PTSNEWS

01/17

FIBRE based solutions for tomorrow's products

PTS PILOT PLANT FOR INNOVATIVE PAPER AND WET-LAID NONWOVEN DEVELOPMENTS

- *Multi-client project: New applications for synthetic and special fibres*
- *Developing thermoplastic materials for lightweight construction*
- *Developing tools to derive plant concepts for the dry sorting of paper for recycling*
- *High in demand - Measuring technology for evaluating paper for recycling*
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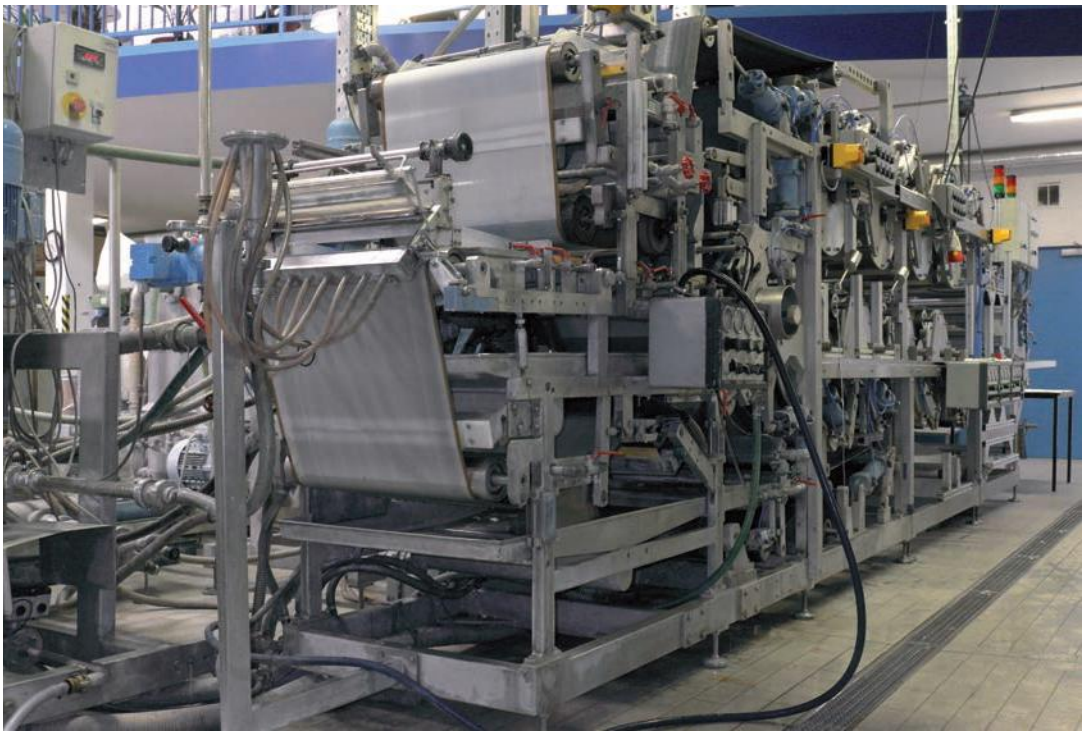
PTS FIBRE based solutions

PTS PILOT PLANT FOR INNOVATIVE PAPER AND WET-LAID NONWOVEN DEVELOPMENTS

In its pilot plant facilities in Heidenau, PTS offers its customers practice-oriented, innovative developments of new processes and products. Test stands for defibration, sorting, refining, disperging, flotation, washing, finishing and the production of papers and wet-laid nonwovens enable investigations across several process steps ranging from the evaluation of raw materials and converting properties to the use value determination of products.

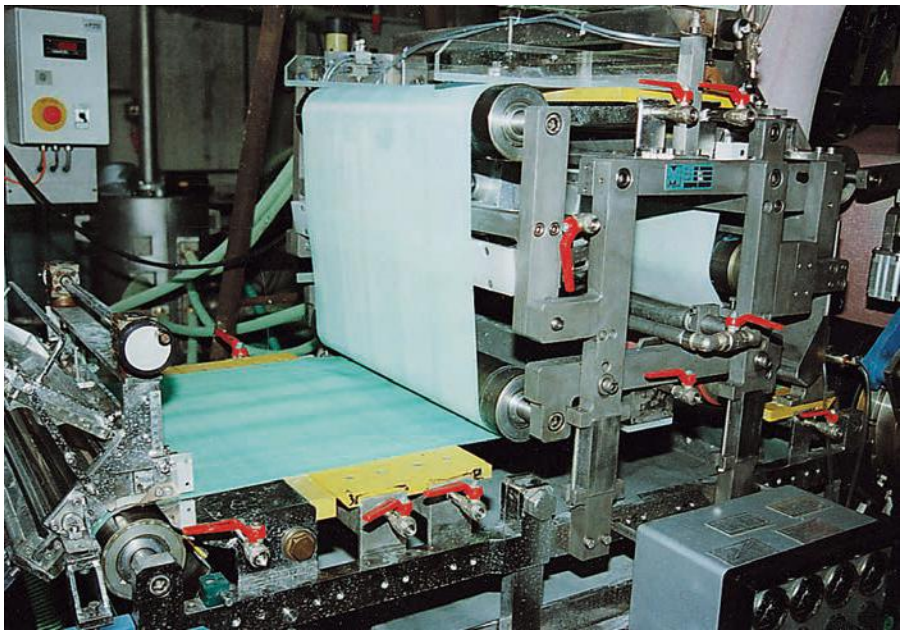


Pilot paper machine for reels or sheets (source: PTS)

In the last two years, we have installed several new state-of-the-art plant units in the pilot plant, for example a new twin-screw extruder and through-air dryer or exchangeable wire modules (inclined /Fourdrinier wires) as well as a spunlacing system for the pilot paper machine. All of them open up completely new opportunities in the fields of fibres and composites. Fibre-based composites can be used in a broad spectrum of applications ranging from simple technical products to high-performance structures for customers in the automotive and aerospace industries.

TWIN-SCREW EXTRUDER

With its throughput range of 5-40 kg/h, the new extruder system fits perfectly well with the infrastructure of the pilot plant. It has been specifically selected to ensure a reliable scale-up of pilot results to industrial plant systems. The variable dosing of pulps, granular materials and dispersions makes the compounder highly flexible. The twin-screw extruder ZSK 26 will mainly be used for modifying pulps with a consistency > 25%, i.e. operated as a continuous reactor with flexible dosing of additives and other process materials. The envisaged target group are customers from the paper manufacturing and other sectors who are looking for intermediate products.



Pilot paper machine with Fourdrinier section for simplex and duplex operation (source: PTS)

PAPERS / WET-LAID NONWOVENS

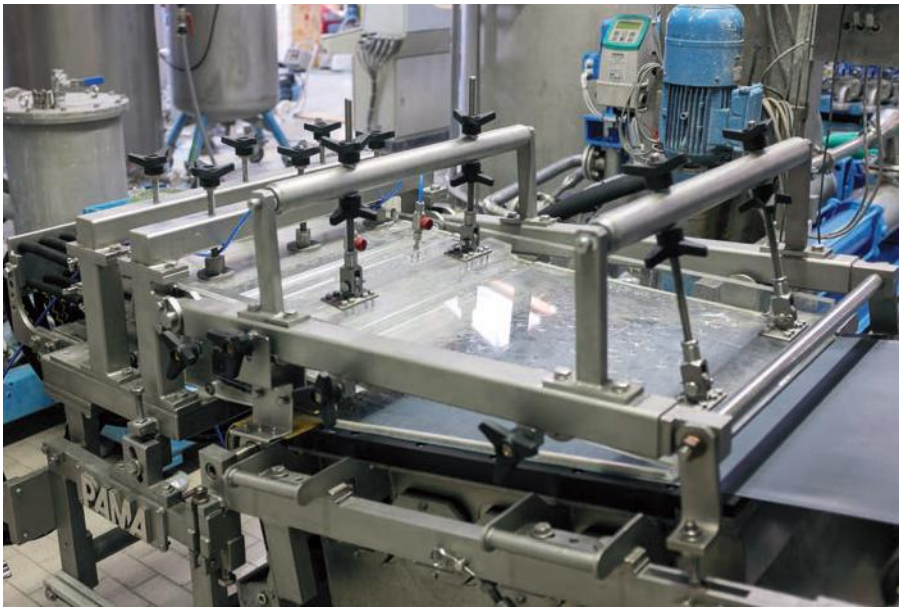
PTS has retrofitted its pilot paper machine with an exchangeable wire module. This makes it possible to choose between Fourdrinier (single/two-layer) and inclined (single/two-layer) wire designs. PTS will use the technology to develop papers and wet-laid nonwovens for novel applications and operating principles, for example papers for filtration purposes, separator papers, nonwovens and fibre-based construction materials for lightweight applications, automotive and building.

The pilot paper machine is capable of

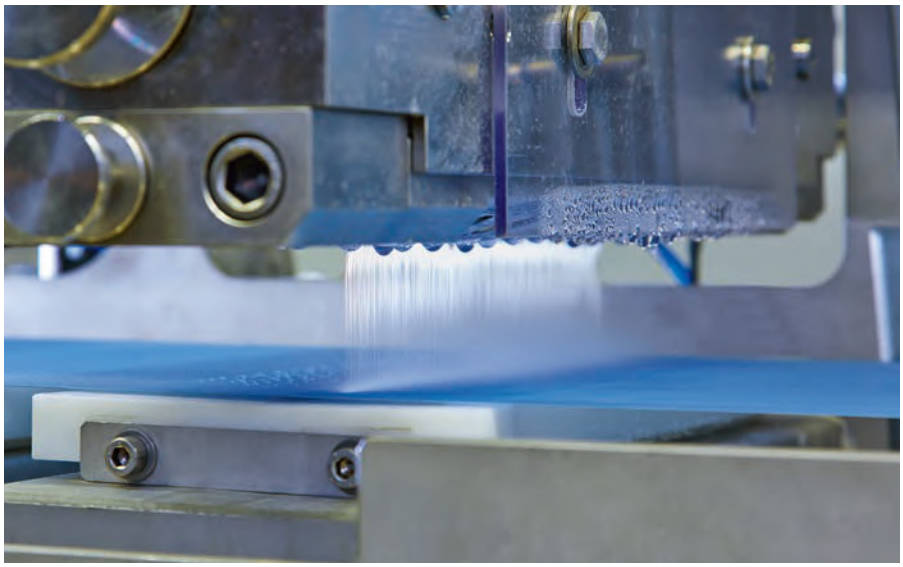
producing papers and wet-laid nonwovens within a broad range of grammage levels and raw materials. Products cover the full spectrum from 100 % cellulose-containing to 100 % cellulose-free, unfilled to highly filled papers containing 85 % fillers, and can subsequently be treated by heatable calenders or a metering size press.

SPUNLACING / THROUGH-AIR DRIER / LABORATORY PRESS

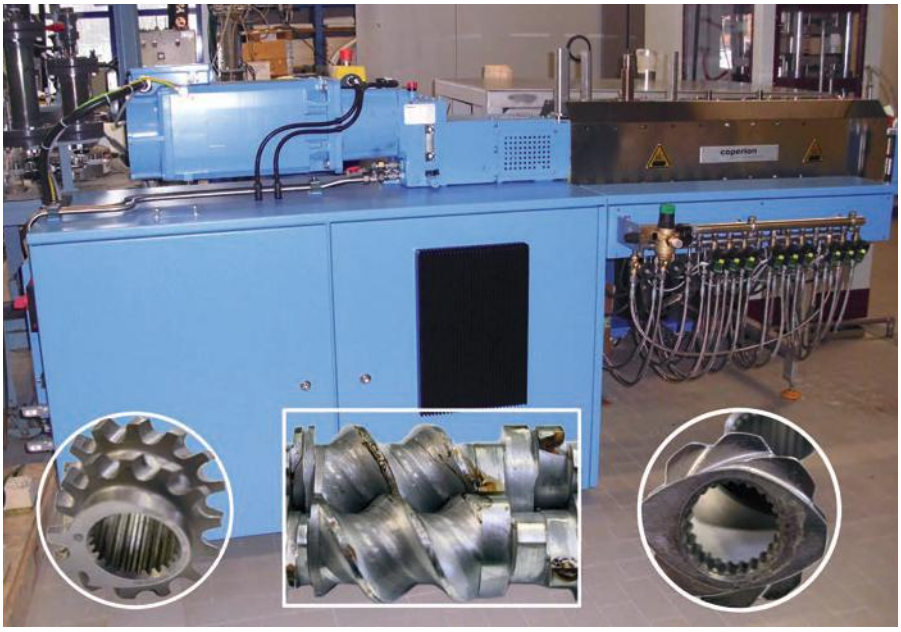
The new inline spunlacing system of our pilot paper machine can be used in combination with the inclined wire module to obtain e.g. fibre-based filter composites for various filtration techniques. Several layers of fibre-based materials (paper/wet-laid nonwoven, dry-laid nonwoven, textile) may be bound permanently and non-destructively, i.e. without reducing the active filter area. The technology can also be used to consolidate webs comprised of long, cellulose-free synthetic fibres. A through-air drier serves as drying aggregate, for example to dry and/or subsequently consolidate the wet-laid nonwovens. The latter is particularly important when using thermo-reactive, so-called thermo-bonding fibres. The dryer may be operated continuously or in batch mode, separately or in combination with the paper machine, and at a temperature of maximally 250°C.



Pilot paper machine with inclined wire mode (source: PTS)



Pilot paper machine with spunlace technology (source: Andritz)

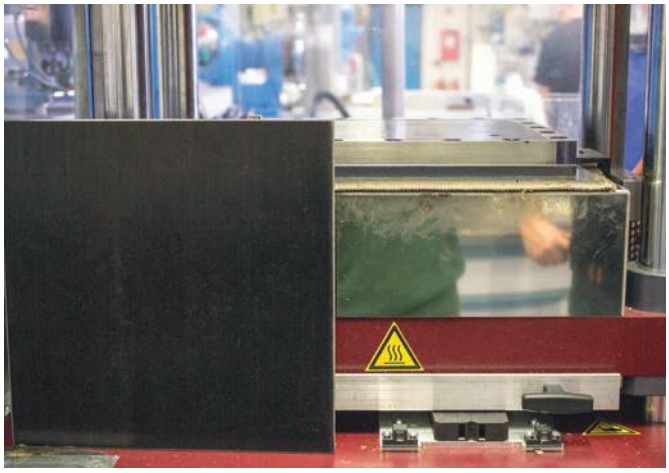


Extruder with screw elements (source: PTS)

A newly acquired hydraulic laboratory press makes it possible to combine different materials, for example to laminate core sheets with overlay or decor papers, or wet-laid nonwovens with fibre-reinforced materials to obtain organic sheets. The press can be operated at specific surface pressures of up to 730 N/mm², temperatures of maximally 300 °C and is suitable for sheet sizes of maximally 30 x 30 cm. This innovative process chain enables the manufacturing of entirely new products on a paper machine. Our service offers are designed to assist customers with new product developments, process improvements and with optimising their material use.

In the field of ***product development and material use optimisation***, we are able to offer the following services:

Through-air drier (source: PTS)



Hydraulic laboratory press (source: PTS)

- Development and modification of pulps using mechanical/chemical/thermal treatment technologies
- Optimising the use of fillers, starch and chemical additives
- Development of new paper qualities and sample production for practice-oriented application studies
- Testing of new additives and formulations
- Cellulose modification

For the ***development of new fibre composites***, we offer the testing of

- Natural and synthetic polymer fibres and inorganic fibres like viscose, PLA, aramid, carbon, glass and basalt fibres
- Combinations of various structural fibres, including recycled fibres
- Woven fabrics and nonwovens for semi-finished products

Process optimisations can be performed through

- Practically relevant simulations and by identifying technically and economically optimal solutions in preparation for mill trials
- Subsequent mill trials
- Improvements of process steps and the optimisation of plant units
- Optimising the use of renewable raw materials and paper for recycling
- Developing and testing new sensors and measurement systems

Our pilot plant services also include ***continuing education and training***:

- The training and demonstration centre for specialized personnel
- Training programmes for machine operators
- Company-specific training courses

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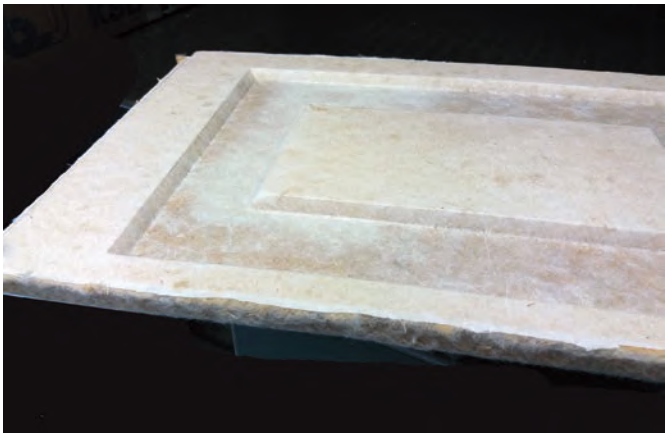
MULTI-CLIENT PROJECT: NEW APPLICATIONS FOR SYNTHETIC AND SPECIAL FIBRES

Aim of a recently completed multi-client project in the PTS pilot plant in Heidenau was the use of natural and synthetic polymer fibres in paper formulations to investigate their effects on paper properties and identify possible ways to create new products or improve existing ones.

First step of the project was evaluating the wet processing behaviour of various natural and synthetic polymer fibres such as PVA and polylactic acid (PLA) fibres, several types of aramid fibres, high-performance fibres leading to special properties like chemical and temperature



Paper materials pressed on semi-finished parts (source: PTS)

resistance, polyester and polyethylene as well as various bi-component fibres.
After demonstrating the general suitability of the fibres investigated, they were used in papermaking trials on the pilot paper machine, using Fourdrinier and inclined wire modes. The papers produced had various grammage levels and contained different shares of synthetic fibres (5 % - 40 %). Some formulations led to significantly improved paper properties: especially the use of bi-component or thermo-bonding fibres, i.e. fibres whose structure melts under heat so that they can provide extra reinforcement at fibre crossings, led to strength gains.
Another focal point of the project was evaluating the forming properties of papers. Papers were made with selected formulations and hot-pressed on semi-finished wood fibre structures at the Institut für Holztechnologie (wood technology institute) in Dresden, using a die geometry with small degrees of deformation.
The moulded parts shown in the photographs above were obtained with around 20 - 40% thermo-bonding fibres in the paper formulations. This share was necessary to make the material structure flexible enough for forming and generate the desired strength levels after curing. The papers could be applied without further treatment on rather coarse fibre mats and covered their surfaces uniformly and without creases or wrinkles.

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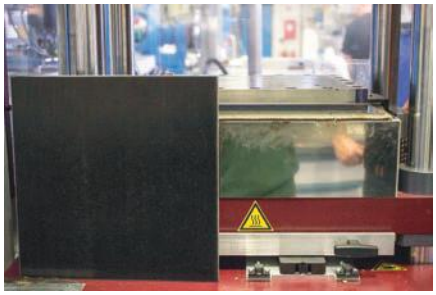
DEVELOPING THERMOPLASTIC MATERIALS FOR LIGHTWEIGHT CONSTRUCTION

MATERIAL CHARACTERISATION OF NEW HYBRID NONWOVEN STRUCTURES AND BASALT FIBRE-REINFORCED ORGANIC SHEETS

In further work packages of the "HyBaVli" project already described in PTS News issue 01/16, the newly developed hybrid basalt nonwovens were processed to so-called organic sheets and the resulting mechanical properties were analysed.
The basalt fibres in hybrid nonwovens must be completely wetted with the matrix material to achieve optimal mechanical properties.
For this purpose, a polymer (PA6) bound in the hybrid nonwoven material is melted under heat and pressure in a hydraulic laboratory press, using optimised process parameters, and then left to cool off. The treatment results in a fully impregnated flat organic sheet.
Micrographs have shown that the above described pressing step leads to a satisfactory basalt fibre impregnation with only isolated small air inclusions in the organic sheet.
Next, continuous basalt fibre reinforced UD tapes were pressed onto the hybrid nonwoven- organic sheets. Subsequently acquired micrographs showed that the connection between nonwoven and tape materials was of a very high quality.
The method makes it possible to systematically adjust the mechanical properties of components to the stresses and loads of their future applications.
The structural components obtained will be used to identify and verify the application options and limits of the new material combination. Based on the project aim, the components should meet two main requirements:

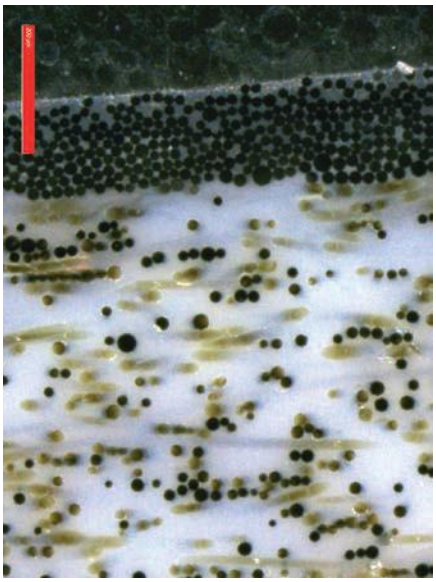
- Low-stress areas with high degrees of deformation, reinforced by hybrid nonwovens
- High-stress areas, reinforced by UD tapes

An aggregate holder developed as demonstrator in the present work package meets these requirements. Its basic structure is an angle section reinforced with various ribs that simulate a bionic structure (e.g. leaf structure) on the inside. By varying the width and depth of ribs,



Hydraulic laboratory press with tool (source: PTS)

Rolls of hybrid nonwovens; left: wet-laid; right: needle-punched (source: Cetex)



Micrograph (source: Cetex)

it is possible to determine the potential flow limits of the fused-on material in the forming process.

The project results can be used to provide especially customers in the automotive and aviation sectors with interesting new materials.

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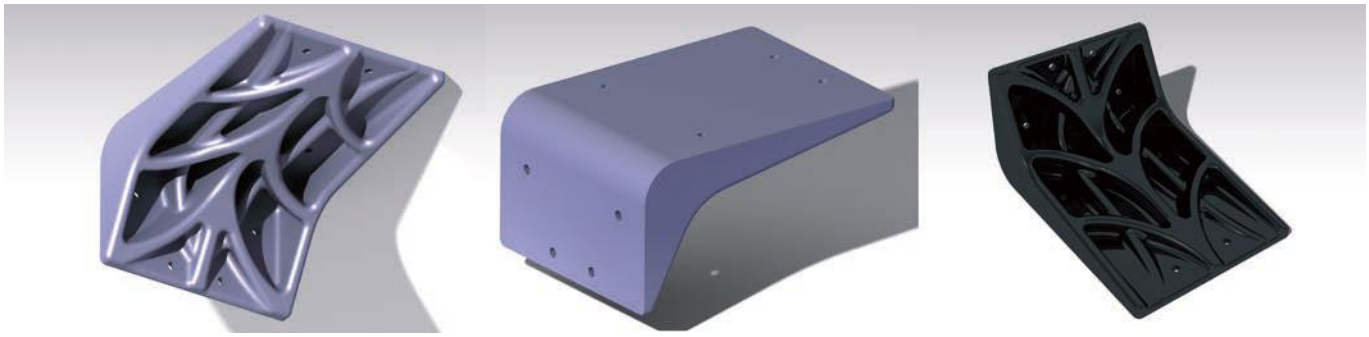

Structural component developed as demonstrator (source: Form + Technik)

DEVELOPING TOOLS TO DERIVE PLANT CONCEPTS FOR THE DRY SORTING OF PAPER FOR RECYCLING

The statistics speak for themselves: graphic paper production has been suffering a steady decline since 2007 – both in Germany and worldwide. Compared to 2007, the amount of graphic papers put on the market and entering the recycling circuits was 20% lower in the year 2015, whereas the production of packaging paper and board has increased by around 10%, mainly due to the growing demand of booming mail order businesses and the larger global flows of goods. This shift in the sector's manufacturing structure is leaving its mark also on the composition of mixed paper and board from households. First, it reduces the yield of sorted graphics for deinking and, thus, the profitability and cost effectiveness of sorting plants. Second, the increasingly broader product ranges of packaging paper producers result in much higher requirements on the quality of fibrous raw materials, i.e. paper for recycling. As a result, especially sorting plant operators are constantly faced with new challenges. Which sorting concepts enable them to profitably operate their plant systems despite changes in

the composition of incoming paper for recycling and in the demand for specific sorted grades?

In a recent research project, PTS scientists have developed a system of knowledge modules and simulation models that can be offered as consultancy service to both sorting plant operators and recycling paper mills. The aim was to assist these two players in the value chain of paper by optimally adjusting the sorting plants for mixed paper and board from households to the needs of paper producers. The consultancy service includes four main tools:

Method to determine the composition and separation characteristics of objects present in paper for recycling

Key feature of the method is a detailed quantification of the shares of paper products or objects present in the various grades and mixtures of paper for recycling. Each object class is listed in a data base together with the physical properties characterising its behaviour in the separation processes commonly used for the dry sorting of paper for recycling.

Decision aid for the selection of sorting units

This tool was developed especially for planning new sorting concepts. It assists the user with selecting sorting units, taking into account the composition of mixed paper for recycling in the sorting plant inlet as well as the sorting targets of the plant, i.e. increasing or decreasing the shares of individual object classes in sorted fractions.

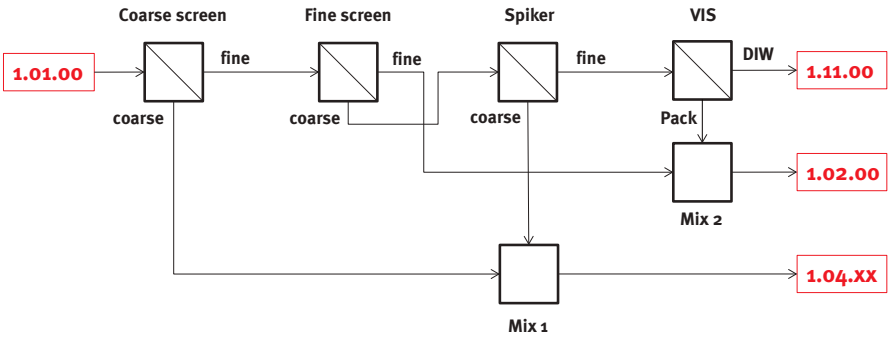

Fig.1: Example of an existing sorting concept (source: PTS)

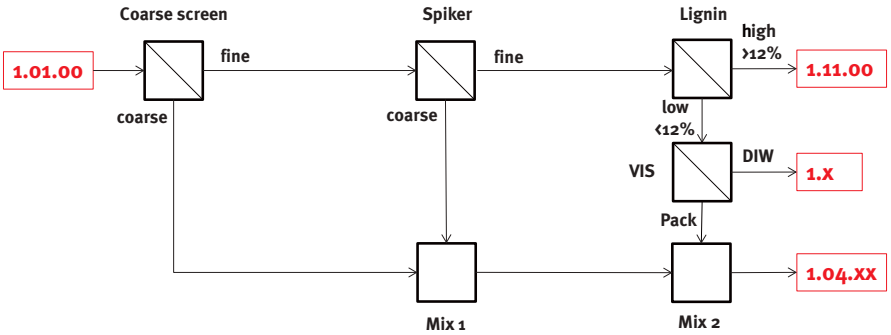

Fig.2: New, adjusted sorting concept based on the concept in Figure1 (source: PTS)

Modules simulating the separation processes used in the dry sorting of paper for recycling

Each single module simulates the separation process of a typical sorting step in the plant. The modular structure makes it possible to simulate sorting plants of any desired complexity. Besides modelling the physical mechanisms of sorting processes, the modules also include a cost calculation to simultaneously assess the economic efficiency and separation result of the sorting step.

Calculation tool for the quality evaluation of sorted fractions

The tool was developed in a previous project and referred to as "use value calculator". The central idea was to derive the paper-technological potential of any mixture of paper for recycling from its composition, i.e. from the shares of individual classes of paper products (objects) present in the mixture. The tool, originally developed for paper mills to enable them to assess the quality of paper for recycling, is now also available to sorting plant operators to reveal the relationship

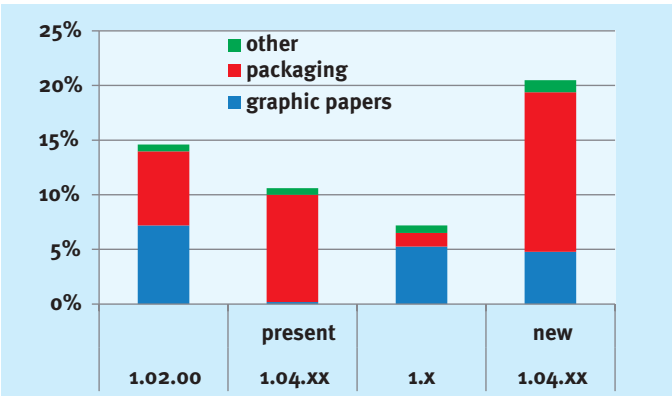

Fig.3: Yield and composition of sorted fractions suitable for packaging paper production and obtained from paper and board from households by means of the existing sorting concept as well as by a new one (source: PTS)

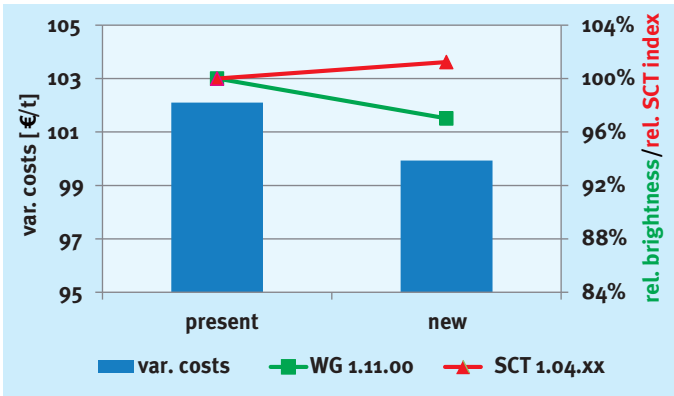

Fig.4: Variable costs of an existing and a new sorting concept, relative brightness of sorted fraction 1.11.00 and relative SCT of sorted fraction 1.04.xx (source: PTS)

between sorting costs and the use value created for paper mills.
The tools are complemented by useful other knowledge modules, for example modules describing the present and future availability of paper for recycling, trends in the quality of individual grades and possible ways of residue utilisation.
To validate the potential of the tools, new sorting concepts were simulated and evaluated by means of an example plant (Fig.1), focusing on the question whether there are any alternatives to existing sorting concepts mainly designed for the production of sorted graphics for deinking (grade 1.11.00). The aim was to obtain grades of paper for recycling that are suitable for both graphic paper and packaging paper production. To answer the question and for demonstration purposes, the new sorting concepts were based on sensor-controlled sorting stages. The latter are capable of detecting the ash and lignin content of objects present in paper for recycling, and their technology is expected to develop most rapidly in future. Figure 2 shows a new sorting concept designed by means of this approach. Besides the two "classic" fractions 'sorted graphic paper for deinking' (grade 1.11.00) and 'corrugated paper and board' (grade 1.04.xx), the sorting concept leads to a new, mixed fraction (grade 1.x) which replaces the previous third main sorted fraction of 'mixed papers and boards' (grade 1.02.00). Because of its higher content of graphic papers (Fig.3), the new fraction has a much better initial brightness than the previous fraction 1.02.00 in the example and is therefore suitable for the production of white lined packaging papers, among other. The new sorting concept partly leads to better paper properties also in the two other fractions 1.04.xx and 1.11.00, and reduces the variable costs by around 2% (Fig.4).
Even though the example is no more than a model calculation, it demonstrates that simulation models can be used to develop innovative sorting concepts for existing and new sorting plants. The new sorting concepts will enable plant operators to economically produce paper for recycling with high use value for paper mills also in a changing market and economic environment. ■

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R&D FORUMS: AN OPPORTUNITY TO DISCUSS PTS RESEARCH

For several years PTS, has been organising research forums in Heidenau and Munich to discuss the content of current as well as the results of completed collaborative research projects with industry representatives. The participants, most of them from companies of the paper sector and its value chain, are informed about new project ideas to enable them to actively influence the direction of PTS research in our core areas. The forums are held twice a year – in spring and autumn. New attendees are always welcome. If you would like to take part, please contact the corresponding project managers at PTS.

Topics of the R&D forum „Paper for recycling and starch" (source:PTS)

R&D forum "Paper for recycling and starch"
Since 1998, the forum has been a communication platform for PTS research on issues related to the subjects Use of paper for recycling (PfR), Stock preparation technology und Starch use in papermaking. Participants also discuss projects focusing on the development of relevant innovative measuring methods and new product ideas. Lectures on topical issues of the industry partners are integrated in the forum at regular intervals. The diagram below shows an overview of the subjects currently discussed at the meetings.
Twice a year, PTS experts present the results of 6-8 ongoing research projects to their partners from industry and develop new project ideas together with them. Attendants from 15 - 20 companies can present their current technological problems to have them solved by publicly funded research. The forums help ensure the rapid transfer of research results to industrial practice.

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R&D forum "Optimised use of pulps and additives"
The forum was launched in 2011 as a combination of the two previous events "Optimised pulp use" and "Wet End" dating back to the year 1999.
One of the aims of our R&D work is to develop the potential of natural fibres for innovative products to enable the optimal use of raw materials and energy and achieve the desired paper properties. The common denominator in the forum is the use of virgin fibres and fillers on the one hand, and possible ways to influence the process and paper properties by innovative fibre modifications and additive use on the other hand. Participants are also continually informed about the latest method developments in pulp and paper characterisation. Main subject of the most recent meeting on 07 December 2016 was "fillers". Among other, PTS scientists presented a new method to precipitate PCC on cellulosic nano structures in an extruder and the results of present collaborative research projects on the use of functional fillers in highly filled papers or pulp moulding. Moreover, PTS scientists are working in a cluster of projects dealing with the forming of paper. The results of these projects are discussed at regular

meetings that are also attended by partners from collaborative research projects.

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R&D forum "Paper finishing"

The research forum was established in 2007 to improve the cooperation between industrial companies and PTS. The rapid transfer of the results of publicly funded research has been and continues to be a main aim of the forum. Another focal point is the presentation and discussion of new topics for future projects, inviting active contributions from participants. While the forum was initially dominated by subjects from the field of coating technology, its focus has shifted more and more to issues of paper converting, corrugated board, recycling and packaging papers in recent years. Main topics in the field of packaging are substances contained in food packaging papers, the migration of critical substances and suitable countermeasures like barrier coatings.

The most recent meeting in Munich on 24 November 2016 started with a representative of SCHAEFER KALK giving an overview of the company's products, their properties and possible applications. After this, the leaders of current research projects presented the results obtained so far:

- The IGF (collective research) project ***"Dimensional stability in sheet-fed offset printing"*** has been launched to improve the elongation behaviour and print quality of offset papers and is handled jointly by PTS and Sächsisches Institut für die Druckindustrie (Saxon institute for the printing sector SID). Ms Genest (SID) and Ms Mair (PTS) presented first results of the project.
- Ms Hanecker (PhD) talked about the IGF project ***"Deinking process water"*** aimed at enhancing the quality of deinked pulps (DIP) and process waters by suitable cleaning methods.
- Mr Kleebauer (PhD) summarised the results of ***"SelectPerm"***, an EU-CORNET project dealing with the use of selectively permeable packaging papers to extend the shelf life of fruit and vegetables.
- Another EU-CORNET project with the short designation ***"Actipoly"*** focuses on the development of thermo-formable papers. Mr Kleebauer presented the results achieved to date, and participants could take a look at the first samples of thermo-formable laboratory sheets.
- Aim of ***"Mineral oil-free printing inks"***, another research project presented by Ms Hanecker, was to reduce the amount of mineral oils in the paper recycling cycle by using mineral-oil free, deinkable printing inks in (coldset) offset printing.
- The IGF project ***"Structural optimisation/barrier coating"*** aims to decrease the mineral oil migration by special barrier coatings. Tortuosity effects will be used to minimise the necessary coat weights. Mr Kossel presented the results achieved so far.
- Mr Thomas Stocker and Mr Schechtel (Bayerisches Laserzentrum) summarised the results of ***"ALasKa"***, an IGF project dealing with the use of laser technology in paper converting. Suitable paper additives and improvements in the laser technology applied have resulted in a significantly higher quality of laser-cut edges.
- Last but not least, Mr Bienert presented the aims and first results of IGF project ***"Starch recycling"***. Key task is the partial substitution of recycled starch for fresh starch in paper surfaces or corrugated board adhesives.

The forum was rounded off by presentations of new research proposals and subjects from the fields of printed electronics, defect-free creasing of coated paperboard materials, laser-cutting of papers, Equilibrium Modified Atmosphere Packaging (EMAP) and flatness improvement of corrugated board.

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STRATEGY-BASED PROVISION OF TRAINING GRANTS: KNOWLEDGE FOR INDUSTRIAL PRACTICE

The promotion of professional and vocational training is a foundation goal enshrined in the foundation articles of the Papiertechnische Stiftung and is thus a core service rendered by PTS for the paper industry. It relates in particular to the education and training of engineers and technical specialists in the field of chemical pulp, mechanical pulp, recycled fibre pulp, paper and paperboard manufacture as well as in the conversion of paper, paperboard and plastic. In the public perception, the services that PTS offers predominate in testing & analytics, further education and in research & development. This should not make us lose sight of the training services rendered in cooperation with universities, technical colleges and institutes – completely without justification since the opportunities for aspiring engineers and graduates to acquire additional qualifications are just as great as the commitment of the PTS employees to provide professional support and knowledge transfer.

Which objectives has PTS set in promoting training and which concrete services does it offer to students?

At the technical colleges and universities offering courses of studies in the field of papermaking and paper and plastic converting/packaging – whether it be Darmstadt, Dresden, Karlsruhe or Munich – students receive a sound, high-quality theoretical education. The companies, in turn, expect and hope that this knowledge will not only address their needs, but can also be implemented promptly – both in the development of new products and in production or marketing and sales. To this end, the graduates must acquire additional skills that are best learnt based on practically oriented industrial problem definitions. And this is exactly the role that PTS uniquely plays in its capacity as an external industrial research institution. Some 40 annually pending research projects, in which students are involved, cover a broad range of issues. A few examples include pulp modification, fibre reinforced composites, alternative raw materials, upgrading and functionalising surfaces, smart packaging or innovative measuring procedures. The research objectives are industry-driven and supervised by an industrial project committee. Within the overall framework of the projects, students can work on individual work packages in the form of diploma, bachelor and master theses. This introduces them to industrial problems. They learn to take an independent approach when searching for innovative solutions under the qualified supervision of experienced PTS employees and are introduced to and become familiar with ultramodern laboratory and analytical methods.

The students are supervised by experienced PTS project managers in close cooperation with the university or technical college. Such supervision is by its very nature time-consuming. Considering the substantial number of 20 diploma, bachelor and master theses on average per year, the scope of services that PTS provides for its sector is significant. All the more so as roughly 10 students per year join the programme who then do a traineeship at PTS. That is also frequently the impetus and the motivation to choose PTS as the institution for their final dissertation. Moreover, a practical training week takes place annually at the PTS pilot plant for papermaking and fibre technology in Heidenau as an established part of the Paper Technology curriculum at Munich University of Applied

PTS promotes vocational education and training in paper technology with tailored solutions. (source: PTS)

In the promotion of vocational training, PTS cooperates with a number of universities, technical colleges and educational institutions.(source: PTS)

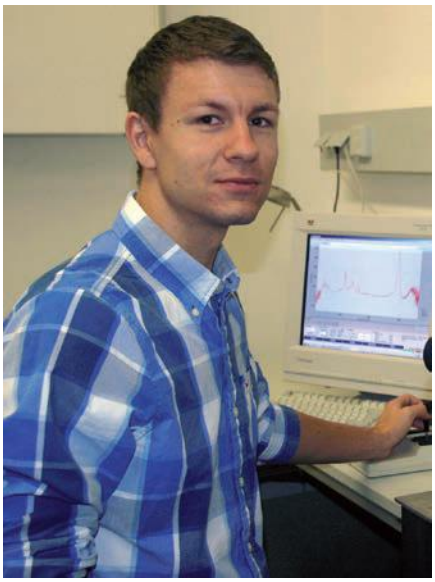
"The independent work that is expected and the freedom to be permitted to try out something in the laboratory are what appealed to me very much", Miriam Demutschek, BA thesis. (source: PTS)

"The working atmosphere is great, the colleagues are very helpful and, in particular, the amount of paper expertise concentrated here is hard to find anywhere else", Gerrit Roosen, doctoral candidate. (source: PTS)

"What fascinated me was the idea of producing nanocomposites in an extruder as well as working in an entirely different setting, since I knew neither PTS nor the paper industry before I came here", Timm Schmid, BA thesis. (source: PTS)

"It is pure luxury to be able to work independently at PTS with a GC-MS (gas chromatograph/mass spectrometer) without having to share it with 20 other students", Sylvia Eger, diploma thesis. (source: PTS)

"What attracted my attention was being able to work hands-on in addition to the theoretical knowledge", Lisa Kaiser, MA thesis. (source: PTS)



"The commitment to innovate, the courage to tread new paths, to develop new methods and thus be able to offer the customers new products and test procedures very much appeal to me", Matthias Finger, doctoral candidate. (source: PTS)

Sciences and at the Baden-Württemberg Cooperative State University. This allows the students to apply and expand their theoretical knowledge in practical work under conditions close to those encountered in industry. On the basis of the honorary professorship for paper technology awarded to Prof. Dr. Frank Miletzky, President of PTS, a particularly close cooperation now exists between PTS and the Institute of Natural Materials Technology at Dresden Technical University. The latter was formed when the Institutes of Processing Machines and Mobile Working Machines, of Wood and Paper Technology and of Food and Bioprocess Engineering merged on 1st July 2016. This new institute pools the competences in the field of producing, finishing and upgrading natural substances along the added value chain, e.g. for food, biotechnological products, wood and fibre materials in the interests of effective recycling management.

Owing to the high-level qualification measures that have been applied for many years, PTS has acquired a good reputation at the universities so that even doctoral dissertations are being successfully supervised by PTS in the meantime. At present, there are four doctoral candidates at the PTS location in Heidenau. Professor Dr. habil. Eike Brunner, Chair of Bioanalytical Chemistry at Dresden Technical University, is currently supervising Matthias Finger who is investigating Raman chemical imaging, a measurement and evaluation procedure for analysing the distribution of substances

in the cross section of paper. Long years of cooperation with Darmstadt Technical University brought Nadia El-Karzazi to Heidenau where she studied the impregnation behaviour of specialty paper. Her thesis, which is nearing completion, is being co-supervised by Prof. Dr. Markus Biesalski, Prof. Dr. Frank Miletzky und Dr. Erhard. Professor Dr. Frank Miletzky is presently supervising three doctoral theses in Process Engineering and Natural Materials Technology in the Wood and Fibre Materials Technology programme at Dresden Technical University. Gerrit Roosen's topic looks into the as yet uncontrollable phenomenon of flatness deviation of paper; Birgit Lutsch is investigating the production of nanocomposites of cellulose and precipitated calcium carbonate for the strength enhancement of paper; and Antje Steinberg is doing a doctorate on developing a process engineering methodology for functionalising paper surfaces by providing them with antimicrobial properties.

As problem definitions become more complex, interdisciplinary approaches become ever more important. The firms in the paper sector therefore have a great interest in inspiring graduates from subject areas other than the traditional ones for paper as a material, whether they be chemists, process engineers, mechanical engineers, environmental engineers or physicists. Thanks to the fact that it is well networked, PTS can provide the companies with support even in view of this formidable challenge. A few examples from the recent past illustrate this fact: Miriam Demtschuk, biotechnologist at the Weihenstephan-Triesdorf University of Applied Sciences, devoted her bachelor thesis to the starch in process wastewater; Timm Schmidt, chemical engineering student at the University of Applied Sciences in Dresden, wrote a bachelor thesis on the optimal reaction conditions for producing nanocomposites from carbonates and cellulose; migration pathways of phthalates was the topic chosen by Sylvia Eger, a food chemistry student at Dresden Technical University; cooperation with the study programme of Environmental Engineering at the Technical University of Munich brought Lisa Kaiser to PTS where she examined the reduction of scale on membranes in

Students from Munich University of Applied Sciences and the Baden-Württemberg Cooperative University are offered a practical training week each year at the PTS pilot plant in Heidenau. (source: PTS)

her master dissertation; in cooperation with Professor Dr. Dieter Hanelt from the Technical University of Hamburg-Harburg, Ludmilla Pell wrote a doctoral dissertation on effluent treatment using symbiotic bacteria and microalgae within the framework of the European research project ALBAPRO in which PTS was the coordinating agency.

The routes to PTS are just as many and varied as the topics that are dealt with. Some students are attracted by announcements in their professorial chairs, some use the PTS website to gather information about current offers. In Munich, PTS in cooperation with Activitas organises an orientation day for new students every year together with lectures and a tour of the institute. In Dresden, PTS regularly recruits young people at the "bonding" recruitment fair as well as via Dr. Miletzky's honorary professorship within the framework of the "Long Night of the Sciences" or other events.

An area that is also very important for the paper industry is the training of technicians and master craftsmen. PTS actively contributes its knowledge, expertise and experience to instruction in this context as well. For instance, PTS supports the vocational training of paper converting engineers at the Alois Senefelder school by holding a lecture in plastics chemistry as well as offering three one-week traineeships in the fields of plastics chemistry, chemistry and paper testing which are held in the PTS technical facilities in Munich. In cooperation with the Bavarian Paper Associations, the Chamber of Industry and Commerce (IHK) and The Educational Association of the Bavarian Economy (bbw group), PTS also takes an active part in designing, coordinating and implementing the professional training of industrial masters in paper and plastics processing.

Totally in the spirit of lifelong learning, PTS continues to provide support for the employees of the paper industry, even after the successful completion of their studies. In some 25 courses offered annually, the continuing education programme of the PTS Academy conveys the paper technology knowledge and skills needed in the production, converting and use of paper as an innovative raw material. The participants also profit from PTS' extensive network. In addition to PTS experts, some 180 lecturers from industrial companies, research institutions, associations and government agencies annually share their knowledge and lend their expertise.

Based on the extremely wide range of services which we offer ranging from training schemes for technician level training, to gaining a doctorate and attending in-service training, PTS fulfils a unique function as a transformer, supplementing the theoretical knowledge acquired in school and university courses with the skills needed in the industrial sector, thus facilitating the rapid utilisation of cutting-edge knowledge and the latest know-how at the workplace. ■

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A PTS LECTURE AT THE "YOUNG RESEARCHERS: EUROPEAN PAPER INDUSTRY" INNOVATION HUB

Again last year, the European Paper Week, one of the largest CEPI events (Confederation of European Paper Industries), took place from 22th to 24th November 2016. The event, at which the most important major corporations in the European paper industry meet, incorporated the Young researchers: European paper industry innovation hub. It was here that ten young researchers from Denmark, Finland, Germany, the Netherlands, Slovakia and Spain reported about the current topics they are working on. The very exciting projects dealt with innovative topics such as linking biotechnology and nanotechnology with the help of nanocellulose, the circular economy in the paper industry, developing new sources of raw materials and new methods for extracting substances required by the paper industry without the need of large amounts of energy. In addition, research projects were presented on the use of papermaking residues in high-quality products, on deep-drawing paper as well as on paper equipped with a shielding layer to provide protection from electromagnetic radiation.

Paper has a great future – „Young Researchers" presented their innovative projects (source: CEPI)

Thomas Stocker from PTS presented the "Reflex absorber – Shielding paper" research project. The objective was to develop a special-purpose coating system that is capable of attenuating high-frequency electromagnetic radiation. The functionality was to be produced by means of a coating and not by adding internal fillers to the paper. In order to achieve this function, a reflecting precoat was applied initially and, on top of that, an absorber layer as the top coat. The absorber layer should contain a pigment to absorb the electromagnetic radiation on the one hand and, on the other, it should contain other metal pigments that provide for multiple reflections of the radiation inside the coat, thus intensifying the absorptive function. This structure was able to be implemented within the scope of research project IGF 18055 BR. Silver-coated platy copper pigments exhibited high conductivity values and were thus found to be suitable for the reflecting precoat. They produced attenuation values of approx. -50 dB with a coat weight of 30 g/m². (Barium) ferrites combined with the copper pigment to produce a metal component were identified as the most effective pigments in the absorber layer. The absorber-metal layer was successfully applied to the reflection coating both in the laboratory and on a pilot scale. As a result, excellent attenuation values as low as -55 dB were achieved. The special development was able to be processed (e.g. die cutting, folding) without any problems. With a view to the cost efficiency of the new coating combination, commercial products can be undercut by far in terms of price. For instance, the shielding layer can be produced for approx. € 3/m² plus relevant processing costs, whereas commercial shielding products are available starting at approx. € 20/m².

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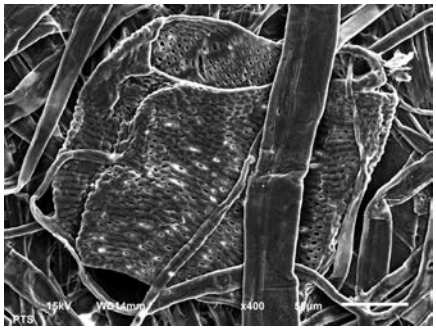
THE USE OF SCANNING ELECTRON MICROSCOPY IN PAPER ANALYSIS

Electron microscopy is a fascinating and useful tool that has become indispensible in the analysis of samples of all classes of materials as well as in a wide variety of different research topics. In addition to studying the topography of a material, scanning electron microscopy (SEM) can also be used to examine material contrasts, molecular structure right down to the individual atoms as well as the lattice structures of crystalline substances.

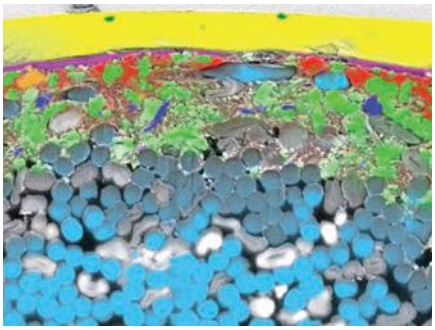
In the paper and board industry, accurate assessments of the coatings, additives or pulps are often of interest. In such contexts, scanning electron microscopy, in its many different modes of operation, can provide answers to questions facing the industry.

For example, high-resolution photomicrographs with magnifications of up to 20,000X and more can be achieved with the help of secondary electrons (SE) that are knocked out of the sample by the primary electron beam. This allows molecules and tiny particles to be imaged and characterised and also provides information about sizes to an accuracy of approx. 10 microns. This in turn permits easy differentiation of commonly used pigments such as kaolin or $CaCO_3$ based on their crystalline structure.

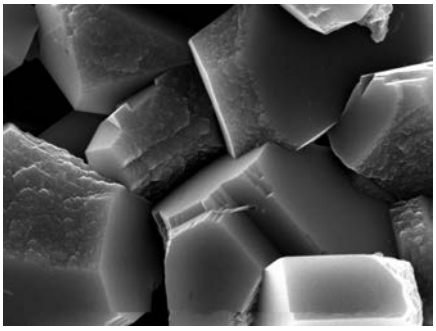
Another application of the scanning electron microscope is the evaluation of coat or coating layer thicknesses as well as the distribution of additives or pigments throughout the paper volume. This is accomplished in another imaging mode known as backscattered electron (BSE) mode, i.e. primary beam electrons are deflected in the material, emerge from the sample and are then detected. They display great material contrast so that heavy elements such as calcium, for example, appear brighter than lighter elements such as carbon. This SEM aspect reveals information about coating thicknesses and the distribution density of fillers.



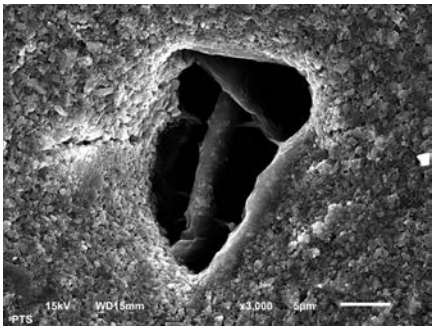
Eucalyptus cell (vessel segment, source: PTS)



Raman spectroscopy (source: PTS)



Rhombohedral calcites (source: PTS)



Coating rupture with fibres (source: PTS)

PTS has years of expertise and experience in the use of scanning electron microscopy. When combined with Raman spectroscopy, which allows for a more accurate determination of the complete species of molecule, these can be colour-coded or respectively highlighted, identified and their positions in the material ascertained. Whether pulps or impregnation, fillers or coatings, we would be pleased to help you meet your objectives.

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HIGH IN DEMAND - MEASURING TECHNOLOGY FOR EVALUATING PAPER FOR RECYCLING

PTS has noticed a clear market upturn and sales increase in the second half of 2016. After installations in Europe and Australia, our Finnish partner company Haarla Engineering has sold the first automated quality inspection system for baled paper for recycling BALEMAT in China. Its installation was completed in January 2017. The first portable PBS devices were delivered to the US.

Besides selling measuring equipment, PTS also focuses on complementary services. We are currently executing two engineering orders from German companies to prepare investments in truck BALEMATs for an improved incoming inspection. The measuring stations will inspect the quality of paper for recycling directly on the truck and are scheduled for start-up in mid-2017.

The engineering services of PTS are based on the special knowledge of its employees about materials and virtually all processes related to paper for recycling as well as on its experience from previous BALEMAT projects and PBS applications.

A specially developed one-day workshop „Quality assurance and improved performance in the management of paper for recycling“ serves as introduction. It is followed by a detailed analysis of the customer's present situation and needs. To plan the investment, PTS uses a list of topics to discuss all relevant aspects with

the customer, e.g. how to integrate the new investment in the company's operating procedures such as internal logistics and corporate IT. This results in a specification that can be used by equipment suppliers to optimally adjust their offers. Project-specific adjustments can thus be identified and defined at an early stage. PTS sees itself as mediator between end customer and equipment supplier here.

We assist our customers during start-up and in the run-in period to make sure all necessary approvals and acceptance tests run smoothly and that future plant operators can be efficiently trained. We also evaluate the functionality of the new installation during this phase.

But our services do not end here: We are planning to use the data collected by the new systems not only for incoming inspections, but also to ensure an efficient raw material use and optimise the relationship between supplier and customer. ■

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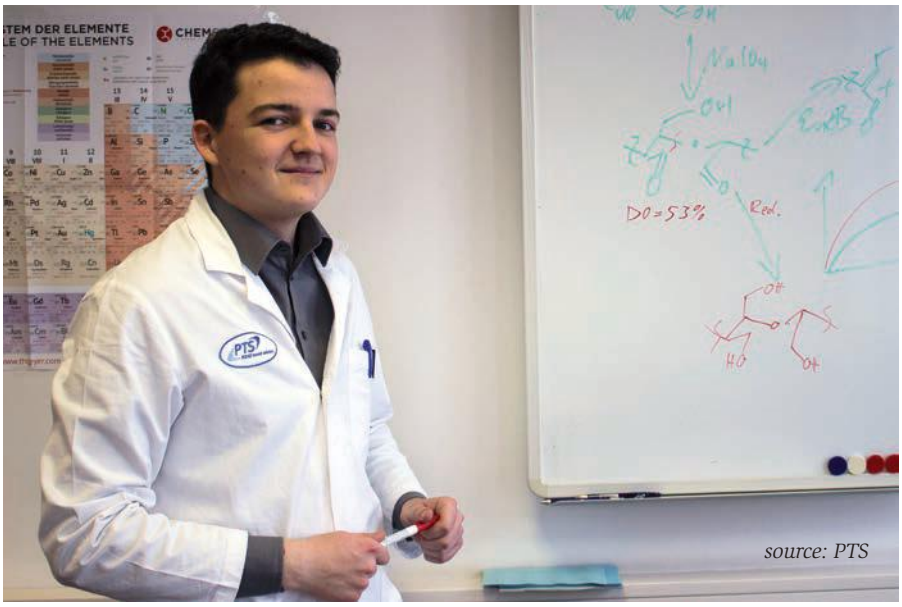
The first BALEMAT for China was installed in January 2017. (source: PTS)

THERMOPLASTIC PAPERS – FROM VISION TO REALITY

HOW TO RENDER PULPS THERMOPLASTIC IS THE TOPIC OF A BACHELOR'S THESIS

Everybody knows from experience that the packaging of goods strongly influences our buying decisions: it should be attractive, impressive, exciting – the creative ideas of package designers make high demands on modern packaging materials. A current trend is the growing need for complex-shaped multidimensional packaging solutions. It would be good if these could be obtained from two-dimensional paperboard by suitable forming methods like deep drawing or thermoforming, for example. So far, however, even the most advanced engineering technology has not been able to compensate for the fact that paper is a non-thermoplastic material.



source: PTS

In his Bachelor's thesis at PTS in Heidenau, Mr Markus Stötzer is currently looking into a new way to make paper thermoplastic without sacrificing its recyclability.

"An acquaintance who had written his Master's thesis at PTS told me that the institute was offering very good conditions to students. His thesis had dealt with the same subject area, which I found highly interesting ", the Bachelor-to-be describes his way to PTS. Having been raised in Löbau in Eastern Saxony, the student had been keenly interested in chemistry already at school and started to study chemical engineering at the University of Applied Sciences in Dresden directly after his A-levels.

"My topic is the chemical modification of pulps to render them thermoplastic", Markus Stötzer explains, "Some starting points were already available, but none

of them had led to satisfying results. What has prevented the breakthrough of thermoplastic papers so far is mainly the low yield and high cost of the two-step synthesis process required for their production".

"What really attracted me to this subject was the chance to enter a largely unexplored territory", the future chemical engineer adds. His new approach is basically the production of a modified pulp as starting material for thermoplastic papers by selectively opening some of the C2-C3 bonds of cellulose. This leads to dialdehyde cellulose, an intermediate product which can then be reduced to dialcohol cellulose. "My work focuses on optimising the reduction process ", the 22-year old describes his topic, "to establish an economically efficient process that enables high yields ". For this purpose, he and Dr Martin Zahel, his supervisor at PTS, are investigating the effects of various catalysts, a research area that is pretty new also to PTS.

Being about to complete his Bachelor's thesis, Markus Stötzer can draw a first conclusion: "I experimented a lot with the method to create optimal process conditions. Even though I am still looking for the final evidence of its functioning, I can say that I have laid a solid foundation and that our approach looks very promising". The student is highly optimistic that he will find such evidence in the next few weeks to include it in his Bachelor's thesis.

For this purpose, the modified pulp samples will be used to form laboratory handsheets whose thermoplastic properties can then be assessed by means of dynamic mechanical analysis (DMA) and temperature-supported tensile tests.

Next step is the pilot production of thermoplastic papers in the PTS pilot plant in Heidenau in the medium term. The plant is perfectly equipped for development work of this kind, but the process must yet be further optimised to increase the yield of the two synthesis steps and minimise the use of chemicals before it can be implemented on pilot scale.

"Our long-term aim is to replace plastics even in applications where conventional paper is currently no viable option because it is not sufficiently formable", he describes the vision behind the project. What the scientists have in mind is especially the packaging sector, where thermoplastic papers could be used to obtain innovative, sustainable and environment-friendly solutions by thermoforming. Could this be a topic for his Master's thesis? Markus Stötzer laughs and replies: "I am currently not planning that far in advance, but I will certainly try to earn a Master's degree ". Anyway – he will continue to work as student assistant at PTS in Heidenau to contribute his experience also in future.

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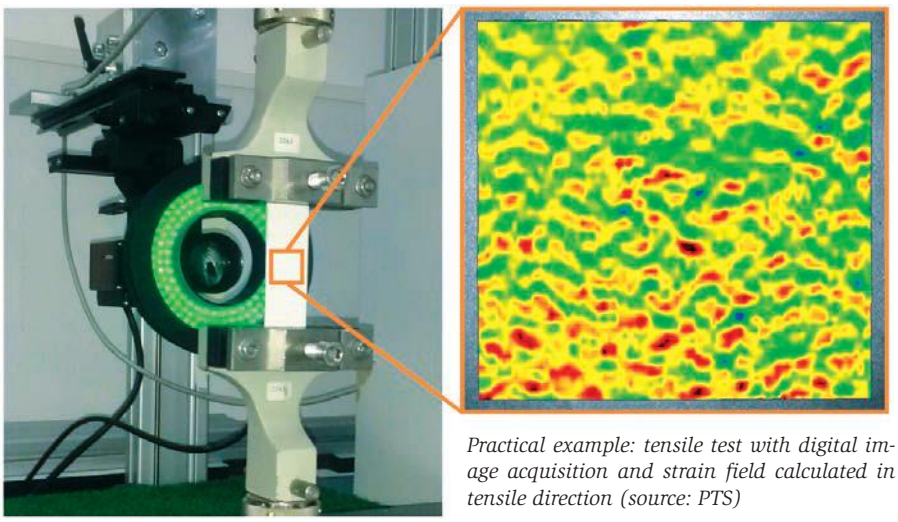
OPTICAL STRAIN FIELD ANALYSIS PROVIDES NEW INSIGHTS INTO MECHANICAL MATERIAL PROPERTIES

Contactless optical deformation or strain field analyses calculate the displacement and deformation of a sample or component surface from the digital optical images of its deformed and non-deformed conditions. The two-dimensional strain or deformation distributions obtained add significantly to the informative value of test results. This analysis offers high spatial or time resolution when examining dynamic and static loading processes together with the excellent reproducibility and measuring accuracy afforded by digital image processing algorithms (DIC – Digital Image Correlation).



Practical example: tensile test with digital image acquisition and strain field calculated in tensile direction (source: PTS)

In several research and customer projects, scientists of Papiertechnische Stiftung are doing intense research into the use of optical deformation analysis for the testing of fibre-based materials because this would make it possible to

- Increase the scope of measuring methods to determine currently inaccessible fundamental mechanical parameters like Poisson's ratio or shear characteristics
- Improve the reliability and accuracy of existing test equipment (e.g. allowing for instrument deformations, controlling mechanical displacement characteristics, assessing inhomogeneities or local strain differences in tested specimens)
- Develop novel test procedures and instruments for packaging papers and packages (e.g. new flute geometries and base papers for low-grammage corrugated board)

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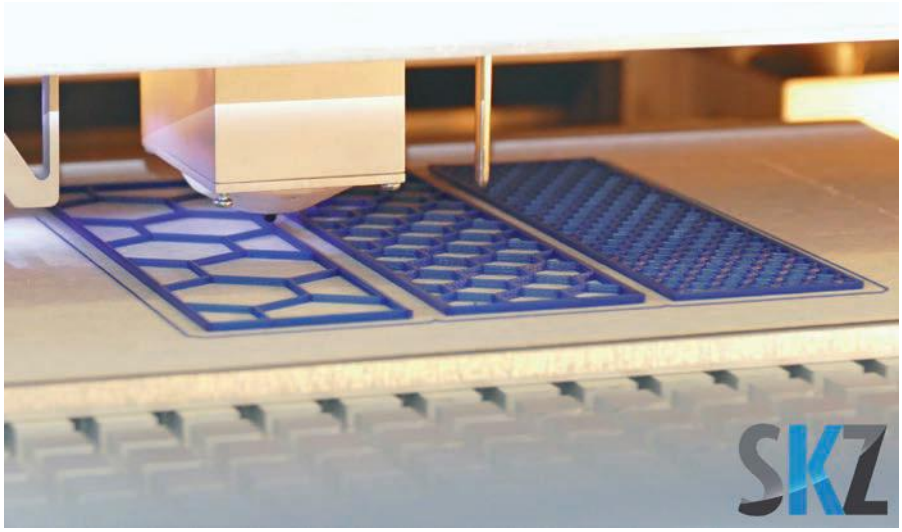
ADDITIVE MANUFACTURING ON PAPER SUBSTRATES

Material and technological developments as well as further improvements in process stability have made additive manufacturing methods an increasingly attractive option also for the (small) batch production of plastic components. In particular the growing trend towards mass customization with its associated small production quantities requires the economic use of these technologies. This makes not only the rapid manufacturing of demonstrators and (semi-) functional prototypes, but also the production of ready-to-use functional and structural components an important application area of additive manufacturing methods.



A growing demand for customized products can also be observed in the packaging sector: small lots of folding cartons that meet special functional, regional, seasonal or advertising requirements or follow a current trend are increasingly popular in the market. A research project launched jointly by the German Plastics Center SKZ and Papiertechnische Stiftung PTS aims to develop the scientific basis for the production of paper-polymer composites by means of additive manufacturing methods (extrusion process/fused deposition modelling FDM). Selected paper substrates and polymers will be characterised to realise an optimised composite. Based on this, the project partners will analyse the compatibility of materials in terms of adhesion and dimensional stability. The results will be used to demonstrate the potential of the manufacturing approach for the example of a folding carton with reinforcing ribs.

The IGF research project 19315 N of the research associations Papiertechnische Stiftung PTS and German Plastics Center SKZ is being funded by the German Federal Ministry for Economic Affairs and Energy within the programme of promoting "pre-competitive joint research (IGF)", following a resolution of the German Bundestag. It was launched at the beginning of February 2017 and will be completed by the end of January 2019.

If you are interested in the project, please contact us at PTS or SKZ.

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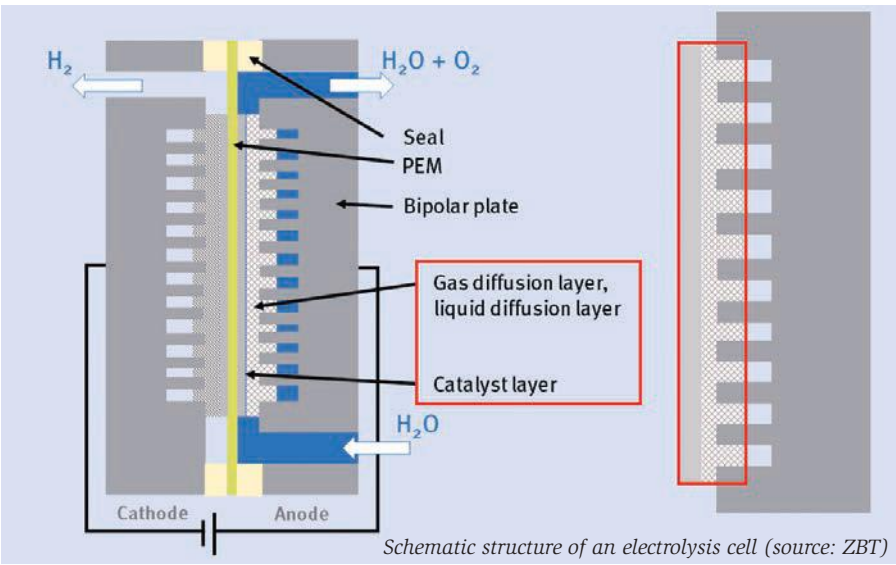
PAPER-BASED ELECTROLYTIC MATERIAL

Paper-derived sintered metallic materials – this somewhat awkward designation refers to a new, lightweight metallic material with adjustable properties developed jointly by scientists from PTS and the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM in Dresden. Paper serves as semi-finished product here, but its manufacturing process has a decisive effect on the properties of the end product. Basis of the technology are specialty papers filled with high shares (more than 75 % by mass) of sinterable metallic particles. The organic paper components are removed by heat treatment (sintering) to convert them into porous metallic structures whose properties, e.g. thickness and porosity, can be varied in a broad range by adjusting certain parameters of



Schematic structure of an electrolysis cell (source: ZBT)

source: 123RF

the papermaking process. The combination of established, technically mature papermaking technology with powder metallurgical processes opens up entirely new opportunities and leads to materials that are vastly superior to traditional ones.

PTS scientists will continue to work on one possible application of these materials in an IGF research project titled "Titanium-paper electrode – developing porous paper-based titanium electrodes for PEM electrolysis" that starts in 2017. Together with The fuel cell research center ZBT in Duisburg and Fraunhofer IFAM, they will develop a cost-effective gas/liquid diffusion layer with optimised functions for PEM (proton exchange membrane) electrolysis cells. The diffusion layer will be based on a porous sintered titanium material and be designed such that it ensures a uniform water distribution and adequate gas diffusion into the membrane whilst being sufficiently electrically conductive, porous and corrosion-resistant in acid media.

Possible applications of PEM electrolyzers range from small laboratory gas generators to decentralized hydrogen generators for hydrogen fuelling stations and central gas production units for so-called power-to-gas applications for the storage of excess power generated from renewably resources.

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PTS AND CNPPRI INTENSIFY COOPERATION

The dynamism of China's economic growth has been without parallel in recent decades, the country's national economy could overtake even the US to become the biggest one in the world in the years to come. The German Federal Ministry of Education and Research (BMBF) has devised a "China Strategy 2015-2020" to help overcome today's global challenges and support sustainable, resource-saving and environment-friendly developments together with partners from China. The China International Paper Technology Exhibition and Conference (CITPE) held in Shanghai on 10 October 2016 has shown that the country's progress doesn't stop at its paper sector. CITPE has been the sector's key event since the year 1989.

Dr.-Ing. Tiemo Arndt and Prof. Dr. Frank Miletzky at CIPTE 2016 (source: PTS)

Following an invitation of China's National Pulp & Paper Research Institute (CNPPRI), PTS had acted as co-organiser for the event and contributed two important lectures to the conference programme: „Paper industry in a change towards innovative applications under Industry 4.0" (presented by professor Frank Miletzky) and „Cavitation technologies in the stock preparation of recycled fibres for better strength and optical properties" (presented by Tiemo Arndt). Mr Peter Dahlvik (Omya) and Mr Wolf Heilmann (company Wolf Heilmann) had been invited as speakers as well, and the event was rounded off by an exciting exhibition.

To intensify their cooperation, Papiertechnische Stiftung and CNPPRI have replied to a call of BMBF to establish a joint research presence in China. They are aiming to form a group to do research on water- and energy-saving paper manufacturing and upgrading technologies. Burning environmental and energy issues offer vast optimisation and development potential in China; research activities in the fields of recycling and resource-con-

serving paper upgrading technology have therefore already been planned. A joint research presence would offer German paper producers and supply firms the chance to (further) establish themselves in the rapidly growing Chinese paper market and make Germany's economic excellence more visible in the partner country.

A Chinese delegation is planning to travel across Europe this summer and visit the institutes of PTS as well as the ZELLCHEMING exposition in Frankfurt/Main.

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At the pilot paper machine of CNPPRI: Dr. Tian Chao, Prof. Dr. Frank Miletzky, deputy director of CNPPRI, Sun Bo, W. Heilmann (source: CNPPRI)

NEW PTS METHOD "DETERMINING THE ADHESIVE JOINT STRENGTH OF FOLDING BOXES MADE FROM CORRUGATED AND SOLID BOARD

Besides corrugated board manufacturing itself, converting steps play a key role in the production of sales and transport packaging: the corrugated board material must be cut, folded and glued to obtain cases or boxes. The quality of adhesive joints is of paramount importance here because it contributes to the stability of packages. In many cases, however, it is also the cause of rupture or damage to packed goods during trade or in the consumer goods sector. The quality of adhesive joints must therefore be tested and evaluated to assure and improve it and prevent possible complaints at an early stage.

The test methods available so far have considerable limitations: in many cases, their measurements are so strongly influenced by the corrugated board grade used that it is impossible to directly identify or relate the influence of adhesive joint strength on the results. PTS method PTS-PR 301/08, a test where the material influence could already be minimised, is only suitable for small folding boxes made of paperboard (sum of length and width values greater than 50 mm) and cannot be used for corrugated board packaging.

In a recent research project, PTS scientists have therefore used this method as basis to design a new, objective and physically correct test method for assessing the quality and strength of adhesive joints in corrugated packaging. The new PTS method PTS-PR 303-2017 is now available for sale and can be obtained from PTS at a price of 45 €.

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TRANS-EUROPEAN NETWORK: PARTICIPATION OF ACTINPAK MEMBERS IN COST ACTION FP1205 TRAINING SCHOOL

The members of the Cost Action FP1405, Ms Adriane Cherpinski from the Spanish National Research Council, Institute of Agrochemistry and Food Technology (CSIC-IATA) and Mr Christian Kossel from the Papiertechnische Stiftung, Germany took the opportunity to participate in the fifth training school within Cost Action FP1205 – Innovative applications of regenerated wood cellulose fibers.

The topic was characterization of nanocellulose that took place in Potsdam, Germany, 17-19 January 2017.

The aim of the training school was to generate knowledge and practice on the characterization of materials based on nanocellulose. The participants learned more about different characterization methods, the application possibilities, advantages/disadvantages, detection limits or sample preparation of the methods.

The first day offered lectures about different possibilities for material characterization of small particles. In detail the participants learned about the possibilities of the X-ray examination for characterization of polymers, the use of electron microscopy TEM/SEM, the characterization of cellulose and nanocellulose via NMR and permeation measurements as well as the characterization of nanocellulose with porosimetry and volumetric gas adsorption.

The topic of the second day was a theoretical introduction and after that the possibility of practical working in the lab with some selected methods. The training was carried out in small groups. On the third day, which had been the last one, the participants had the possibility to present their research work. Ms Adriane Cherpinski and Mr Christian Kossel presented results of their joint research work dealing with the topic: Application of electro-hydrodynamic processing to coat paper and board – Use of nanocellulose as the coating filler for high performance papermaking products. This joint research is based on a Short Term Scientific Mission of Mr. Christian Kossel between PTS, Germany and the CSIC-IATA institute, Spain.

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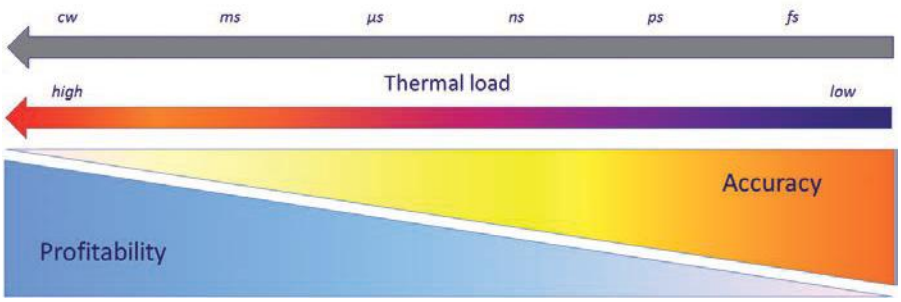
„ALasKa“ – DEVELOPING A METHOD FOR THE ECONOMIC USE OF PULSED LASER TECHNOLOGY IN PAPER AND BOARD CONVERTING

Individualisation is currently a clear trend in the paper and packaging sectors. Another one is the rapid development of new high-tech materials like nano corrugated board. To keep up with these developments, the techniques used for the converting of paper and paper-based products must meet increasingly higher demands. Manufacturers need “non-impact processes“ to minimise the material changes and damage caused by mechanical or thermal influences during converting, higher degrees of freedom to realise sophisticated packaging designs, and are interested in methods that guarantee pre-defined removal depths for the generation of haptic features. Moreover, there is a growing demand for high-speed and increasingly flexible converting techniques.

Established CO_2 laser techniques can meet some of these requirements, but the material changes caused by them are still considerable. The use of pulsed laser sources, for example, can lower the thermal loads leading to the discolouration of paper substrates.

(Ultra)short pulsed solid-state lasers are currently mainly used to clean paintings and old writings. Applications were limited to science and research in the past because the suitability of the technology for the great variety of materials to be treated in industry was not sufficiently investigated. PTS and the non-profit research company Bayerisches Laserzentrum (blz) have therefore conducted a research project to look into the suitability of laser methods for industrial applications.



Profitability and accuracy developments as a function of the duration of laser pulses (source: PTS)

The cutting quality achieved on industrial substrates shows that the laser is a viable alternative to conventional separation methods. The carbonization of paper substrates was found to decrease considerably from the continuous wave (“cw“) mode to the thermal ablation by means of µs or ns pulses and “cold” ablation by means of ps pulses. Moreover, the project partners managed to introduce laser-active additives both in paper coatings and in the paper itself to increase the local absorption of certain spectra and, thus, energy. This is of particular interest to the serialisation of pharmaceutical cartons by laser coding, for example. Suitable coatings were found to reduce the discolouration of paper surfaces – by covering discoloured areas as well as through additions of special coating pigments lowering the discolouration tendency of substrates during laser treatment.

The technology makes it possible to develop new, innovative solutions for the growing packaging market. We cordially invite you to join us in developing future-oriented products for this sector.

The final report of the research project is available from the PTS homepage.

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PTS FIBRE based solutions

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