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NORNER NEWS 03

Technologies for Polymerisation of CO_2

Plastics secure digital data For the next 500 years

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Leader

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CARLOS BARRETO

Hello, I have dedicated the last years of my career in research of CO_2 polymerisation. It has been very exciting and resulted recently in my PhD.

JØRGEN NYHUS

Hi, I care for some of our projects and are exited to be involved in novel developments of thermoplastic foams for wind mill applications.

DAG ROAR HEGNA

I have been lucky to be involved in our compliance testing method development and implementation. That was challenging and fun.

Our growth in development projects and testing assignments for the oil and gas industry is very encouragiing for me and our organisation. We make a difference to the industry.

Tine Rørvik
CEO

Dear reader

First of all, I would like thank all our clients from across the world for Norner's growth and success the last years. We are pleased to see that over 60% of our business is with our international clients and that our competence do reach far out.

In Norner we are obliged to understand your needs and develop our services accordingly. Through our past history, we have strong traditions within petrochemical industry and the downstream value chain.

During the past years we have developed our competences and facilities even further to fulfil new requirements within R&D and testing for our clients. I would like to particularly emphasis two areas, first the polymers for the Oil & Gas industry and secondly infrastructure. Both areas are highly regulated with strict quality demands.

Oil & Gas is also an industry with a continuous push for new technologies to go deeper, harsher and colder in more challenging environments. We see clearly a strong demand in new polymer materials and competence. Norner has had an encouraging 50 % growth in business turnover within this segment only.

In this edition, we are proud to present some of our new testing capabilities like in compliance and food migration and Norsok testing of materials for Oil & Gas. We are now also an certification body of INSTA-CERT, the common Nordic pipe certification.

You can also read about our dedicated R&D team who explore the technologies of tomorrow together with leading partners and clients. We cover plastics from CO_2, extreme longevity of plastics, new wind mill technology and surface modified packaging making them easy to empty, just to mention a few.

Enjoy reading !

- Tine

Highlights

IM Barrier technologies

Norner was invited by IHS to present a paper on barrier technologies for injection moulding at their recognised Dubai Plast Pro 2012 conference. Our rigid packaging specialist, Morten Augestad took the challenge.

He discussed the alternative technologies, their performance and suitability based on our projects and experiences. Norner is involved in a series of projects in this field and provide development and performance testing.

Shelf life simulation @ AMI

AMI invited Ole Jan Myhre of Norner to present his insight in barrier performance of packaging at the AMI Multilayer Packaging Films 2012 conference. The presentation covered the free Norner barrier calculator and simulations of shelf life.

QR Link to the calculator.

Norner Academy with success

Since 2008 then we have delivered a variety of customised training sessions to our international customers.

For the second year now, our Norner Academy week attracts >40 industrial attendees. Some of them participate in several seminars.

We are proud of the feedback we get from our participants telling that our seminars were high and useful.

The Norner Academy week 2013 was arranged in September and included five different seminars:

- Polymers and properties
- Plastics for Oil and Gas
- Characterisation of plastics and rubbers
- Failure analysis and prevention
- PE polymer and sealability

We look forward to welcome a new delegation of participants in 2014.

Participants in the Polymers and Applications seminar 2012

Norner @ SPE

Svein Jamtvedt was invited by SPE to share his insights in stabilisation of polyolefins.

The Society of Plastics Engineers (SPE) is a key industry organisation with the main target to support the success of plastics by spreading knowledge, strengthening skills and promoting plastics.

Norner participated with table top and presentation at SPE European Additives & Colors Conference, March 6-7, 2013.

PhD in Green Polymer Technology

Carlos Alberto Barreto Soler, Senior Researcher at Norner AS, defended his PhD "Properties of poly(propylene carbonate) and nanocomposites thereof" Sept. 6th 2013 at The Univ. of Oslo.

The evaluating committee consisted of Professor Kristiina Oksman, Department of Engineering and Mathematics, Luleå University of Technology, Vice President Dr. Keith Redford, Conpart AS and Professor Harald Waldehaug, Chemical Institute, University of Oslo. Dr. Barreto has for the last 4 years been involved in R&D in the field of making plastics from carbon dioxide. His work has also resulted in 4 patent applications of importance for commercializing technology for the making of polycarbonates and polyols, the latter as building blocks for the making of polyurethane.

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Oil & Gas

We continuously develop our service offering to the oil and gas industry.

Our key services for Oil & Gas are:

- Polymer material know how
- Innovation projects
- Durability and life time testing
- Failure analysis
- NORSOK material testing
- HTHP / High temperature - high pressure testing
- Exposure and compatibility testing

ONS 2012

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ONS is the second largest exhibition for the energy sector globally and attracted close to 60 000 visitors from 109 countries in Stavanger, Norway in 2012.

Since its launch in 1974, ONS has become what is today regarded as one of the world's leading energy meeting places.

Our visitors included people from system providers and engineering companies in the sector.

Polymer Industry

Plastic products, production and applications are our core know-how.

Our plastics industry services include:

- Catalyst development
- Polymer innovation
- Polymerisation laboratory
- Additive optimisation
- Processing trials
- Compliance testing
- Harmonisation and cost reduction

ARABPLAST 2013

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ARABPLAST is the key International Plastics& Rubber trade show in the GCC region and was arranged for 11th time. It attracted 25 646 visitors from 113 countries in Dubai, UAE in January.

Arabplast 2013 has grown 34% since the 2011 edition, following greater response from exhibitors and sponsors.

Our visitors main interest was to discuss how Norner can help develop their business through projects involving our unique plastics expertise and polymer laboratory.

Meet us at
- leading international events

K 2013, Stand 7.2 A32
16-23 October 2013, Düsseldorf, Germany

OTD2013, Stand 4109, Hall D
23-24 October 2013, Stavanger, Norway

MDI2013, Medical Device Innovation Conference
13-14 November, Paris, France

Multilayer Packaging Films 2013
18-20 November 2013, Vienna, Austria

NORSOK M-710
testing of non-metallic materials

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Norner demonstrates commitment to the Oil and Gas industry through investments in new test facilities for Norsok M-710

New investments in test facilities have been installed and methods for testing of non-metallic materials in contact with media related to Oil and Gas production according to ISO and Norsok standards are established. We continue therewith to extended our laboratory for ageing, compatibility and weathering durability with test methods for qualification of systems used in offshore and marine sector.

Norner laboratories can now offer:

Ageing under high pressure and high temperature
- High pressure water / seawater
- High pressure / temp, aggressive fluids and gases
- Rapid gas decompression
- Evaluation of material properties

Norsok M-710
- Qualification of non-metallic sealing materials and manufacturers
- Compatibility testing, ageing under severe conditions

ISO 2393
- Non-metallic materials in contact with media related to Oil & Gas production, part 1 : Thermoplastic
- Non-metallic materials in contact with media related to Oil & Gas production, part 2 : Elastomers

“These extended capabilities for ageing and durability studies give established and new customers in the offshore industry an even more complete range of competence and capability in material technology” says Tine Rørvik, Managing Director of Norner.

“We are a leading provider of failure analysis and third party material testing and the new tests demonstrate that Norner takes the challenges in oil, energy and marine industries seriously.” Says Henning Baan, Laboratory manager at Norner

Norner engages in product development, research projects, quality assurance, durability testing, failure analysis and consulting through the whole plastics value chain. The labs include advanced test facilities and process pilots with ISO 9001 approval and Achilles qualification.

Achilles JQS
empowered by Achilles
Qualified

High polyolefin longevity in aggressive environments

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Thermoplastics, as most materials, have their pros and cons. Norner has developed additive recipes which dramatically extend the service life of PP in aggressive media.

This proprietary technology was developed with a team of Norner's researchers and laboratory engineers, many with up to 30 years of experience in plastics additives.

The innovation has been done by development and testing of different additive recipes for PP in liquids and solvents with the target of reaching service life longer than 20 years at elevated temperature. The results are very good and even at 70 °C more than 25 years have been demonstrated by accelerated tests.

Norner runs a portfolio of customer projects in this field and is a key resource in several R&D programs. A success factor is our extensive contacts with additive suppliers, polymer producers and end users and our capability to tailor solutions according to end use.

The proprietary solution developed for PP is currently in implementation phase in a harsh industrial chemical environment.

Larger blades for off-shore wind energy

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NORNER has joined a project consortium of eleven organisations that has secured EU funding to create cost-efficient, lightweight and recyclable wind mill blades.

The four-year project, called WALiD[1], is funded by the European Commission under the Seventh Framework Programme. The goal is to combine process, material and design innovations in an integrated approach. Its key innovation is the introduction of thermoplastic composite materials and processes into wind blade for large offshore wind turbine installations. These materials will replace thermosets in the root, tip, shell core and shear web.

Some expected benefits are new designs leading to substantial weight saving, faster processing via automated processes and enhanced durability.

It is expected that the technology developed within the WALiD project will lead to the production of highly durable blades that are able to withstand challenging environmental offshore conditions.

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1 - Wind Blade Using Cost-Effective Advanced Composite LightWeight Design

Technologies for plas
- utilising the greenhouse


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Norner has during the last years been active in the research of polymerisation of CO_2 to form polymer. The projects have focused on several critical aspects including additivation, catalyst, process efficiency and application testing.

The interest in making polymers from CO_2 is huge due to the utilisation of a waste product that is harming the climate, as well as the substitution of petro based raw materials which are more costly than CO_2. Such polymers substitute 35-45% of the hydrocarbon based raw material with CO_2. Norner has developed a position as a recognized player in the emerging «Carbon Capture and Use» industry. In this regard, Norner has developed technology since 2008, building up knowhow within this field as well developing a number of technology concepts supported by patent applications.

Poly(propylene carbonate), PPC, is produced by the copolymerisation between the greenhouse gas carbon dioxide and propylene oxide in the presence of a catalyst. PPC is an environmentally friendly material that needs to be considered for much broader applications than the current limited commercial use.

PPC WITH INCREASED THERMAL STABILITY[1]

The thermal properties of PPC poses a challenge as the polymer has a low glass transition temperature (softening) as well as is prone to degradation especially when containing catalyst residues. In a recent scientific article, Carlos Barreto Soler (PhD) discusses ways to overcome these hurdles, by Norner's own purification and stabilisation technology.

In fact, PPC may be purified without the use of organic solvents, and the thermal properties may be tailored to be dramatically increased compared to today's scientific and industrial benchmarking PPC materials. Norner's novel procedure renders the PPC thermally stable at 200 °C for ca 60 min, thus expanding the processing window for PPC.

1 Novel solventless purification of poly(propylene carbonate), Tailoring the composition and thermal properties of PPC. Carlos Barreto, Eddy Hansen, Siw Fredriksen, Polymer Degradation and Stability, Volume 97, Issue 6, June 2012

tics from CO_2 gas as raw material

MELT BLENDS OF PPC AND PE OR PP

Polymer blends have over the years drawn great attention in both scientific research and industrial production as they can often provide better performance tha individual polymers and are more cost efficient than synthesising completely new polymers.

PPC is a material with significant opportunities, but also with some limitations. One limitation is its use in conventional thermoplastic applications due to a low glass transition temperature, Tg, and a low decomposition temperature. One way to overcome this limitation, and speed up the time to market for PPC, is by the use of blends and multilayered solutions with conventional thermoplastic resins (for eksample PE and PP).

BLOW MOULDING

PPC has superior melt strength compared to conventional polyolefin. This is an advantage with respect to parison and blow moulding performance. As an example blends and bottles of PPC and polyolefin with up to at least 60% content of PPC could be made. The result is bottles with 25% wt% CO2 as a base material.

INJECTION MOULDING

The injection moulding should apply the same temperature recommendations as given for the compounding step above. Blends and injection moulded items of PPC and polyolefins with up to at least 50% content of PPC can be made. The stiffness can be modified with the content of inherent plasticiser, propylene carbonate

From left: Director Chemicals Procurement Kirill Maksimov, Lars Evensen and Head of Technical Support Vadim Gayfiev

Saving costs for SIBUR in polyolefins

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Our core competence in polyolefin additivation is now being utilised in a project for cost saving and know how development at SIBUR, the largest integrated petrochemical company in Russia and CIS.

A strong asset of Norner is high knowledge and long experience in additivation of polymers including supplier contacts and network, performance testing, raw material approvals and purchasing strategy.

SIBUR choose Norner to train their organization in additives for polyolefines followed by a program for qualification of additives and suppliers as well as co-development and implementation of new procurement processes. In this fruitful cooperation with SIBUR, Norner's experienced employees and scientific laboratories has been utilised during the training which took place both at Norner in Norway and at NIOST, which is SIBUR's scientific centre in Tomsk, Russia.

"Cooperation of NIOST LLC with Norner AS started in 2012. During this time we reached the significant advance within the range of project and got ahead with the assistance of high-qualified Norner specialists. We know Norner AS as a trusted partner and we expect a long-term cooperation with Norner, – says Director for science and technology of NIOST LLC Yury Kazakov."

During the last months, our cooperation has involved the following activities:

- Training in laboratory practices for testing and characterisation
- Re-engineering of procurement strategies and introduce cross functional processes
- Cost-performance optimization of products and simplification of supply chain

Giving:

- NIOST the position to secure qualification of market leading additives to SIBUR
- Highly efficient and transparent procurement processes for additives securing high quality at the right cost
- Boost SIBUR knowledge in polyolefin additivation to provide products that exceed client's expectation and more efficient plant operation

"SIBUR is continuously working to improve the quality of its products to better serve its customers' needs. We are happy to cooperate with Norner - a recognized leader in polyolefin additivation for polymers. Its wealth of experience and technical expertise in this segment will contribute to further quality improvements of SIBUR's products." Says Kirill Maksimov, procurement director at SIBUR.

Based on the positive outcome from the additive project, SIBUR and Norner have discussed innovation projects aiming to further strengthen SIBUR's position in domestic and export markets

New Polymer Webshop

Imagine, having access to the polyolefin samples you need. You can now order them in our webshop!

Morten Lundquist
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We can now provide small samples of polyethylene and polypropylene produced in our bench scale reactors at our webshop.

Based on your needs we can provide the samples through our regular offer of polyethylene or tailor made PE and PP according to customer specification.

If you need…

- Specific compositions, comonomers, Mw, MWD
- Selected samples with defined characteristics and variations
- Thoroughly characterised and well defined

NORNER's polymerisation laboratory can supply this!

We supply a wide range of PE materials polymerised with standard catalysts and comonomers in slurry conditions. These polymers are suitable for scientific, research and development work where well defined polymers are needed for physical or chemical studies or for calibration purposes.

Samples will be delivered with Material Safety Datasheets (MSDS) and Certificate of Analysis (COA) with analytical data like MFR, density, comonomer content, DSC, GPC and information of additivation for pellet samples.

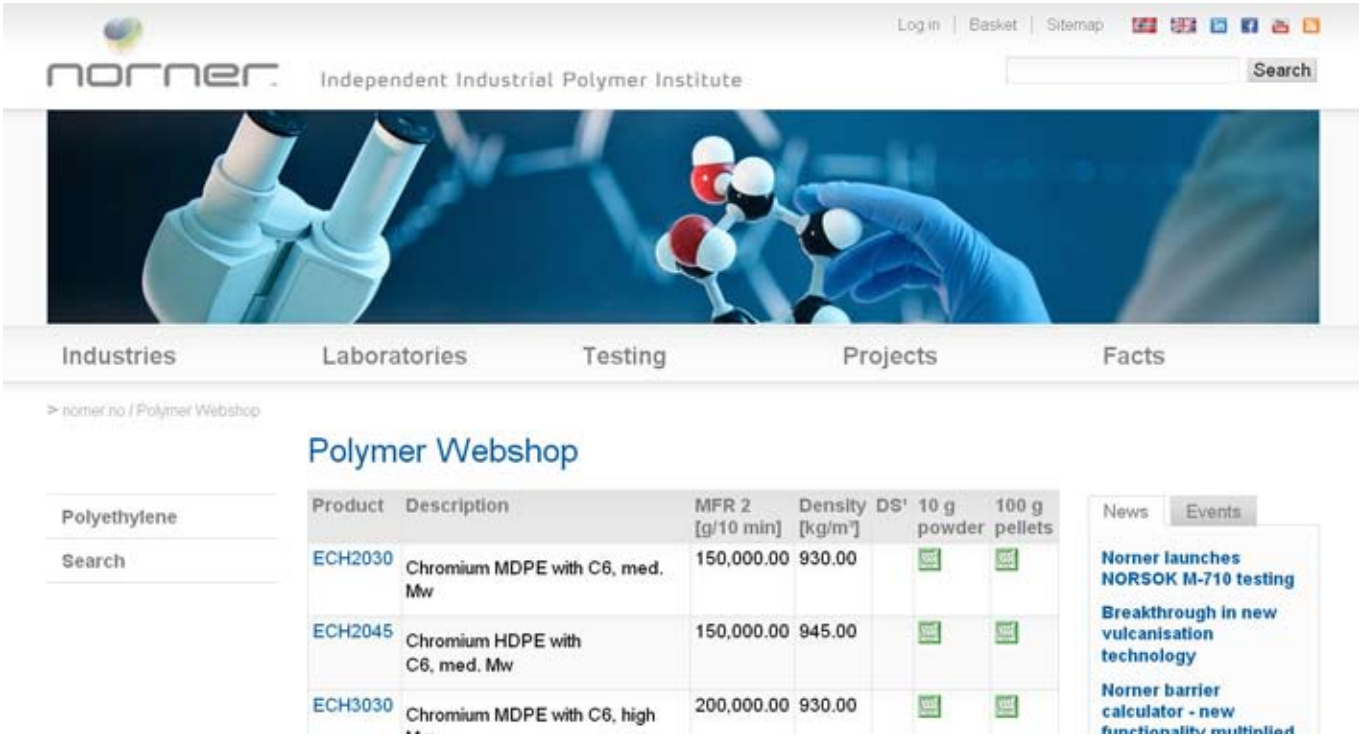
Extended offer on request

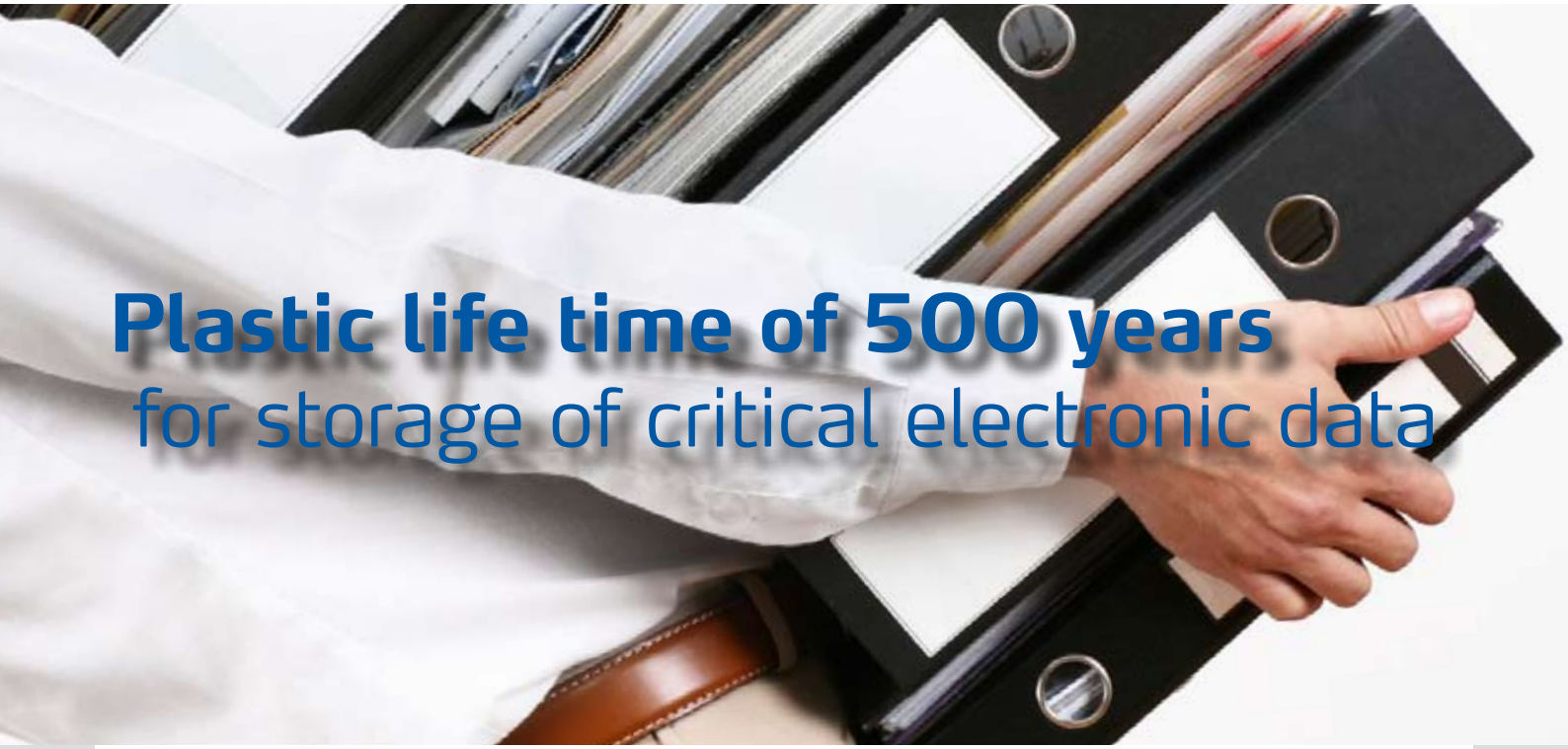
In addition to our standard offer we can provide a wider range of materials on request or in larger amounts.

Alternative PE materials can range from uni-modal materials made in gas phase, slurry or bulk, to more advanced or complex compositions of bi- or tri-modal PE.

We provide PP homo, random or heterophasic polymers, multistage polymerised PP and PP produced with a variety of catalysts and comonomers.

Tailor made products according to our clients' own chemicals, such as catalysts, comonomers, additives etc. can be prepared by our polymerisation facility including pelletisation and additivation. Additional analyses, polymer test data etc. can also be provided.





Plastic life time of 500 years
for storage of critical electronic data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Together with a consortium of highly reputed companies and institutions supported by the EUROSTAR program and the Norwegian Research Council, Norner is dedicating its world leading competence in polymers and additives to protect data of high value to companies and mankind.

The amount of data we're producing and need to keep safe for future generations is increasing daily. The digital data we store is arguably the "DNA" of our modern civilisation and represents our thinking, our creativity, our problem-solving ability and our discoveries. It holds the key to sustaining modern life. Keeping this data tamper-proof and retrievable in its original form whenever needed, is extremely important.

Current storage media and related hardware and software need updating at least every 5-10 years and require more and more investment. The integrity of data is at risk every time it's retrieved and re-stored. With the recent natural disasters all over the world and expectations to an increasingly tougher climate, traditional digital data storage solutions and paper files are not safe.

Cinevation AS of Norway has developed technology to store digital information on photosensitive film, and their Archivator® will provide solutions to the challenges at hand.

Cinevation is the lead partner of the collaborative project and Norner is the main material technology provider, securing longevity of the total solution.

"The US Library of Congress is required to retain some of its data for the lifetime of the Republic plus 4,000 years", says Lars H. Evensen, Business Development Manager at Norner. "Our ambitions does not stretch that far, but we want to secure that the materials involved in our solution can protect the data for 500 years plus".

Norner is working closely together with all stakeholders from manufacturers of film stock, film processing equipment, film recording and printing and providers of physical storage solution, mapping all potential sources having negative impact on longevity performance of the system. In addition, Norner is responsible for the development of a complete packaging solution for the film stock, capable of protecting the data medium for the required lifetime.
Norner provides expert knowledge in degradation mechanisms for polymers, available stabilisers and state of the art test methods for longevity and lifetime estimations. New highly accelerated methods must also be developed. On top of in-house capabilities, Norner is building on competence at IPI – Image Permanence Institute (USA) and the University in Oslo.

"With the complexity of materials involved and the extreme time horizon where even trace molecules can play a role in relevant degradation mechanisms, we have to cooperate with the best brains", says Svein H. Jamtvedt, Project Manager at Norner.

Compliance testing of Food Contact packaging materials

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It becomes increasingly important to understand the food contact regulations, to be able to make assessments, chemical analysis and to fulfill the required documentation to authorities.

Norner has leading expertise in plastics and packaging including additives, catalysts and monomers. Our expert group has broad knowledge in international regulations such as for food contact, medicals, toys, utensils, water pipes and REACH.

Several regulations require control and documentation of chemicals, additives, migration and food contact safety. Norner is determined to develop and deliver sustainable solutions and reliable results to our clients.

Our broad approach allows us to influence product development and specification starting from polymer type, design and manufacturing process via the additives to the actual processing and packaging application.

Norner carries out a wide range of services relevant to packaging, medical and consumer goods.

- Analysis of additives and monomers in packaging
- (EC) 1935/2004, (EU) 10/2011, REACH and FDA expertise
- Overall migration testing according to EN 1186
- Identification of possible SML components
- Specific migration testing according to EN 13130
- Notification services for US and EU regulations
- Analysis according to European Pharmacopeia
- Testing according to other standards
- Analysis of Bisphenol A
- Analysis of Phthalates
- Heavy Metals in toys
- Odour and taste testing
- Analysis of volatiles
- Compliance of Materials for Drinking and Potable Water
- Analysis of odour and fogging for automotive

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EasySlip - developing self cleaning packaging

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An everyday phenomena met by consumers worldwide is the fact that it's actually not possible to empty many containers without scraping or flushing.

NORNER took the initiative to create a consortium project together with other leading institutes, packaging producers and consumer goods manufacturers. The overall idea of this project is to develop an environmentally friendly packaging concept with inner plastic surfaces with extremely good slip properties (easy slip) will enable more or less no residues in the package when emptied.

Typical examples of products which are difficult to empty can be yoghurts, tomato ketchup, shampoo, mineral oil products or paint to mention a few. The thicker the liquid the more difficult to empty. Often these products are relative expensive too, so loosing access to up to 10 % can be quite annoying for the customer.

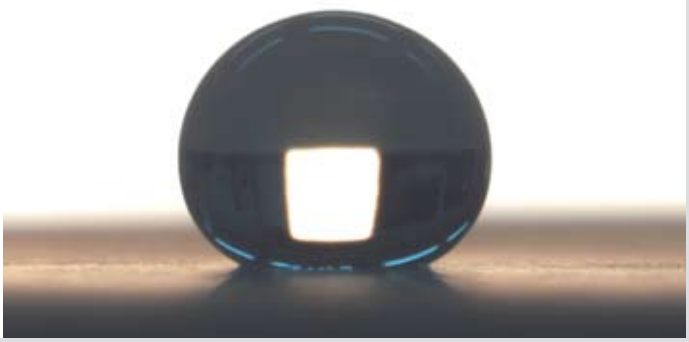
When waste handling or recycling is considered packaging products (e.g for paint) might end up as special category waste or both consumer and waste handling companies excessively perform cleaning by water – a limited resource in many parts of the world.

Due to the environmental aspects as well as increasing customer focus on these challenges different industries target to find solutions to the problem.

The main targets of the projects are:

- Develop non-wetting polyolefin surfaces by selected bulk and surface modifications
- Utilise the non-wetting technology to develop selected packaging application demonstrators
- Develop prototypes with industrial scale process and product potential and fulfilling all regulations
- Ensure and verify a positive environmental impact of the project.

The recent achievements of this project prove that both some commercially available as well as proprietary solutions are available. The photo demonstrates the very high contact angle we have achieved for developments in the project for aqueous products.



Qualification of pipe-in-pipe
- minimising the risk of leakage

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When installing water distribution domestic houses and apartments surely the PEX supply pipe will be covered by a corrugated pipe. Often called a Pipe in Pipe solution.

The inner pipe is a PEX plastic pipe with very stringent regulations. The outer corrugated tube has a security function of leading away potential leaking water if the PEX pipe gets a rupture. These tubes have had no regulations until recently and the quality has been poor resulting in cracking tubes and several insurance cases.

A new test scheme for approval was recently implemented in Norway and includes the analysis of several quality parameters by microscopy like;

- Pigment dispersion and homogeneity
- Raw material quality vs. gels
- Thickness distribution of the profile
- Presence of notches in the tube profile

Thereby, Norner help protecting the homes of our customers, reducing failures and saving costs.

Patented Trimodal Technology
- to advance next generation HDPE

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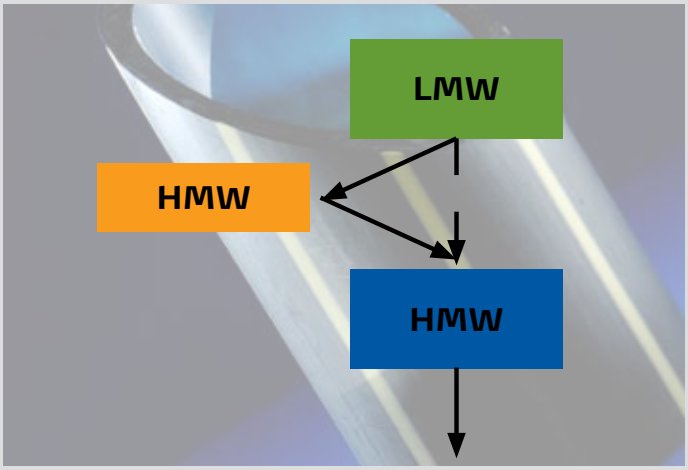
Norner Trimodal Technology introduces a small fraction (< 10 %) of a third polymer (HMW2) in a small third reactor containing comonomer. Existing bimodal plants can be upgraded by adding a third reactor.

In addition to several advantages compared to existing trimodal and bimodal plants, the technology also utilises the possibility to produce the HMW fraction early in the process, allowing better comonomer incorporation compared to conventional technologies. Promising mechanical properties indicate potential for high quality PE100RC pipe grades.



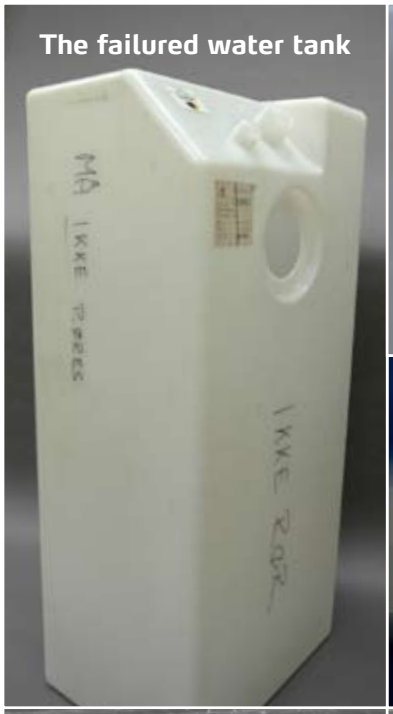
The technology has been developed in Norner advanced Polymerisation Reactor Park, and is now ready for first production tests in larger continuous pilots before full scale implementation.

The figure describes the principle with one of the configurations patented, where the small fraction containing comonomer is produced early in the process (when the catalyst is young). This allows, among other;

- Potential for increased comonomer content of HMW2 component for more extreme composition
- Younger and therefore better comonomer incorporating catalyst for critical HMW2 component - for e.g. stress crack property
- Potential for lowered temperature in HMW2 reactor and therefore higher molecular weight

Norner is currently evaluating potential partners for commercial utilisation of this patented Norner Trimodal Technology.

Return address: Norner AS, Asdalstrand 291, NO-3960 Stathelle, Norway



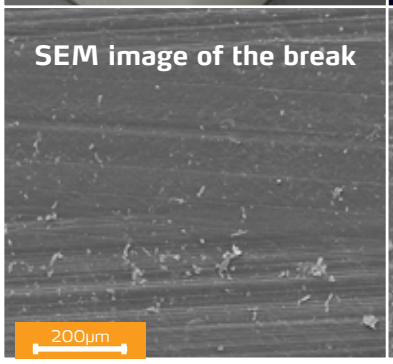


Photo in this issue by: Tom Riis, Sibur, Istockphoto, Norner

At the back

Failure analysis and failure prevention is a key competence at Norner. Some times failures are even manipulated!! With proof from Norner, this insurance company saved 50.000€.

An owner of a holiday residence claimed his water tank had broken and caused water leakage and damages worth 50.000€. The insurance company again claimed the producer who did not understand the failure and contacted Norner.

The tank was broken in the middle of the side wall and our microscopy team made their investigations by sample preparation, light microscopy investigation and SEM analysis of the surfaces inside the break. **Obviously this was fraud!** The surfaces showed no sign of stress, material failure or production errors. It showed however clear signs of being cut by a knife.

With the help of our team the house owner lost the case AND the insurance company saved 50.000€.

Did you miss earlier editions?

You can access these earlier editions of Norner News through the following QR code or at http://issuu.com/norner

NORNER**NEWS**

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