need to unite industry, governments and intergovernmental and non-governmental organisations to develop and invest in projects that harness their collective resources and technical expertise to develop solutions that will prevent the leakage as well as recover and create value from plastic waste.

» *Norner champion: «When walking my dog this month, we took on the challenge. The result was more than 500 pieces of litter removed from the environment. I call it a win-win walk!"*

In order to enable the waste management systems to work, we also need a change in people's behavior and attitude to littering. Even in countries where advanced waste management systems, deposit schemes and modern infrastructure are in place – littering is still a major challenge to be solved.

Clean-up campaigns has proven to be a successful way to engage people around the world to remove litter and debris the environment. These actions help to identify the sources of the litter, but also contribute to changing the behaviors that cause pollution through direct involvement of individuals in local communities all over the world. In order to increase our impact in 2020, we are proud to have partnered up with the Alliance to End Plastic Waste (the Alliance) in the world-wide All_TogetherGlobalCleanup campaign, a global initiative to remove litter, one piece at a time from the environment.



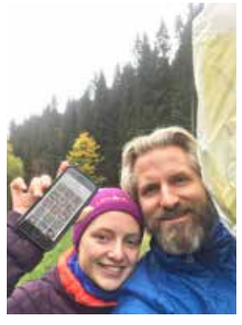
» *Figure 1: Norner pick-up campaign results.*

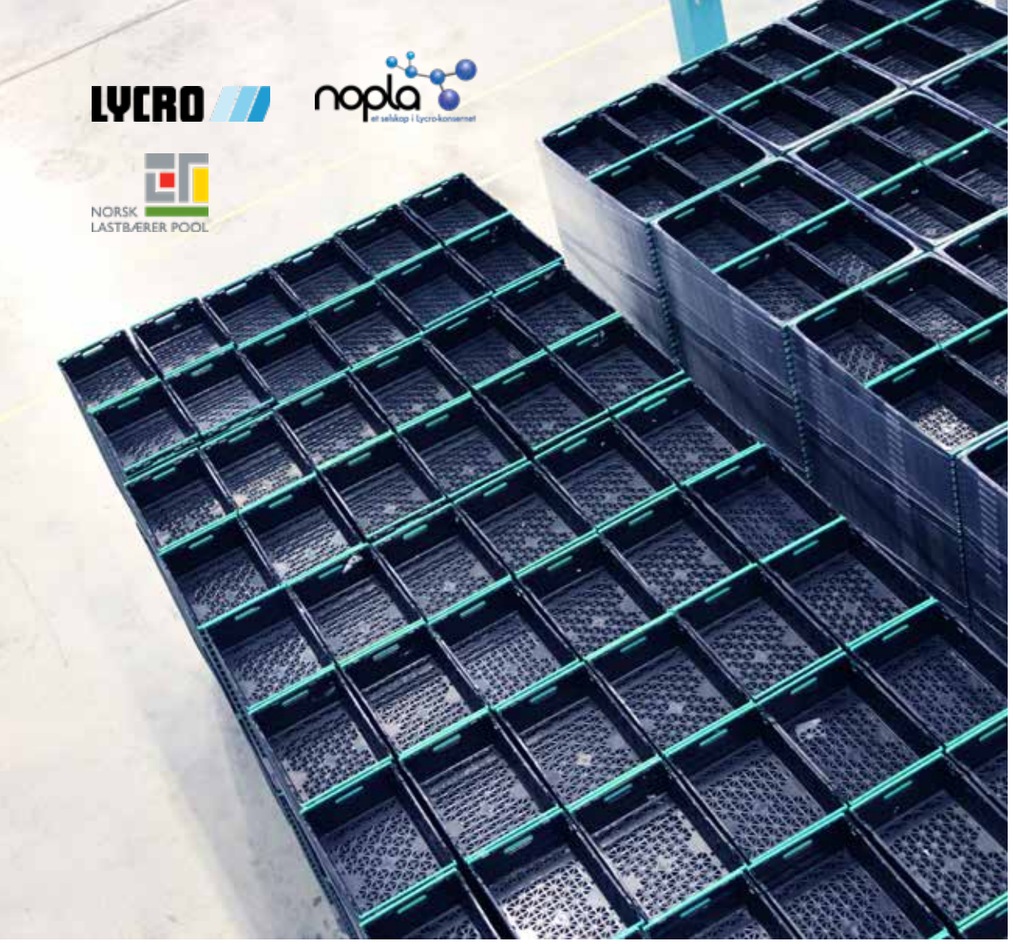
Starting at World Cleanup Day 2020 (3rd weekend of Sept.) and continuing for a whole month, we encouraged all our employees, friends and families to pick litter as individuals and in small groups to show how we can have a major impact when we work towards the same goal.

The pickup efforts and results were monitored in the world's largest open accessible litter-database by using mobile phones and the inspiring Litterati app, which everyone can use when they are outdoors. The free-to-use app allows immediate registration of the litter-items being picked up by just taking a picture with a mobile phone. Litterati uses artificial intelligence to interpret the images and identify the litter. By geotagging the results, the data are made available in a world map and an openly accessible database where details about the littering can be analysed. The Litterati app allows for pickup efforts to be monitored with concrete data, which in turn makes it possible for changes of lasting impact—from behavioral shifts, improved waste management systems, changes in corporate packaging changes and more.

We are proud to see that the joint effort through the All_TogetherGlobal-Cleanup-campaign initiated cleanups by a wide range of companies in the plastics value chain in 78 countries all over the world, and helped the Litterati community to reach a total litter pickup of more than 1 million pieces of litter during the campaign period.

In Norner, we managed to remove more than 3100 pieces of litter from the environment. That is more than 3100 reflections of how and why resources end up in the environment, but most importantly, how can we prevent it in the future. We believe we can solve this challenge – piece by piece!





THE RE-CREATE PROJECT

Returnable food packaging from discarded CRATES

LYCRO has an ambition to significantly improve the sustainability for their returnable crates business and created the RE-CReATE project.

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Returnable crates are used to pack and protect various products like fresh produce, packed food and other consumer goods from production to grocery store. They ensure efficient transportation, excellent protection and reduced product waste rates. Hence, they are a sustainable logistic enabler. Such crates are typically made of food contact approved polypropylene (PP) due to its excellent properties, durability and purity which make it ideal for contact with food.

LYCRO is a Norwegian based company specialised in mould design and injection moulding with various crates and boxes in their portfolio under the brand of NOPLA. Norsk Lastbærer Pool (NLP) have developed and are operating a logistic solution for returnable transport crates in an efficient and environmentally friendly way that optimise the supply chain for suppliers and retailers in the Norwegian Grocery sector. NLP reuse the returnable crates in their pool for up to ten years.

LYCRO, as the producer of crates for NLP, proposed the brave idea of recycling discarded PP crates from NLP and other similar pools back into new crates and thereby drastically improve the sustainability of these. The main objective of the project is to establish closed loop recycling of crates into new food approved crates for the food and grocery sector. They have a high ambition to offer this solution to enable improvement of their customers environmental position.

Polypropylene is the second most used plastic in the world and in Europe 4 Mtonn/year are used in food contact applications. Crates made of Polypropylene can be recycled and used to make new crates. However, before being used for food contact applications the plastic requires high purity and to be recertified for food contact to ensure the material has no risk for the consumers.

Despite the high demand for virgin polypropylene for food contact applications, there is at present no commercial availability of recycled polypropylene compliant for food contact. Therefore, LYCRO and NLP have joined forces in the RE-CReATE project and invited Norner to be the R&D partner. The project is owned by LYCRO and supported with grants from the Norwegian Research Council. The target of the project is to enable the incorporation of recycled materials in food contact applications by investigating and developing commercially relevant processes compliant with EU food and safety regulations.

RE-CReATE will tackle the challenges from a holistic perspective looking into raw material sourcing and traceability, recycling and purification process and material development as well as on product design using LCA to validate the environmental friendliness of the new solutions. Furthermore, it will develop technology and methodology for analysis and documentation which fulfils the strict regulations for food contact approvals.

RE-CReATE will develop new systems and sustainable technology and products which will be implemented by LYCRO. This will improve the environmental footprint for NLP and their customers in the grocery sector.

The returnable crate market is very large in European terms with a high potential for closed loop recycling with food approval. The project will establish LYCRO as a key supplier of sustainable and circular rigid food packaging from returnable crates.

NONTOX

A new life for contaminated plastics

Removing hazardous substances, valorizing side streams and applying eco-design principles on material design to improve the sustainability and recycling rates of WEEE, ELV and C&DW waste plastics.

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Norner Research AS is a partner of NONTOX a project funded by EC-Horizon 2020-SC5. and the leader of the work package dealing with Upgrade of Plastics. The project is coordinated by VTT and partners from seven different European countries complement the consortium: STENA Metall Group (SE), Coolrec (NL), Relight (IT), Galea Polymers (ES), FRAUNHOFER IVV (DE), AIMPLAS (ES), IMDEA Energy Institute (ES), Relight (IT), ERION (IT), University of Campania "Luigi Vanvitelli" (IT), Aalto University (FI).

WASTE HANDLING PANORAMA ON WEEE, C&DW AND ELV

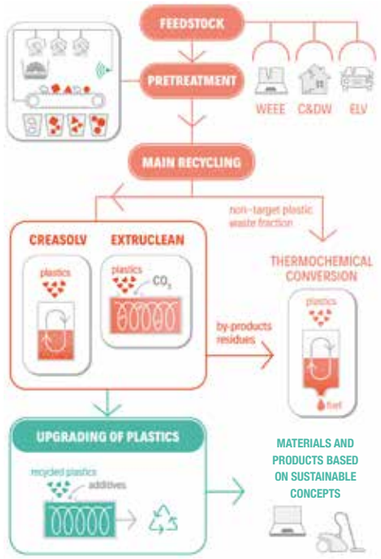
The European plastic demand is of about 50 Mt (2018) of which 6.2% (~3.2 Mt) in Electrical and Electronics Equipment (EEE) sector; almost 20% (~10 Mt) in Construction sector; and 9.9% (~5Mt) in the Automotive sector[1], Based on those volumes the plastic recycling targets are set to about 45% for Waste of Electrical and Electronic Equipment (WEEE), 30% for End-of-Life Vehicles (ELV) and 36% for Construction & Demolition Waste (C&DW).[2, 3]

A significant limitation for the recycling is the content of legacy hazardous substances (LHSs) such as brominated flame retardants (BFRs) and Persistent Organic Polutants (POPs) [4, 5, 6] and produce safe, high performance recycled plastics. Due to the content of LHSs a large proportion of this materials are used for energy recovery or landfilled in the absence of technically feasible, environmentally sustainable and cost-effective purification and recycling processes.

THE CHALLENGE OF NONTOX

NONTOX project takes a holistic approach in bid to increase the recycling rates of such plastics in a cost effective and sustainable way. Essentially, improving the whole value chain right from the start, where these waste streams are collected after the end of their life, until the very step where the recycled plastics are safely introduced back into the value chain.

The project aims to (i) optimise and demonstrate the efficacy of different technologies to extract LHSs and produce high quality recycled plastics; (ii) develop and improve techniques for efficient characterisation and pre-treatment of hazardous plastic waste as well as (iii) increase the efficiency of downstream recycling technologies towards high performance upgraded plastics and by developing and demonstrating guidelines for each step of the plastic value chain. Moreover, (iv) the efficiency, sustainability and competitiveness of the entire system will be increased by the valorisation residues and non-target plastic waste, using thermocatalytic conversion. Finally, (v) life cycle assessment tools for the economic, social and environmental impacts will be implemented to evaluate the benefit of the technical solutions and boost the market uptake of plastic recycling technologies and of their recycled products.



» *Figure 1: The NONTOX concept.*

BASED ON

Removing hazardous substances to increase the recycling rates of WEEE, ELV and CDW plastics Vincenti N, Campadello L, Qureshi S, Schlummer M , Quiros S, Moreno J, Fermoso J, Barreto C, Taveau M, Ardolino F, Cardamone G, Arena U. Electronics Go Green 2020 Conference.

NONTOX has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No.820895.
Find more about the project at: www.nontox-project.eu

Waste streams and handling

Three input streams are the focus of NONTOX project: WEEE, ELV and C&DW (Figure 2). More specifically, BFRs are the most common HLSs in WEEE [5]. In ELV plastics (excl textiles) BFRs play a minor role, however PCBs and plasticizers are significant [6]. With respect to C&D waste, plasticizers and the BFRs are the main LHSs [5].

Mixed plastics streams or streams with less than 90% of a specific polymer type (mainly at density >1.1 g/cm3) are specially enriched in BRFs. CreaSolv® (solvent recycling) is suitable to purify and separate these streams. Complementarily, plastics streams with high single plastic content and lower content of flame retardants (e.g. density < 1.1 kg/L) are addressed by the Extruclean ® (extrusion with supercritical CO2). Side steams of both processes as well as waste plastic streams not targeted by these fractions are treated with thermocatalytic conversion (TCC) processes in NONTOX (Figure1).

Material and product design

Increasing the recycling rates of plastics, improving the economy of the recycling process as well as the quality of the recyclates is also achievable by proper material and product design. NONTOX from the perspective of design for recycling and from recycling, works in the development of materials with recycled content and products designed to fit the nowadays commercially available and economically feasible separation by density to mitigate the formation of mixed plastic streams (Table 1) and demonstrate performance on materials with significant recyclate content. The work focuses on monomaterial products and self-reinforced composites with polyolefins, styrenics and polycarbonate matrices.

Density range (g/cm3)	Major polymers in the stream
<1.0	PP, PE and versions with low levels of filler and reinforcing fibres
1.0-1.1	ABS (low Br), PS &HIPS (low Br), filled and reinforced polyolefins
1.1-1.25	ABS (high Br), PS &HIPS (high Br), PC, PC/ABS, PA, soft PVC, PMMA. Filled and reinforced polyolefins and styrenics
>1.25	Hard PVC and other high density and highly filled polymers

» *Table 1: Density separation: Practical density ranges in NONTOX for separation in WEEE, ELV and C&DW.*

Polyolefins and styrenics are the most abundant polymer groups in the recycling streams, therefore is worth to design properly their next life with focus on density. In their density ranges, the recyclates show commonly levels below 2000 ppm Br. Considering the applicable EU regulations, these fractions are, in most of the cases, not considered hazardous and do not require decontamination prior to application. When the polyolefin-based compounds exceed density 1.0 g/cm3, e.g. by the addition of fillers they become detrimental for the fraction of styrenics or become part of the fractions of mixed plastics above density 1.1g/cm3. Therefore, designing with focus on density for both polyolefins and styrenics is a critical need to enhance the recyclability and mitigate the need of purification of all waste streams.

» *Figure 2: Polymer waste stream in the scope of NONTOX.*

WEEE: *Waste from electrical and elecronic equipmenyt.*

C&DW: *Construction and Demolition waste.*

ELV: *Waste from End of Life Vehicles.*

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NEXTGEN TPO

Next generation intelligent, recyclable waterproofing membranes for the construction industry

The NextGen TPO – project will develop sustainable, safe and intelligent polymer membrane solutions, fit for the current and future needs of the construction industry.

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Sustainability and recyclability are high on the agenda in the construction industry. This, combined with a strong drive for transforming roofs from passive to active parts of the building envelope by way of rooftop solar energy generation, roof gardens and rainwater retention systems, create new opportunities for the waterproofing industry; requiring novel innovative material and system solutions.

Protan, a leading international manufacturer of roofing membranes, will start the ambitious NextGen TPO project in 2020. The project is an innovation project for the industrial sector, supported by The Research Council of Norway. The goal is to develop an innovative new product portfolio of advanced, sustainable materials that are easy to install, durable, climate-independent, environmental-friendly - and 100% recyclable. The project combines demanding interdisciplinary research and development activities in the areas of materials technology, manufacturing processes, building and installation, as well as in modelling and simulation of product performance. Protan is currently in the initial phase of this highly interesting and important research project and will work together with Norner Research throughout the project.

NORNER RESEARCH CONTRIBUTION

As an active R&D partner in the NextGen TPO project, Norner Research is seeking to contribute with world-leading expertise within advanced polymer development, hereunder polymer structure-properties-processing competence, thermal, chemical, rheological and mechanical analyses, accelerated ageing testing and lifetime predictions, molecular characteristics, and laboratory-scale polymer processing pilots. Key personnel from Norner R&D will assist in in the development activities and implementation of the project. Norner Research will contribute with essential competence within formulation design and development of formulation compounds (polymers, additives, fillers, stabilisers, fibres/textiles) through a unique global supplier network in combination with own know-how. Norner Research will, in particular, use market-leading expertise on polymer additives and polymer structure-properties-processing relationships to achieve a new polymer material with best-in-class durability and mechanical performance.

NEXTGEN TPO OUTCOME – HUGE ENVIRONMENTAL BENEFITS

The development project will require high quality, high risk and interdisciplinary R&D efforts in applied polymer research, advanced materials characterisation, process development and modelling and simulation. The project outcome will be a direct contribution to specific UN Sustainable Development Goals (SDG). The NextGen TPO will offer a new membrane material which is recyclable and not containing any hazardous compounds. These features are particularly addressing SDG 3, 12, 13 and 14, by ensuring good health and well-being for producers, installers and end-users, in addition to preserving the climate and life below water by promising no release of hazardous substances to the environment. Furthermore, the NextGen TPO will be engineered to reduce heat island effects in urban areas, contributing to achieve more sustainable cities and communities (SDG 11).

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Contact angle – the key to easy slip surface

Norner has developed and offer a novel own technology for modification of the injection moulding process to create an easy slip surface of plastics articles and packaging. Norner can deliver this technology and specifications with a license agreement.

Several applications will benefit from an easy slip surface that enable liquids to leave the surface very fast. This non-wetting technology makes it easy to empty a package, surfaces stay clean or reduce the friction. It is suitable for both watery and fatty environments.

The modification can be applied to different types of plastic resins and is therefore applicable in several kind of products and has a proven high process efficiency.

A key factor for implementing and customising the solution is the understanding how the process parameters will influence the surface tension of the relevant material. For this purpose, Norner has recently invested in a "Drop Shape Analyzer – DSA30".

The new instrument can benefit customers in many areas from infrastructure and coating to packaging and healthcare.

NORNERNEWS

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The Polymer Explorers

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