PTSNEWS

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FIBRE based solutions for tomorrow‘s products

Thinking 70 years ahead … Perspectives in paper research

70 YEARS
Papier-technische Stiftung

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PTS
FIBRE based solutions

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Editorial

Dear readers,

As the new and meanwhile active Director of PTS, I am pleased to write the introduction to the latest – and my first – PTS News issue in which we have again prepared current information about recent developments and topics of interest for you.

PTS (Papiertechnische Stiftung) is the central research and service institute of the paper industry. It has two main functions: one is to fulfil crucial higherlevel tasks for the entire industry, the other is to produce research results with the aim to strengthen the competitive standing of papermakers and converters on a sustainable basis.

PTS has been performing this important role with success for 70 years now – something we are proud of and for which I, as the new PTS Director, would like to express my gratitude to all of my predecessors and especially to the staff members of PTS. Further, I wish to thank the founders for their sustained interest in PTS, because it is their decisions and their involvement that have decisively contributed to the launching, development and future viability of PTS. I would like to continue and progress on this path together with the PTS team.

Staying viable for the future is closely related to the ability to adapt to changing environments and to set and identify new trends. The team members of PTS practise this principle every day, and I am deeply impressed. I consider myself lucky to work with highly motivated and creative people.

For me, that is the general basis enabling us, as a research and service institute, to successfully meet the needs, expectations and requirements of our customers and project partners and thus fulfil the mission of our foundation also in the future.

The challenges of the future, such as carbon-neutral paper production, are huge and complex and often require entirely new research approaches and structures. For this purpose, it is important to enter into and promote strategic partnerships and to seize arising opportunities for incremental and disruptive innovations. The cooperation between PTS and the Technical University of Dresden is of special importance in this respect and should be further enhanced and expanded with the aim to create an internationally visible nodal anchor point for the themes of bioeconomy, circular economy and product development.

Paper research of the future is going to be faced with numerous challenges and tasks in order to solve and manage the problems and changes of the future. We, as a research institute, gladly accept this challenge while considering this a commitment towards the companies in the paper industry – a commitment that we as PTS will meet. This issue's cover story on the occasion of the 70th anniversary of PTS gives an outlook on what paper research development might look like when "thinking 70 years ahead". In addition to that, you will again find reports on current research projects, services and upcoming PTS events in 2022.

On a personal note, I should like to add that I am already looking forward to the months to come during which I will also get into touch with you and make your acquaintance – preferably of course during the upcoming PTS events in 2022.

I hope you enjoy reading and find many suggestions for working with us. Stay healthy.

Dr. Thorsten Voß, PTS Director

Paper & Board for Food Contact
Conference 2022

02. - 03.03.22
Dresden

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veranstaltungen

Thinking ahead ... Perspectives in paper research

Papiertechnische Stiftung (PTS) was founded in 1951. For 70 years, PTS has been researching into paper manufacture and conversion. PTS has made it its mission to provide the industry with access to findings from research and development and to be a continuous engine of innovation for the sector. In the past, up-to-date environmental standards were introduced and the technological manufacturing limits were shifted towards maximum efficiencies. Future paper research will bring even greater transformations than the past decades suggest.

Production changes from carbon-neutral paper manufacture and energy.

The exit from coal and nuclear power is a done deal and the German government decides on further measures to fulfil the Paris Climate Agreement, which will also change the paper industry. Energy transition scenarios show that there might be an end to the generation of steam and power in mill-owned natural gas or coalfired cogeneration plants. Biomass might then play a major role as a primary fuel, but only in case there is at the same time a way to ensure early separation of released CO_2 via carbon capture and storage (CCS) or power-to-X. It is at this point at the latest that the integration of hydrogen should be envisaged as a fuel or as a reactant for the production of platform chemicals. It is important to estimate and announce the demand for hydrogen in the industry as early as possible. For this purpose, the federal German government is currently sponsoring three lead projects for having generation, use and transport solutions checked. PTS contributes the requirements in the area of infrastructure for paper manufacture to the lead project TransHyDE-Sys. This is where the basis for the future security of supply of green hydrogen is laid.

Basically, the signs are pointing to the fact that most of the production processes will be transformed to electric power. The papermaking sector would then have to look into ways how to produce while being an integrated part of a power grid of the future. The expectable withdrawal of the non-dynamic levy under the Renewable Energy Act (EEG), grid fee exemptions and highly fluctuating energy demands in the power grid might cause a shift away from 24/7 production towards more flexible production schemes in combination with energy storage facilities and appropriate business models.

But that is not all. Because full integration of renewable energy sources does not mean that one kilowatt-hour less is consumed in production. As energy will remain one of the cost drivers also in the future, a drastic reduction in energy consumption based on new manufacturing processes is necessary to ensure that paper production has a future in Germany.

PTS together with Jülich Research Centre, RWTH Aachen, University TU Darmstadt, TU Dresden and FH Aachen University of Applied Sciences are working on the design of a Model Factory for Paper (MFP) in Düren which includes investigations into the aforesaid problems and research on technological papermaking solutions. The first RoadMap MFP project develops a research agenda for the areas of raw materials, methods and processes, digitisation, and for the energy and overall paper mill system. Work in Düren is planned to start in 2024 at the latest when the currently designed technology carriers are first available.

Circular economy of the future

Another research field of the future will be the further development of the paper circuit. Today's well-established collecting and sorting system are the basis for stable supplies of recovered paper to the paper industry at lower cost than virgin fibre. At the same time, the driver of growth in the area of packaging papers is the recyclability of paper. However, the development of new paper materials makes it necessary to rethink and question well-established systems and look into ways how to

MODELL FABRIK PAPIER

Leitprojekt TransHyDE

More information: **www.wasserstoff-leitprojekte.de/leitprojekte/transhyde**

ensure effective collection and supplies to paper mills. As such, it is in turn important to adapt also the stock from the preparation process to the new materials. It is up to the researchers to come up with appropriate technological solutions. In addition, the paper industry must develop a joint vision on how to close the paper circuit even further and come to an agreement on joint standards for keeping the paper circuit closed. Eventually, there may be a steering effect from political and regulatory interventions to be respected by the paper circuit.

The German single-use plastics ordinance in force since 03 July 2021 can be quoted as an example. Any interpretation to the effect that the use of aqueous polymer dispersions in paper coatings will cause a product to fall within the scope of the Directive (SUPD) would be, figuratively speaking, a disaster for the development of paper-based packaging products having a water vapour, moisture or grease barrier. Nevertheless, paper researchers should consider this an opportunity to demonstrate and provide companies with appropriate solutions for barrier designs fully based on "natural polymers" ad defined by the SUPD. But this will probably not provide an answer to all of the urgent questions. It seems wise already today to do research on the potential impacts of water-soluble, wax-like or polymeric substances and of higher amounts of soluble organic components on the production processes of a paper mill, and how to meet conformity requirements during the use of recovered paper-based products. Future research topics will thus need to be increasingly focused on cleaning processes and material re-use of rejects with the aim to ensure high recycling qualities in well-recoverable products.

Digitisation will play a major role in the closing of circuits, especially the further development of track and trace technologies for the integration of functionalities in packaging products. Technologically, a lot is possible already today. An increasing level of integration of pieces of information that change the practical value and characteristics of the material in each of the treatment steps will lead to a digital twin of a product along its value-added chain and will very probably also result in new business models. Until now, the idea to use block-chain technologies to rethink transparency and business relations is considered to a limited extent only. In the light of the rapid developments and requirements from the supply chain, it must be the task of research, however, to identify possible user scenarios allowing an assessment of opportunities for the stakeholders in the value-added chain.

Research in the future: innovations for safeguarding the future

During the past 70 years, much progress has been made in the race for best solutions regarding cost reductions, minimized environmental impacts and of course new applications of paper. Today, paper manufacture is no longer the same as it was 70 years ago, although the fundamentals of the manufacturing technology have remained the same. So papermaking can be expected to be different also 70 years from now. In the light of the pending challenges for the 15 years to come, one can say that the required knowledge of technology readiness level (TRL) 1 is available in basic research already today to be ready for the market in 2035. On the other hand, the cycles of TRL 1-9 tend to become shorter in the future. This is supported by an increased use of artificial intelligence (AI) in research, simulation and modelling as well as by a significantly higher agility in the world of research. Further, an increasing open-science policy approach to the management of research data will lead to a rapid increase in the availability of knowledge in the form of publications, research data and software programs. What is especially new to an industry such as paper manufacture is that research results will no longer be available as demonstrators or reports only, but as digitally usable knowledge algorithms. The crucial factor of success in the innovation process of the future will not be access to knowledge, but an ability to identify knowledge, place it in its context and make it applicable for a specific purpose. For an institute of research, that also means planning ahead for a digital innovation process and integrating an appropriate software and hardware architecture into the data management process of the future. In the past few years, PTS could build up the necessary infrastructure and use it already in some of the research projects. In 2022, PTS will work together with institutes of TU Dresden and the Hannah Arendt Institute for Research onTotalitarism (HAIT) on a Data Trust Centre that can also be used for industrial innovation processes in order to design future innovation processes for companies in a safe and secure manner.

4ever green

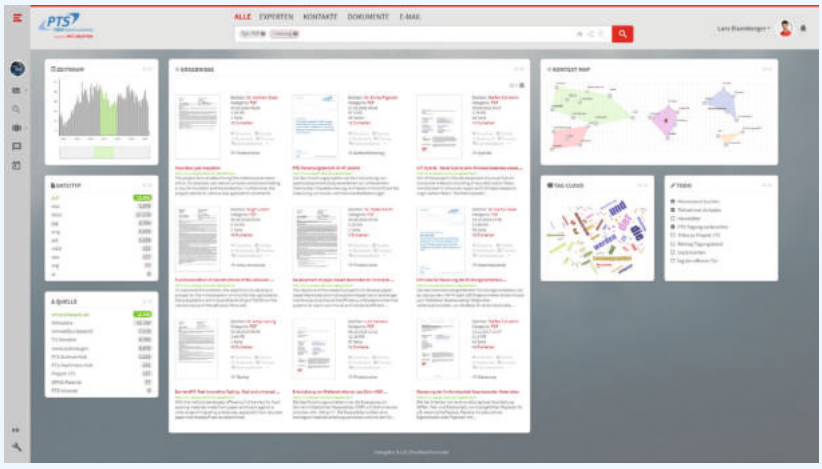
Cepi RENEWABLE RECYCLED RESPONSIBLE EUROPEAN PAPER

PTS is a member of the 4evergreen initiative – harmonization of the assessment of recyclability at an international level (CEPI).

BiPaRe BioPaperRecycling

PTS participates in the project regarding the "Conception of recyclable biobased coatings for paper packaging" (project report on page 16)

PaperDocAnalytics



Papiertechnische Stiftung is co-working with interface projects GmbH to develop a modern information portal for rapid detection of material defects in paper manufacture on the basis of neural networks and deep learning. In a first step, the PTS research database will serve as a demonstrator to show on a text recognition basis how to interlink problems and solutions of paper manufacture. It is intended to add further modules for the recognition of image and material data.

Research database: **https://search.ptspaper.de/web/pts/index.html**

As a result, the industrial research facilities and the transfer-oriented facilities of ZUSE will be of increasing importance in the innovation process for companies. Because one core mission of institutes like PTS is to facilitate exactly such transfer, i.e. to transfer basic research knowledge into pre-competitive application-oriented research projects and ensure the utilisation of the findings by companies for their specific problems. Research will adopt an even higher level of interdisciplinarity and a higher degree of cooperation between companies, and must always take into account the relevant business processes of the companies.

But the importance and benefits of research cannot often be seen to their full extent at the moment they are created. In many cases, the result of a project is nothing but a puzzle piece in a higher-level theme complex. It is imperative for companies to have their own in-house experts to transfer research findings into their specific application and to be able to identify the concrete research benefit. The Fibre & Paper 2030 project (www.faserpapier-2030.de) for the future of paper application, which was created with the participation of industrial associations, researchers and corporations, can be quoted as an exemplary way for how to think ahead into the future with success. 375 directly paper-related and 265 indirectly paper-related ideas for future applications of paper were elaborated within 9 theme landscapes. Today already, just five years later, we see where paper conquers new fields of application in construction, mobility or energy storage systems as a system wall, a flat heater or an electrolyser component. ■

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More information: **www.faser-papier-2030.de**

Dimensional stability in inkjet printing

Forschungsnetzwerk Mittelstand

SID

Project goal

The goal of the project was not only to know the flatness properties when printing with a high water input but also to be able to predict the dimensional stability and the modulus of elasticity of the substrate. Knowing the stability characteristics in the flat plane (x, y direction) during inkjet printing makes it possible to estimate potential effects on further processibility (especially on the resultant position of the printed image in relation to the outer contour of a product) beforehand. It was intended to classify the substrates according to their deformation characteristics and come up with recommendations for improving the dimensional stability.

Research findings

One aspect of the project was to look into the hydroexpansion of the substrate in an inkjet printing context, that is to study the change a substrate undergoes when aqueous ink is applied. Several papers were selected and characterised for this purpose. The measuring apparatus "Luchs" developed by SID Leipzig was used as an internationally accepted standard for the assessment of register or position differences. The dimensional change of the substrate paper as a flat sheet was assessed by a measuring method on this basis. By way of structural adjustments to existing measuring devices and further development of the related software, a test method was created for the rapid assessment of the shape of the papers immediately after the inkjet process.

After a comprehensive analysis of the substrates and a comparison with an industrial plant, a model for predicting their further processibility was developed, which allows a risk assessment on the direction and level of curl / warp / z-deformation from known significant paper parameters and can be applied for a defined printing layout (amount of ink) and process (tensile force). The level of warp showed a very good correlation with the basis weight, the modulus of elasticity and the tensile strength index (TSI) of the paper substrate and a high dependence on the liquid amount applied.

The dimensional changes in the x-y direction increased with a higher usage amount of ink. The least changes were found in materials having a high thickness or basis weight. Also, there were different levels of dimensional change for different substrate classes: higher dimensional change for graphic papers, lowest dimensional change for single or twosided coated boards. The dimensional changes were a function of time and most significant immediately after moisture impact. Some of the size changes were reversible, some of them were not. After 24 hours, dimensional change in cross direction was more pronounced than in grain direction.

The expected dimensional changes in the x and y directions are predictable when many aspects (paper properties, conditioning, load during printing (web/sheet), ink properties) are taken into account. As a result, it was not possible to come up with a full-scale prediction model; but a general finding is: papers that tend to undergo high dimensional changes in the first place will always show a similar behaviour.

Also, it was found that the formulation of the ink has a significant impact on the dimensional change of the substrates. The application of three different inkjet printing inks (for corrugated board optimised / slow-drying / fast-drying) of different composition, i.e. different viscosity and surface tension, on identical substrates with varied usage amounts of ink gave different extensions in the x-y-z direction. The various inks mainly produced similar results in the length direction.

Conclusions

The dimensional changes in the x-y-z direction are highly dependent on the liquid amount applied. The basis weight is in so far of importance as there is no longer any significant dimensional change from the amount of applied liquid beyond a certain material thickness. The application of high ink volumes, as is the case in fourcolour and whole-surface printing, may cause significant changes in the zdirection, whether unrestricted or subject to additional tensile forces (web-fed process), depending on the printing layout. Such changes might impair the further processing steps, causing e.g. wavy edges in sheet items or tight edges in sheet piles. Very pronounced z-deformation may result in gluability problems or difficulties in joining the corrugated board liners to the flute. A well-aimed adjustment of the image composition and colour separation allows the applied liquid amount to be optimised already in the prepress stage in order to keep subsequent dimensional changes as low as possible. ■

Dr. Sabine Genest,
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Project title:
» Development of a predictive model for the dimensional stability of substrates in inkjet printing

Project period:
» 01/02/2019 – 31/01/2021

Project type/sponsor:
» Joint Industrial Research (IGF), IGF 20425 BR

Research locations:
» Papiertechnische Stiftung (PTS), project leaders: Dr.-Ing. Martina Härting, Dr. Sabine Genest
» Sächsisches Institut für die Druckindustrie (SID), project leaders: Beatrix Genest, Carolin Sommerer

Ageing processes and their impact on the ink-jet printability of folding boxboard

Initial situation

Processing complications, such as gluing or printing problems not exclusively related to poor storage conditions of the board, may occur already shortly after the manufacture of the board. Such processing complications are often connected with changes in the surface properties. A changed wetting behaviour or insufficient adhesion can be a reason for insufficient gluing or quality fluctuations in substrates.

The sources for surface-active paper additives are manifold, comprising wetting agents and flocculants as well as classical internal sizing agents, such as ASA and AKD, plasticisers, hydrophobic substances, such as polysiloxane-based defoamers, and antistatic additives. Although various standards define the basic requirements for the mechanical strength and material composition of ageing-resistant printing and writing papers, there are currently no standards for the testing of the long-term stability of the surface of coated paper and board. The valuable information carrier, however, such as a folding box serialised by a data matrix code, is always the coating located on the board itself.

Project goal

The goal of the research project was to identify the ageing processes that can occur within the usual processing period of up to one year and may cause a change in the surface-related processing characteristics. One aspect was to analyse changes in paper coating chemistry as a function of the coating formulation. For the practical application of the project results, another aspect was to develop a method for simulating such changes by accelerated ageing.

Test set-up

For a comparison with commercial folding boxboards, samples were prepared with nine different formulations of known coating compositions in the laboratory with special emphasis being placed on the coating binders and co-binders. The samples were subjected to a one-year realtime ageing process in three different locations (standard climate, nonconditioned laboratory and Technical Centre hall with frequently open doors) and to extensive two-monthly tests. The temperature and the air humidity in the Technical Centre and in the nonconditioned laboratory over the 12-month test period exhibited large fluctuations as shown by way of example for the laboratory in Figure 1.

Further, the samples were subjected to 12 different accelerated ageing scenarios, which were derived from applicable standards such as EU Plastics Regulation 11/2010, DIN SPEC 5010 or PTS DF 103-2019.

Results

The two-monthly tests were focused on various parameters such as contact angle, free surface energy, roughness, porosity, material changes and ink-jet printability. Strongest changes were found in measuring the water contact angle or the contact angle with other test liquids and, by way of consequence, in the determined free surface energy of coated boards.

For example, a sample containing styrenebutadiene (SB) binder and starch showed an increase of the water contact angle (maximum measuring error ± 3°) of up to 5% within the first four months, regardless of the storage conditions/places. Under standard climate conditions, the value remained increased until the end of the experiment; the contact angle showed higher fluctuations in the laboratory and in the Technical Centre.

Project title:
» Ageing processes and their impact on ink-jet printability of folding boxboard

Project period:
» 01/06/2019 – 30/09/2021

Project type/sponsor:
» Joint Industrial Research (IGF), IGF 20724 BR

Research locations:
» Papiertechnische Stiftung (PTS), project leader: Dr. Sabine Genest

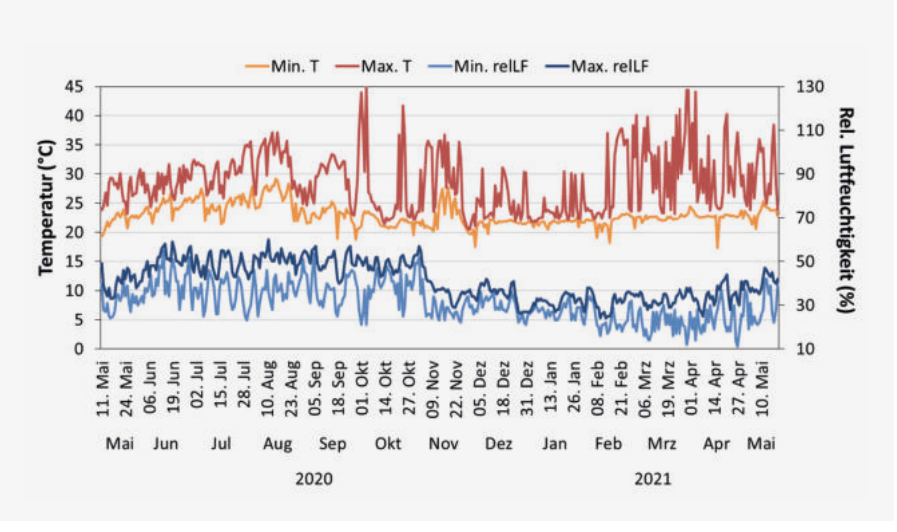

Fig. 1: Climatic conditions in one of the three locations (non-conditioned laboratory) during one-year real-time ageing

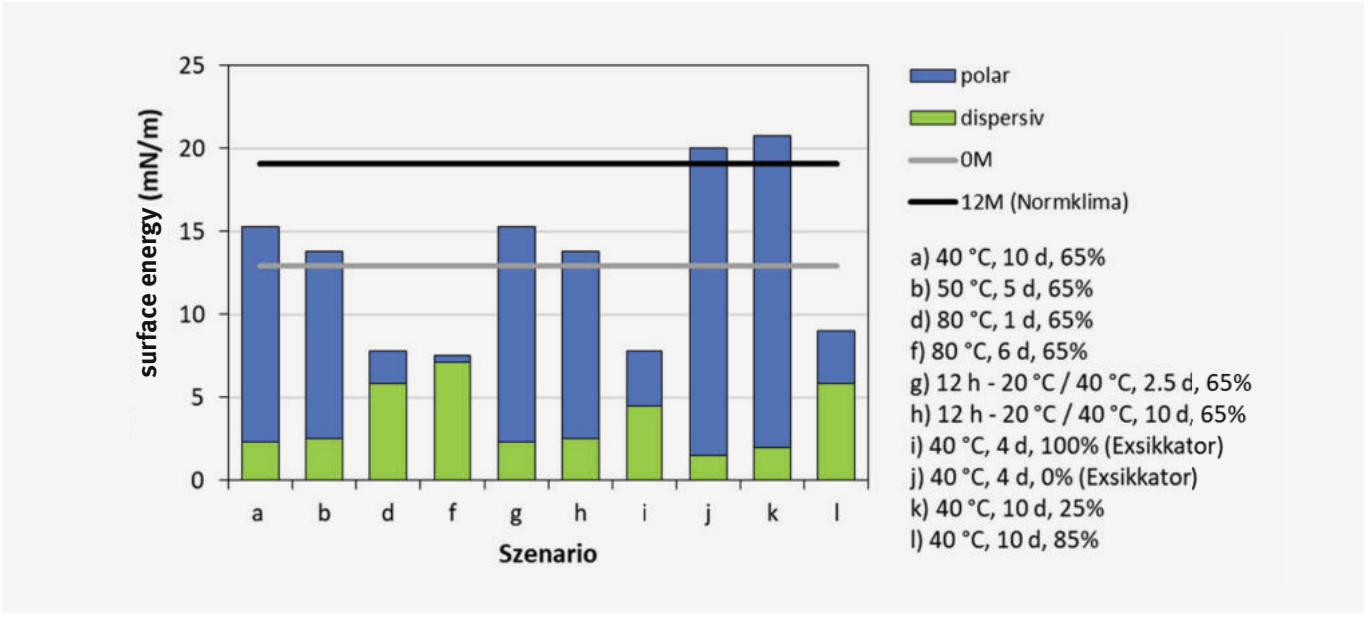

Fig. 2: Surface energy in the paper coating of a sample containing SA binder and polyvinyl alcohol after various accelerated ageing scenarios (a-l) in comparison with the initial value (grey) and the corresponding value after 12-month real-time ageing (black).

The comparison between the time curve of the water contact angle of aforesaid sample and those of other samples, inwhich the binder (styrene acrylate (SA) instead of styrene butadiene) and cobinder (polyvinyl alcohol instead of starch) were varied, showed significant dependence on the individual components: So the polyvinyl alcoholcontaining coatings, in contrast with the starch-based ones, exhibited a reduction of the water contact angle over time. Although the applied pigments (silicic acid or Ca silicate hydrate) have an impact on the absolute value of the water contact angle, they do not affect its change over time. In concrete terms, it can be summarised that the analysed coating substances have the following time-dependent effects on the paper surface:

- SA binder & polyvinyl alcohol cobinder: hydrophilization
- SB binder & starch co-binder: hydrophobization
- Precipitated silica / Ca silicate hydrate: no effect

The effect of the coating formulations that contain polyvinyl alcohol was higher than the effect from contrasting SB binders, despite the 50% lower (dry matter) content. Basically, it was found that the changes of the water contact angle over time, as well as those of other variables such as free surface energy, coating porosity and ink-jet printing quality, were significant, but only showed a low dependence on the storage location.

Accelerated ageing method development

Figure 2 shows the effects of different ageing scenarios on the free surface energy of a sample containing SA binder and polyvinyl alcohol. In addition, the values at the beginning and after 12 months of real-time ageing are marked as reference values by horizontal lines.

The changes as compared with the initial value and the corresponding surface energy value after 12-month real-time ageing are significant. It can be clearly seen that the scenarios j and k are the best matches for this sample, both in terms of the overall surface energy and in terms of its dispersive/polar parts.

Chemical analysis of the paper coating

A comprehensive analysis by pyrolysis GC MS showed that signals obtained in the analysis of pure coating additives were retrieved in the coated samples and thus allow conclusions about the composition. After the identification of substances such as solvents, aromatic hydrocarbons, fatty acid derivatives, naturally occurring substances (terpenes, triterpenes, sesquiterpenes), as well as alkanes and dialkyl ketones, 15 reference substances were selected and divided into four groups by their volatilities. Over time there was an enrichment in highly volatile components, which might suggest a partial decomposition of the binder. Additionally, an enrichment in ADK degradation products (dialkyl ketones) from the base board was observed at the surface.

Also, comparative ToF SIMS investigations were carried out, but the evaluation and interpretation of all data are not fully complete yet. First results support already the suggested migration of AKD degradation products during the course of the ageing processes. Further, the results of the accelerated ageing process confirm the information obtained from the determination of the free surface energy: excessively high temperatures and an air humidity ≤ 85% cause large changes in surface properties and, with them, significant differences in relation to the changes occurring during real-time ageing. Moreover, it was found that the suitability of a scenario for accelerated ageing depended on the coating composition and thus the effects on the analysed paper coatings were not the same in every accelerated ageing process.

Inkjet printing tests

Ink-jet printing tests of solid areas and an evaluation of the ink-jet codability in the form of GS1 data matrix codes were carried out in parallel with surface characterisations of real-time aged coatings. The printing quality was assessed by evaluating the readability of the codes (before and after a wipe test).

Ink-jet printing was selected as a quick and highly sensitive example for the further processing of a coated board in order to identify ageing-induced surface changes. Unfortunately, it was not possible this way. The largest changes were found in print gain, the value of which is influenced by too much or too less ink on the substrate as well as by its ink absorption behaviour. Print gain increased for all samples over the 12-month real-time ageing period. Accelerated scenarios also exhibited an increase in print gain regardless of the coating composition, and milder conditions (at 40 °C) generally showed values closer to those of real-time ageing.

Summary

Within the project, it was possible to identify individual paper coating components that can have a large impact on the surface properties by way of ageing processes. Also, it was possible to establish a readily applicable laboratory method that translates real ageing processes within one year, but is not generally applicable to paper coatings on a whole. ■

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Forschungsnetzwerk Mittelstand

Use of paper-derived ceramics as a thermally insulating material in a ceramic hybrid component

PTS has been developing paper-derived ceramics for several years within the scope of dedicated research projects. Paperderived ceramics show versatile use potentials in various industrial sectors such as filtration, membrane technology, lightweight construction, catalysis, or thermal insulation. In order to look into the application potential of the latter case in more detail, the "ForWerk" project (20646 BG) was used to successfully implement the industrial development of a ceramic hybrid component that is suitable for being used as an insulation material in the force flow during hot forming.

Hot forming of metal sheets and tubes plays an important role in modern automotive engineering, where temperatures of up to 900°C are reached (superplastic forming of titanium materials). Here, the mould needs to be maintained at a constant forming temperature. Figure 1 is a schematic representation of what the insulation can do as an enclosure (left) or in the force flow (right). Insulation in the force flow is preferable to largely avoid heat transfer to the press. This avoids energy losses and thermal overload of the press thereby contributing to a longer service life and higher accuracy.

Until now, there was no commercially available material having the required mechanical and thermal properties, which made it necessary to use energetically poor active water cooling for the press parts.

The ForWerk project allowed the successful development of a ceramic hybrid material that meets both the thermal and the mechanical requirements of the described field of application. The material consists of a frame structure made of fi-

Project title:
» Shape-retaining mould insulation in the force flow with improved thermal characteristics due to a hybrid structure

Project period:
» 01/04/2019 – 30/11/2021

Project type/sponsor:
» Joint Industrial Research (IGF), IGF 20646 BG „ForWerk" AiF

Research locations:
» Bayreuth University, CME – Georg Puchas, Felix Lindner
» Fraunhofer IWU Chemnitz – Ricardo Trân, Elmar Galiev
» Papiertechnische Stiftung (PTS) – Dr. Cornell Wüstner, Mandy Thomas

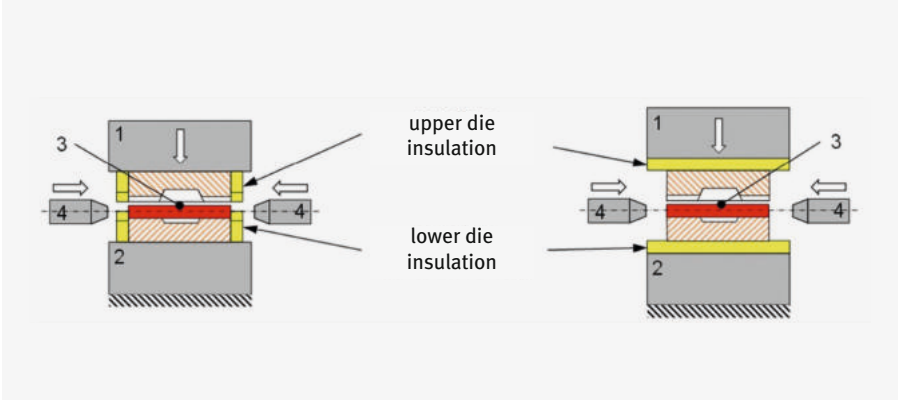

Fig. 1: Schematic view of a heated moulding tool for internal high-pressure forming with a heat insulation as an enclosure (left) or in the force flow (right); 1 – punch, 2 – press table, 3 – blank, 4 – sealing punch (source: Fraunhofer IWU)

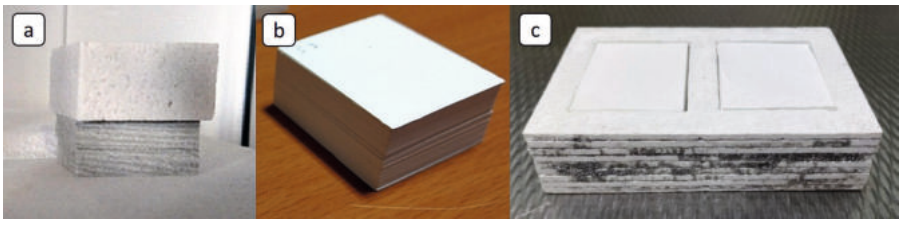

Fig. 2: Manufacture of PA ceramics and use in a hybrid component: a) pile of preceramic green paper bodies in the sinter oven (source: PTS), b) component made of PA ceramics after sintering (source: PTS), c) hybrid component made of optimised OFC ceramics (frame) and PA ceramics (inlays). (source: Fraunhofer IWU)

bre-reinforced OFC ceramics, which not only provides good thermal properties but also exhibits a high mechanical robustness in terms of compression loads. The recesses in the frame are filled with high-porosity PA ceramics, which has lower mechanical robustness, but provides high thermal insulation instead (refer to Figure 2c).

The fibre-reinforced OFC ceramics was developed at the Ceramic Materials Department of Bayreuth University. Mullite was selected as the matrix and fibre material, because it has a significantly lower thermal conductivity than the mechanically more stable aluminium oxide (Al_2O_3) (mullite: 6 W/mK at room temperature or 3.5 W/mK at 1000°C; Al_2O_3: 20 – 30 W/mK). The size of the ribs of the frame can be increased to make up for the somewhat lower mechanical properties.

In practical application, the OFC frame structure (fibre volume content of 35,5 %) must withstand compressive loads of about 70 MPa. Compression tests at 100 MPa were carried out to demonstrate the robustness. After a certain subsidence at the initial load (flattening out uneven zones of the sample), the sample was then found to remain stable and intact for up to 100 load cycles. In addition, a flexural strength of 87 ± 4 MPa was determined according to the three-point bend method (after ISO 17138).

Apart from the good mechanical properties, also the thermal conductivity values of 1,52 bis 1,23 W/mK determined according to the LFA method were significantly lower than those of monolithic mullite (see above), what can be explained by the high porosity of the matrix (> 50%) and the transitions between the matrix and the reinforcing fibres.

Within the project, it was possible to successfully develop layered high-porosity ceramic materials having a high thermal insulation effect at PTS. The first step was to develop highly filled papers with ash contents between 80 and 90 % by weight in the laboratory. Several filler materials were tested, such as aluminium oxide, mullite or mixtures of aluminium and zirconium oxide (Al_2O_3/ZrO_2). After sintering, the latter mixtures were found to be particularly well suited, because the resultant ceramics exhibited high porosities (50 - 60 %) as well as an acceptable mechanical stability (flexural strength of approx. 20 MPa). The Al_2O_3/ZrO_2 mixture also results in a low heat transfer, especially by the low thermal conductivity of ZrO_2 (2 – 3 W/mK) and the phase boundaries of the particles in the mixture. In the best case, this leads to thermal conductivities as low as below 0.3 W/mK at 800 °C to 1000 °C.

It was possible to successfully demonstrate the production of the green papers on the pilot paper machine. Mechanically stable papers with a filler content of up to 87 % by weight were produced. Papers having an ash content of just over 80 % by weight provided best performing ceramics after sintering in terms of flexural strength, porosity and insulating effect.

Also the sinter programme for the manufacture of mechanically stable ceramics was optimised at PTS. Here, the main focus was placed on the final sintering temperature and the area of debindering. For debindering, the temperature is varied only slowly, and with interruptions in between, within a range of approx. 200 – 500 °C such that the pulp fibres and organic additives can be carefully removed without causing excessive damage to the matrix of ceramic particles. The components made of PA ceramics are sintered by piling up a certain number of paper sheet layers and placing a weight on top (Abb 2a). The individual layers of the ceramics will finally adhere to one another in a stable manner and can be used as an inlay (Fig. 2b).

The developed hybrid components were simulated and practically tested for their heat transfer properties by Fraunhofer IWU. The simulation software LS-DYNA was used to optimise the performance characteristics of the

component. The load tests were carried out under real conditions on a 20-mm-thick hybrid insulation with a maximum compressive load of 15 N/mm² and a temperature of 870°C on the heated side. The simulation was validated and improved by means of temperature measurements in several points (at different levels) in the insulation material. At the same time, comparative measurements were performed on the OFC bulk material and other inlay materials. The tests also showed the potentials for optimised geometries of hybrid components.

On the basis of the tests, the PA ceramics was found to have a similar effectiveness in its heat insulation potential as compared with the more expensive OFC ceramics. So it was possible to confirm the suitability of PA ceramics for the intended use and the cost-cutting potential of the overall component.

Finally, a profitability analysis provides interested companies with a comparison between the newly developed hybrid insulation and alternative materials. A user guideline summarises the major test results of the project for the industry in order to accelerate their economic implementation. ■

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Forschungsnetzwerk Mittelstand
Industrielle Gemeinschaftsforschung

Gefördert durch:
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aufgrund eines Beschlusses des Deutschen Bundestages

Paperonics – printed electronics for smart packaging

The implementation of new electronic features in packaging items, such as consumer interaction and feedback via cell phones, traceability, security in ecommerce, or monitoring of transport, handling and storage conditions, is always a challenge for packaging manufacturers. For the sake of flexible low-cost manufacture, it is important to integrate as many manufacturing steps as possible in the packaging company. Printing processes play a key role. The project looks into the potentials of various printing technologies in conjunction with suitable inks and paper substrates.

It is obvious that the properties, especially surface properties, of the substrate have a crucial impact on the performance of printed electronics. As there is broad range of paper substrates with different surface characteristics, the project consisted in characterising and assessing a selection of 76 papers and printing a large number of promising substrates with various printing methods. Many papers showed good printability when suitable silver inks were used. A roll-to-roll screen printing process allowed circuit-board conductors to be printed at high conductivities and accuracies even on uncoated greaseproof paper. Substrates with smoother surfaces and lower absorptive capacities were found to be suitable for Aerosol Jet® printing using low-viscosity inks. It was possible to optimise substrate surfaces for this printing method and improve their printability by means of planarizing coatings.

The substrates such optimised were provided with additional barrier characteristics by means of vapour deposition of inorganic materials in combination with organic layers. Another aspect of the project was to study the interaction between inorganic barrier layers and absorber materials within film composites that can

Project title:
» PAPERONICS – low-cost multisensory paper for packaging applications

Project period:
» 01/01/2019 – 31/03/2021

Project type/sponsor:
» Joint Industrial Research (IGF), IGF 242EBG

Research locations:
» Fraunhofer IVV Freising (project coordinator), Klaus-Dieter Bauer
» TU Chemnitz, Dr. Thomas Weißbach
» Papiertechnische Stiftung (PTS), Lydia Tempel
» Hasselt University
» KU Leuven
» IMEC Leuven

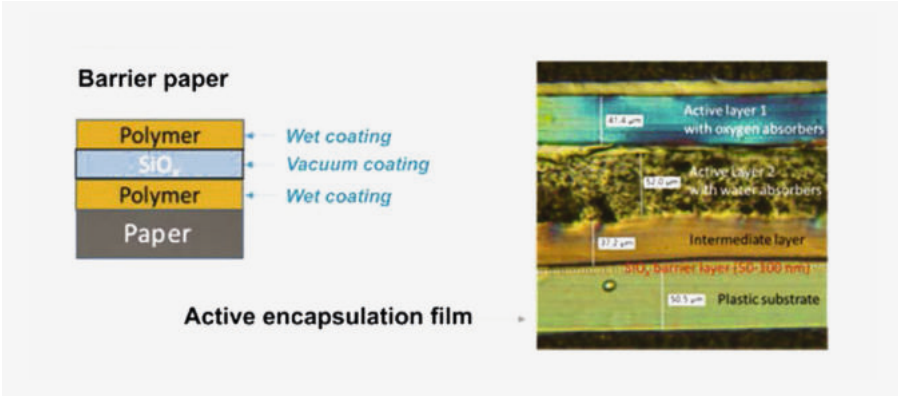

Fig. 1: Encapsulation solutions developed under the project (source: Fraunhofer IVV)

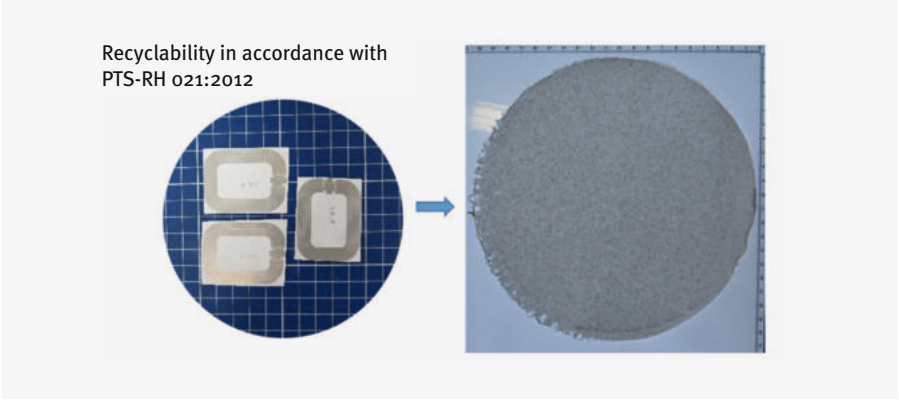

Fig. 2: Accepts sheet (right) made of defibrated and sorted paper samples printed with Ag-RFID antennas (left). (source: PTS)

be used as a translucent encapsulation of components sensitive to oxygen and water vapour (Figure 1). Thanks to the integration of oxygen catchers, it was possible e.g. to decelerate the oxygen breakthrough. Although the integrated absorbers reached a high effectiveness for water vapour, their capacity was depleted faster than that of the oxygen absorbers. This was due to the fact that the barrier films showed a significantly higher permeability to water vapour than to oxygen. Especially sensitive components such as organic solar cells or OLEDs need to be protected from water vapour. Therefore, appropriate encapsulation materials are expected to impart high barrier effects. Water catchers, however, reduce the translucency and thus produce significant light scatter affecting the function of the components. This illustrates the limits of this solution. But absorbers can take up gases entrapped during the manufacture of the components and thus can ensure cost-efficient processing without protective atmosphere. The encapsulation materials were also tested for their printability. Printable encapsulation films and coated substrates allow the use of light-absorbing substrates to be reduced and thus are very beneficial. In the trials, the flexo printing method for solar cells was used to manufacture typical transparent electrodes or current collectors. They showed no disadvantages in comparison with traditionally manufactured components.

Another focus of the project was on the recyclability of the non-printed and printed substrates. This feature was tested by means of an adapted PTS-RH 021:2012 method. Printing with silver inks led to visual impurities in the recyclate. However, this impact can be tolerated in a mix like collected household waste, or when the electronic feature is applied to a packing box made of e.g. corrugated board, because of the related thinning effect.

The printed structures were also tested for their robustness to stress or ageing processes. Subsequent functional tests involving flexural, torsional and abrasive loads as well as accelerated ageing simulated by heat and light exposure showed no or just minor adverse effects on the functionality of the printed structures.

Three demonstrators (Figure 3) developed and manufactured in the project with different functionalities (1 customer relation, 2 anti-falsification, 3 temperature monitoring) showed that printed electronics on paper can be a promising and sustainable alternative to comparable products on plastic films. For this purpose, the NFC antennas required for two of the demonstrators were produced by sheetfed screen printing and then adapted to the industrial manufacturing process – web-fed roll-to-roll screen printing. In connection with a microchip, they can be used for interaction with the customer or for logistical purposes. A remotely readable temperature sensor for the monitoring of e.g. cold chains was developed by connecting an antenna and a microchip to an irreversible temperaturesensitive resistor. Demonstrator 2 was integrated with further printed electronic elements for embedding new functionalities. A flexible printed-circuit board (pcb) of paper was produced according the web-fed screen printing method in which an electrochromic display, a solar cell and an opening sensor were combined. The display will indicate in an irreversible manner when the packaging is opened and thus identify the unauthorized use of the packed item or any exchange of the product.

It seems realistic to embed said or similar printed electronic components in fibrebased packaging in the near future. PAPERONICS demonstrated possible approaches for companies of the packaging industry. But the project findings can also be used by manufacturers of printing substrates and inks to improve their products. ■

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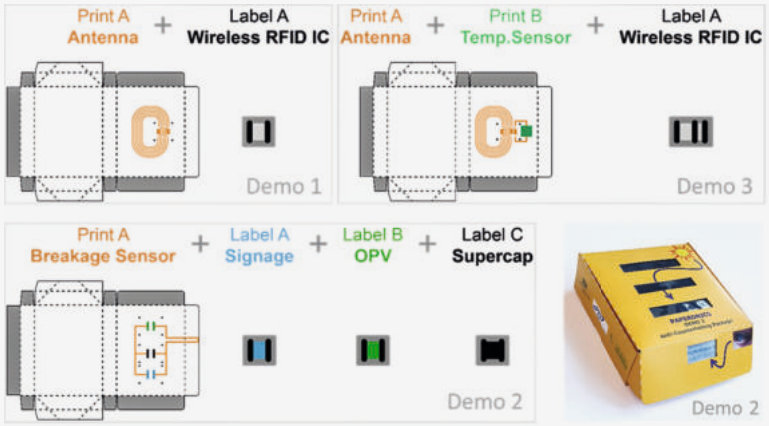

The detailed project report is available at **www.ivlv.org/project/paperonics**.

Futher information on processes amd methods used within the project can be obtained at **(booklet on PTS website)**.

Fig. 3: Demonstrators produced in the project (source: PAPERONICS/TU Chemnitz)

Binder free bonding of papers by laser radiation

Since cellulose is not thermally meltable, papers cannot be used in bonding processes such as welding and sealing, which widely used for plastic films or coatings, without the application of additives. Joining methods with form-fit and force-fit connections such as embossing or knurling are used e.g. for coffee filters or tissue, but the strength values such obtained are comparatively low, even after enhancement e.g. by ultrasound. For all other cases, manifold adhesive systems such as starch adhesives, hotmelts or dispersion adhesives are the means of choice. However, they have certain disadvantages such as an increased presence of sticky formers in recycling circuits or a higher migration potential due to mineral oil components contained in the adhesive.

In an IGF project already completed, PTS and the Fraunhofer Institute for material and beam technology (IWS) developed together a method in which cellulose is exposed to CO laser radiation and thus changed into a bonding medium without the need to use additional binders.

The key hypothesis of the project was that cellulose could be selectively melted thanks to said radiation. In a first step, the interaction mechanism between paper materials and laser radiation was an-

Project period:
» 01/01/2019 – 31/12/2020

Project type/sponsor:
» Joint Industrial Research (IGF), IGF 20487 BR

Research locations:
» Papiertechnische Stiftung (PTS), project leader: Dr. Martin Zahel
» Fraunhofer Institute for material and beam technology (IWS), project leaders: Dr. Michael Panzner, Florian Lull

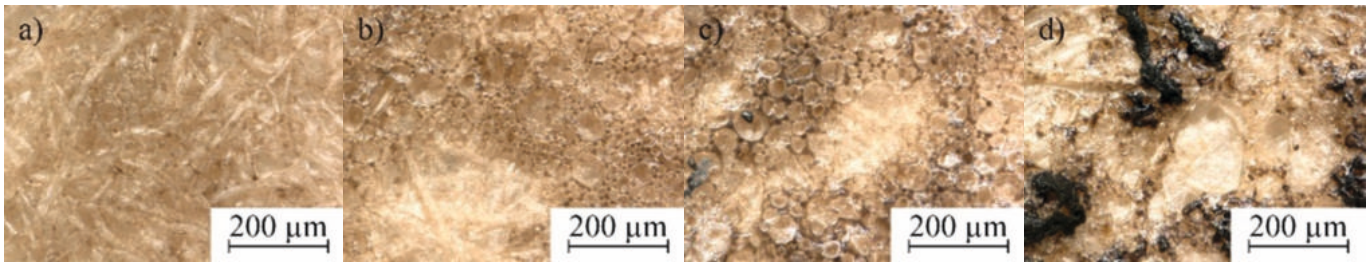

Fig. 1: Substrate after irradiation at a peak fluence of 1.02 Jcm^{-2}. a) linters, b) sulphate (kraft), c) sulphite, d) CTMP substrate.

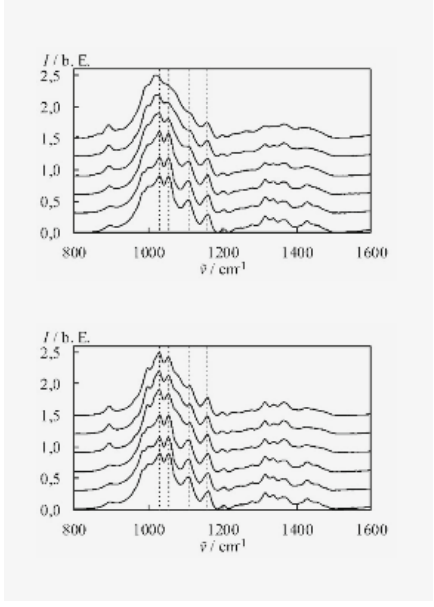

Fig. 2: IR spectra of an irradiated (top) as well as a radiated and aqueously extracted (bottom) linters substrate as a function of laser fluence. From the bottom to the top: 0.0 Jcm^{-2}, 0.3 Jcm^{-2}, 0.5 Jcm^{-2}, 2.1 Jcm^{-2}, 5.2 Jcm^{-2}, 13.7 Jcm^{-2}.

alysed with the aim to identify effective material states for a bonding process. During the exposure of paper samples (linters, kraft, sulphite and CTMP substrate) to CO laser radiation of wavelength 5.6 µm, two fluence-dependent interaction regimes were identified.

Low fluences up to a material-specific threshold fluence tend to cause browning of the paper. Further increase of the energy density will lead to removal. However, homogeneous accumulations of melt-like residue in the form of bubbles with several 10 µm in diameter can still be found after irradiation. This suggests coexisting gaseous and liquid matter. (Fig. 1)

The irradiated samples were analysed by IR spectroscopy to characterise the nature of the conversion of the material. The peak intensities were found to be reduced in the range between 800 cm^{-1} and 1600 cm^{-1}. Taken in isolation, an identical result is obtained from conversion into a cellulose-II configuration, which would suggest melting and solidification of the cellulose. However, the return of the same bands after aqueous extraction of the irradiated samples suggests a split into short-chained water-soluble products. (Fig. 2) Therefore, the observed results cannot be a purely physical melting phenomenon.

Then, it was analysed how and to which extent the conversion products such obtained could be used for a bonding process. This was in fact the first time that paper was bonded together without the addition of binders. For this purpose, the paper substrates were first irradiated and then hot-sealed in a following step. (Fig. 3)

The achievable strengths are in the range of 1-3 N/15mm and thus in the range of soft-peel seams and vary depending on the fibres and additives used. An additional increase in the sealing strengths was observed when drying and wet-strength agents were added, whereas the use of fillers had a negative effect on the strength of the seal seam. The tests showed two mechanisms of failure. So failure was either in the paper structure or in the actual joints. Using a substrate having a good internal bonding strength proved to be beneficial in this respect.

The project provided a significant gain in knowledge about CO-laser irradiation of papers and binder-free bonding of papers. In addition, relevant material and process parameters were identified for process optimisation at a later point of time. The project findings allow the manufacture of binder-free bonded materials for application e.g. in means of packaging.

The final report can be downloaded from the website of PTS. ■

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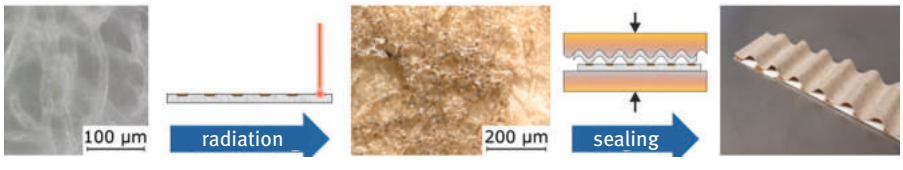

Fig. 3: Schematic description of binder-free joining process

IGF
Industrielle Gemeinschaftsforschung

Gefördert durch:
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aufgrund eines Beschlusses des Deutschen Bundestages

Biobased paper coatings: IGF project BiPaRe kicked off

The use of biobased paper coatings for achieving barrier properties in the food packaging area has become more and more popular. Especially in the light of the recent Single-Use Plastics Directive (EU 2019/904) and the related restrictions imposed on materials made of "plastics", biobased coatings offer a potential alternative.

The project "BiPaRe: Strategic development tool for a well-aimed product design of recyclable biobased paper coatings" is designed to analyse in more detail the impact of the coatings on the recyclability behaviour of the corresponding products. The project is sponsored under the Industrial Joint Research scheme and was kicked off on 01 June 2021. The project work is performed at PTS in Heidenau and Fraunhofer IVV in Freising.

In a first step, the focus is placed on defining suitable base papers and coatings, then the impact of the coating on the recyclability of the product is analysed. In addition to typical parameters such as reject volumes, optical homogeneity and stickiness of the accepts, the purpose of the project is to analyse the aqueous phase for redispersed, dissolved and colloidal substances. The goal is to come up with a development tool for means of packaging in the food sector which use biobased coatings and are recyclable. So the project makes a contribution to design for recycling. As a result, there is huge interest from the industry: the project advisory commission is made up of altogether 25 members covering the whole value-added chain of papermaking, coating manufacture, packaging design, marketing and industries using recovered paper. ■

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Project title:
» Conception of recyclable biobased coatings for paper packaging

Project period:
» 01/06/2021 – 30/11/2023

Project type/sponsor:
» Joint Industrial Research (IGF), IGF 21805 BG, AiF

Research locations:
» Fraunhofer Institute for Process Engineering and Packaging IVV, Dr. Klaus Noller, Klaus Dieter Bauer, Marius Jesdinszki
» Papiertechnische Stiftung (PTS), Dr. Annika Eisenschmidt

Forschungsnetzwerk Mittelstand

BiPaRe BioPaperRecycling

Regenerative, superhydrophobic paper coatings based on renewable resources – "Regenerate"

With this project launched in October 2020, PTS and TU Darmstadt made it their goal to develop superhydrophobic coatings for paper on the basis of renewable (regrowing) materials. The regenerative capacity of the surface structures and a simple application of the material are the points of special interest. Superhydrophobic papers provided with such coatings are predestined for use as a construction material.

Paper as a construction material

Paper as a regrowing, biodegradable and recyclable resource has a great potential as a construction material, especially for lightweight applications, e.g. in furniture construction, interior finishing or vehicle construction. All these applications require utmost water resistance, because moisture is the main source for damage. Superhydrophobic coatings can provide paper substrates with reliable protection from the destructive effects of water, especially from strength loss, deformation, microbial colonisation, and dirt.

Need for research

At present, there are no superhydrophobization strategies in the market that combine the features of material safety, simple application technology, recyclability and regenerative ability, e.g. after damage. The latter constitutes problem

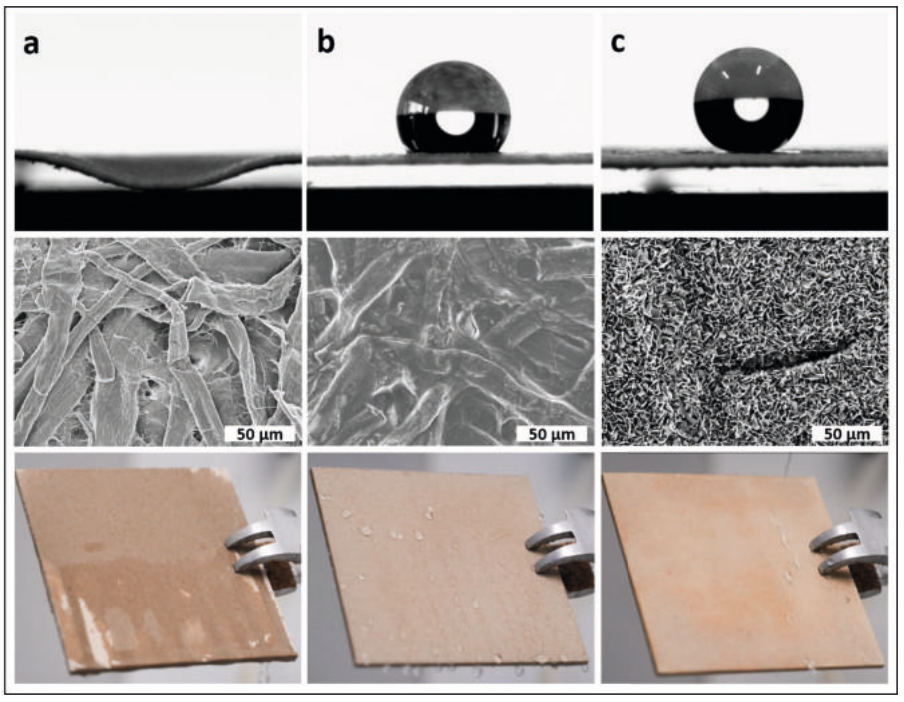

Fig. 1: Contact angle images, electron-microscopic surface images and photos of (a) uncoated, (b) hydrophobic, and (c) superhydrophobic papers.

especially in terms of the further processing and conversion of coated substrates, because conventional coatings are destroyed or damaged under the prevailing process conditions. If there were a way to regenerate the coating after forming, it would be possible also to make inaccessible surfaces superhydrophobic, such as in honeycomb panels.

The goal of the "Regenerate" research project is to serve the manufacture of functional coatings that meet the aforesaid property requirements. For this purpose, it is intended to combine polysaccharide fatty acid derivatives as a hydrophobic matrix component with crystallizable waxes. The combination with waxes of plant and animal origin, as a structural component, allows microstructuring of the coating by cooling it down from the melt and thus offers for the first time the possibility of thermal regeneration. Another aspect of the project other than the basic functionality of the coating is to analyse various application methods and the relationship between properties of the paper substrate (e.g. roughness, surface energy, porosity) and coating efficiency in more detail. ■

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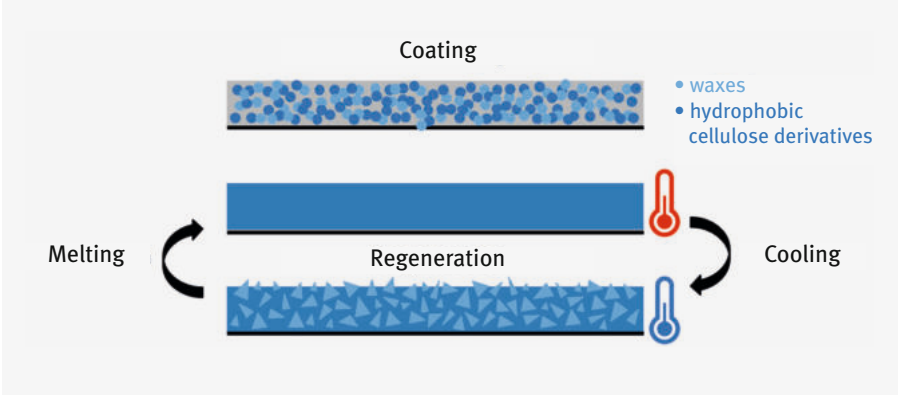

Fig. 2: Schematic diagram of the temperature-induced regeneration process.

Project title:
» Wax-polymer coatings for regenerative super hydrophobization of paper products – „Regenerate"

Project period:
» 01/10/2020 – 30/09/2022

Project type/sponsor:
» Joint Industrial Research (IGF), IGF 21373 N

Research locations:
» Papiertechnische Stiftung (PTS), Dr. Marcel Haft, Dr. Jennifer Daeg
» Technical University of Darmstadt, Institute for Macromolecular Chemistry and Paper Chemistry, Dr. Andreas Geißler, Cynthia Cordt

TECHNISCHE UNIVERSITÄT DARMSTADT
Macromolecular and Paper Chemistry

AiF Forschungsnetzwerk Mittelstand

IGF Industrielle Gemeinschaftsforschung

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

Double-curvature honeycomb parts based on flexibly shapeable honeycomb cores

One way to realise resource-saving and energy-efficient products and processes is to implement principles of lightweight construction. The use of lower-weight components in the mobility sector reduces the necessary power demand and thus energy needs of the vehicles. Based on their comparatively low thermal conductivity, closed components can fulfil a heat-insulating function in addition to their structural supporting function. Therefore, lightweight construction is considered a "game changer" technology for meeting the climate and sustainability goals and is therefore funded under various programmes, e.g. by BMWi[1].

Problem situation

The honeycomb panel combines the advantageous lightweight construction principles of honeycomb and shell construction into one component. For this purpose, a honeycomb core is sandwiched between two liner layers (cf. Fig. 1). The production of lightweight construction elements based on honeycomb panels is a well-established application in housing, furniture and vehicle construction. However, most of the construction elements in these applications are flat. This is due to the fact that conventional honeycomb core structures cannot be bended without destruction (cf. Fig. 2). Curved components in connection with specially shapeable honeycomb cores are only used in the upmarket sector.

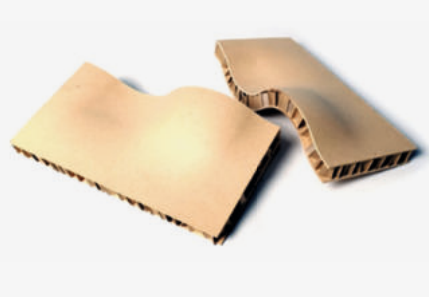

Fig. 1: Double-curvature honeycomb part[2]

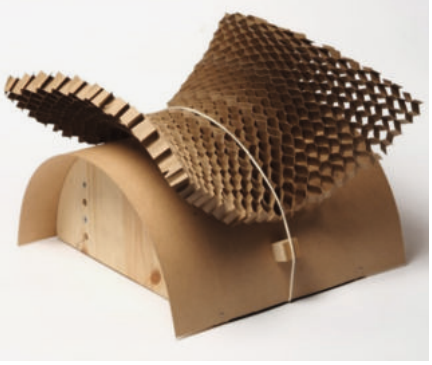

Fig. 2: Saddle formation when bending a nonflexibilized honeycomb core[2]

A method for the manufacture of shapeable low-cost honeycomb cores from web-style honeycomb cores was already developed and patented at the Technical University of Dresden (TUD) [WO2020234083]. For this purpose, the endless honeycomb cores are precompressed and flexibilized by creating an elongation reserve. However, there is a comparatively limited selection of such endless honeycomb cores in terms of materials and geometries. But his limitation is not true for block-style honeycomb cores. Therefore, one aspect of the project "2k-WaFo" is to transfer the existing flexibilization principle onto the honeycomb cores in question, which are mainly in the medium-priced segment. It is due to the absence of flexibly shapeable low-cost honeycomb cores that there has been almost no research on their processing and conversion.

Project goals

The project partners, i.e. SmartPac, Deutsche Werkstätten Hellerau, the Chair for Wood and Fibre Material Technology of TU Dresden, and Papiertechnische Stiftung (PTS) launched a joint ZIM cooperation project to work on the two main topics. The goal is to obtain a ***low-cost method for the manufacture of shapeable honeycomb cores*** based on block-shaped honeycomb cores of diverse materials for a multitude of applications and ***efficient manufacturing methods for single and double-curvature honeycomb*** parts.

Project title:

- Overall theme "2k-WaFo" (Moulded doublecurvature honeycomb part)
- Sub-project "Detailed analysis and modelling of the forming principle (flexibilization of hexagonal honeycomb cores) for reducing the need for application-specific development and testing, and model for the prediction of low-damage forming limits"

Project period:

- 01/04/2021 - 31/03/2023

Project type/sponsor:

- ZIM-KK 5244401 PK1

Research locations:

- Deutsche Werkstätten Hellerau GmbH (DWH), project leader: Alexander Hoffmeister
- Papiertechnische Stiftung (PTS), project leader: Toma Schneider
- TU Dresden (TUD), Institute for Natural Material Technology, Chair for Wood and Fibre Material Technology, project leader: Prof. Dr.-Ing. A. Wagenführ
- SmartPac Verpackungsmaschinen GmbH (SmartPac), project leader: Frank Lippert

Responsibilities of the partners

The machine manufacturer SmartPac develops the flexibilization process in conjunction with TU Dresden, inclusive of the mechanical implementation of a prototype of a flexibilization unit. Deutsche Werkstätten Hellerau develops the shaping and joining processes of the flexibilized core and the outer layers for the curved component. TU Dresden develops and tests various flexibilizations inclusive of optical analysis methods and is the coordinating project partner for

networking purposes. PTS supports this project by means of models and investigations based on numerical prediction models for reshaping semifinished sheet parts with the aim to reduce the amount of application-specific development, testing and trial expenses.

Responsibility of PTS

For flexibilization, the horizontally extending honeycomb core is fixed in position and prefolded on a segment-by-segment basis around the web edges by means of vertically moving grippers such that the hexagon of the honeycomb becomes a polygon having a highest possible number of vertices (cf. Fig. 3). The higher the honeycomb structure (vertical direction), the higher the required force for plastic pre-folding and desired bending around the vertical axes (cf. Fig. 4). However, a greater structural height means a reduction in the blank holding force of the forming tool as a result of possible undesired kinking effects around the horizontal axes. This is a goal conflict to be examined on the basis of a prediction model. The modelled sub-processes are overexpansion, safe gripping of the honeycomb webs and precompression of the core. The parametric models are then used to run variant studies regarding the impact of material and the honeycomb and tool geometries. An important aspect is to look into the effect caused by imperfections of the honeycomb core. An additional aspect is to develop a model for predicting the maximum curvature that can be imparted to a component without tensile rupture of the core structure.

Results and evaluation

The findings of the investigations are expected to lead to design instructions for the flexibilization process and materialspecific geometry limits for the shaping and joining process. In perspective, the results to be obtained can be used to develop a design tool for dimensioning a panel-type curved honeycomb product and the required manufacturing processes and to offer related design services. ■

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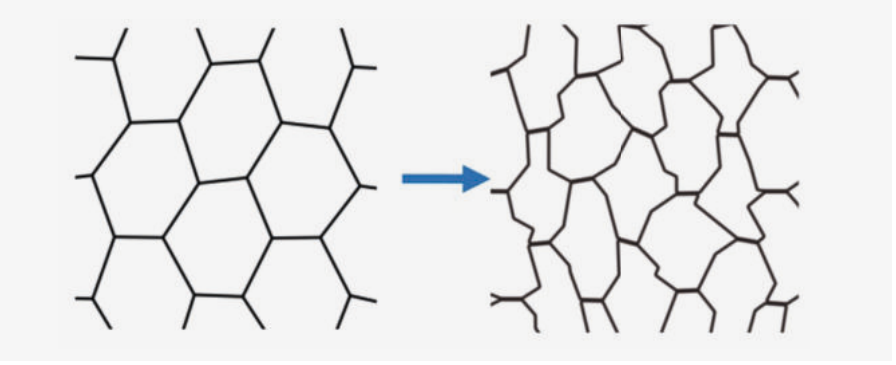

Fig. 3: Structural change from flexibilisation[3]

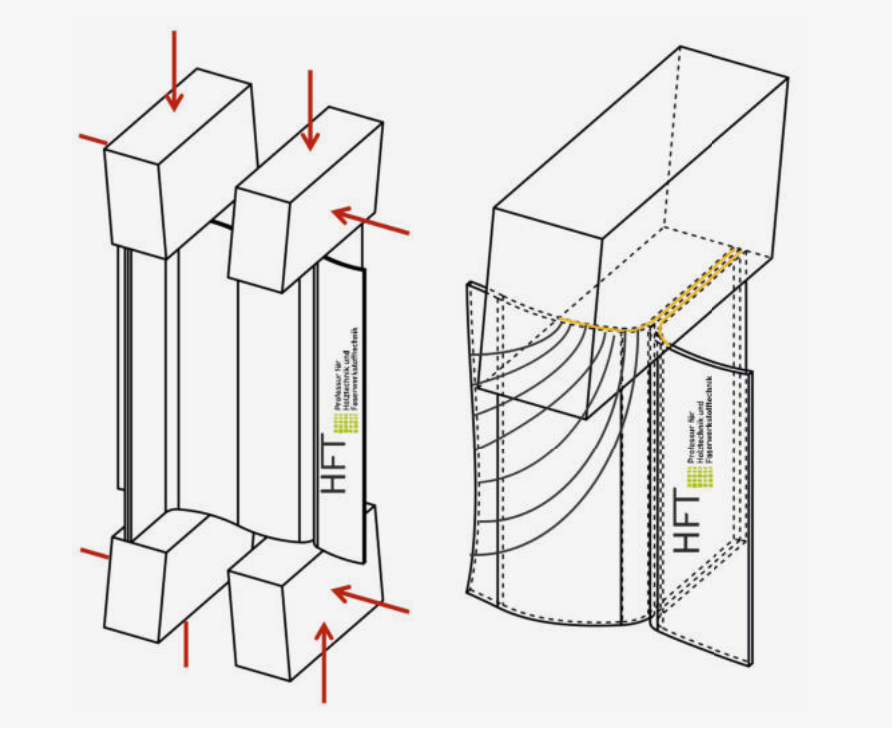

Fig. 4: Schematic view of web gripping process[3]

ZIM
Zentrales Innovationsprogramm Mittelstand

Gefördert durch:

Bundesministerium für Wirtschaft und Energie

aufgrund eines Beschlusses des Deutschen Bundestages

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2 Lippitsch, S. et al.: (2019). FlexCore – 3D Waben für den Möbelbau, Artikel und Poster zu den 12. Internationalen Möbeltagen, Dresden, 2019.
3 Lippitsch, S.: Weiterentwicklung eines Verfahrens zur Flexibilisierung von Wabenkernen, Präsentation, TU-Dresden, Professur für Holz- und Faserwerkstofftechnik, Dresden, 2019.

Wood-based materials in mechanical engineering (HoMaba)

At present, it is not possible for CAD designers to use wood, wood materials, wood hybrids and especially natural fibre reinforced sheet materials, such as paper or board and materials made therefrom, e.g. corrugated board, for applications in mechanical engineering and plant construction. This is due to the fact that there are no validated calculation concepts for said natural materials and that users cannot rely on the parameters indicated by manufacturers and vendors.

Nine research institutes from all over Germany have joined forces to pool their expertise and work on the project "HoMaba" together with the aim to create more confidence in the material. They are Technical University of Munich (Munich Wood Research), Technical University of Dresden (Institute for Natural Material Technology), Technical University of Chemnitz, Fraunhofer Institute for Wood Research, Wilhelm Klauditz Institute, Institute for Wood Technology of Dresden, Georg August University of Göttingen, University for Sustainable Development of Eberswalde, University of Rosenheim and Papiertechnische Stiftung (PTS). The first step towards implementation was to develop a calculation concept for static and uniaxial loading and to come to a decision which parameters are relevant. For this purpose, the material itself was looked at to see whether it is a two-dimensional material like veneer or paper in which the thickness properties can be neglected, or a three-dimensional material like corrugated board. Said decision formed the basis for developing test concepts intended to generate the required material parameters in 2D or 3D. In contrast with the previous measuring methods in the paper industry, the adjusted parameter determination requires a new elongation rate of one per cent per minute and elongation measurement by means of an optical system. Both requirements are fundamentally new to the paper industry and thus are a challenge to all tensile, compression, bending and shearing methods available in the market or known in science. The current work is focused on a demonstrator. Also, the project consortium is looking into additional fields of application for wood-based materials in the industry. ■

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Project title:
» Wood-based materials in machine engineering (HoMoba) – calculation concepts, parameter requirements, parameter determination; Sub-project 8: Parameter determination of fibre composite

Project period:
» 11/2018 - 04/2022

Project type/sponsor:
» Fachagentur Nachwachsende Rohstoffe e. V.; FNR 22003218

Research location:
» Papiertechnische Stiftung (PTS), Benjamin Hiller

FNR Fachagentur Nachwachsende Rohstoffe e.V.
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CHARTA FÜR HOLZ 2.0 KLIMA WERTE RESSOURCEN

Mobile fuel cells: research, development and innovation measures within the national innovation programme "Hydrogen & Fuel Cell Technology – Phase 2"

Fuel cells (FC) for mobile applications still have significant scope for improvement in terms of minimised space requirements, reduced manufacturing cost and longer service lives. One component of the FC stack with relevance to all of abovementioned properties is the gas diffusion layer, briefly known as GDL. The GDL is located between the bipolar plate and the electrode and must ensure an optimal distribution of gases as well as the transport of water, heat and current. Today, a GDL is preferably composed of porous graphite mats or graphite sheets, which

are still somewhat insufficient in terms of mechanical stability, service life and cost.

The goal of the project is to develop an allmetal gas diffusion layer (GDL) with better application characteristics, manufacturability and assembly properties using the sinter paper technology. For this purpose, papermaking processes are used to process organic fibres, fillers and additives together with a metal powder to form a paper-like sheet product, then to remove the organic components through heat treatment and convert the structure into a pure metallic high-porosity material. The total void volume and the shape of the voids can be adjusted over a broad range, and it is also possible to generate anisotropic properties supporting e.g. the targeted transport of gas and water. In perspective, it is intended to impart a microscopic structure to the GDL to allow simplified 3D screen-printed bipolar plates to be used. The GDL material to be newly developed is planned to be tested in a short stack for 500 hours under application-relevant conditions. In parallel, a structured sinterGDL with integrated flow field is planned to be tested in combination with a simplified bipolar plate with the aim to simplify the manufacturing process and reduce the size of the component. ■

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Project title:
» Development of sinter paper - gas diffusion layers for space, manufacture and costoptimised-mobile fuel cells „SinterGDL“

Project period:
» 01/11/2021 – 31/10/2024

Research locations:
» Fraunhofer Institute for Manufacturing Technology and Advance Materials IFAM, Dresden Division (coordinator)
» Papiertechnische Stiftung (PTS)
» DLR Institute of Engineering Thermodynamics of Oldenburg

Project partners:
» Papierfabrik Louisenthal GmbH
» balticFuelCells GmbH
» Picosun GmbH

Nationales Innovationsprogramm Wasserstoff- und Brennstoffzellentechnologie – nip

Funded by: Bundesministerium für Verkehr und digitale Infrastruktur

Coordinated by: NOW-GMBH.DE

Project sponsor: ptj Projektträger Jülich Forschungszentrum Jülich

Successful renewal of accreditation acc. to DIN EN ISO/IEC 17025:2018

DAkkS Deutsche Akkreditierungsstelle D-PL-17375-01-00

The PTS Quality Management team was able to complete this year's accreditation round with success and thus obtain the accreditation for the revised standards of DIN EN ISO/IEC 17025:2018. After the assessment in April this year, the PTS laboratories were issued the notice of renewal of the accreditation.

The accreditation comprises testing in the fields of:

- physical and mechanical technological testing;
- testing of optical properties;
- testing of surface conditions and porosity;
- selected chemical analyses and environmental simulation tests on paper,
- board and corrugated board and technical products from the paper industry.

The laboratories can now continue to offer their customers testing services according to DIN EN ISO/ IEC 17025:2018 and ensure a high quality. ■

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Insight into material science with the scanning electron microscope (SEM) – Series #2

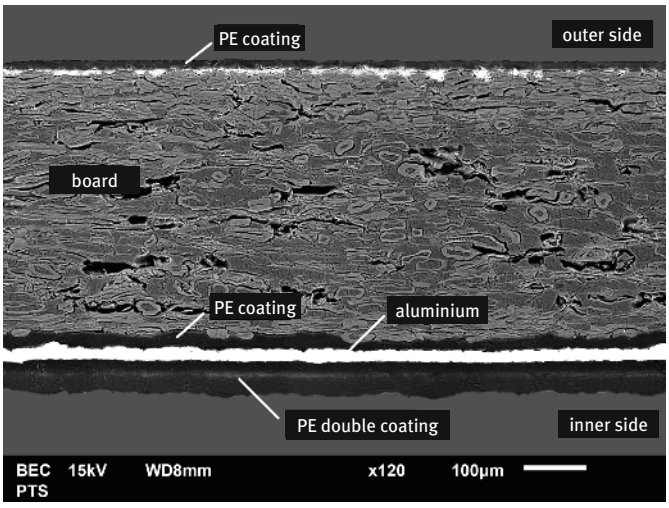

Fig.: SEM cross section of a resin-embedded board packaging for liquid food (120x magnification)

Object/material:
Liquid board containers (LBC)

Description:
Liquid composite board containers were developed at the beginning of the 19th century with the aim to reduce the weight of conventional packaging containers (e.g. glass bottles) and increase the storage life of the packaged product. Also, the intention was to protect perishable substances and ensure better transport efficiencies. Liquid composite board containers have been manufactured to a larger extent in Europe since the middle of the 20th century. Every year, 9 billion packaging containers are sold all over Germany. The single-use packaging containers are composed of several layers in which the primary fibre-based board is the main component accounting for 75 % in addition to plastic material (PE, PP) and aluminium[1]. As well as the aseptic filling process, each of the individual layers forms an effective barrier against external impacts (light, oxygen, liquids, germs) and internal impacts (fruit acids). The base board provides for the necessary shape, stability, processibility and environmental compatibility. The liquid board is governed by stringent food-related regulations, directives, guidelines and recommendations and is almost entirely recyclable in specialised treatment and preparation plants. The fibres recovered from the board are used e.g. for the manufacture of corrugated board base paper and core board. The plastic and aluminium components are used as secondary fuel for the cement production.

Application:
Liquid composite board containers are mainly used to contain fresh milk and extended-shelf-life liquid dairy products (LDP), nonalcoholic non-sparkling beverages (e.g. fruit juice), wine, soups, sauces, vegetables and convenience food.

SEM analysis:
Layer thickness analysis for determining the relationships of the material layers (thickness, uniformity and distribution).

Failure analysis in the coating, the layer structure and in case of adhesion promoter problems. ■

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1 LBCs for fresh products typically have no aluminium layer

Customer-specific development of apparatus

The Digital Optical Measurement and Analysis System – DOMASmultispec – is a modular analysis system for the characterisation of fibre-based products. The system has been well established as a quality control and process monitoring tool in the worldwide market for more than 20 years. It comprises various evaluation modules which are used along the entire value-added chain. The most widespread modules are dirt specks count, stickies analysis, formation measurement and, as a result of current development projects, measurement of polymer impurities by means of NIR (refer to PTS News 2020-01). Further examples for the assessment of printed products are the helio test, the mottling analysis, the missing dots analysis or the evaluation of coverage.

In addition to the analysis modules, the DOMASmultispec provides a high compatibility with various imaging systems. Meanwhile, a broad range of optical measuring systems can be used to generate a digital image of the samples (refer to the picture).

The most common approach is to use professional flat-bed scanners, but cam-

Fig. 1: DOMASmultispec supports a multitude of imaging systems. Its flexible use allows specific solutions to be developed for metrological tasks.

era and microscopic systems can be used, too.

These optical systems for obtaining resultant images are verified and calibrated by PTS according to a specific method. They ensure the comparability of results obtained with different systems.

Most recent systems also use near-infrared cameras and line cameras. Both systems were designed in close cooperation with industrial customers and thus for specific requirements. The use of near-infrared measuring techniques for the analysis of sticky and non-sticky impurities became established in cooperation with Voith Paper and then even standardised as DIN SPEC 6745.

We, PTS, are an expert partner with many years of experience in the development of measuring equipment for the requirements of the paper industry. We offer to conduct feasibility studies allowing concrete solutions to be derived for specific problems or development ideas. ■

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You are interested?
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- Roughness (Bendtsen)
- Air permeability (Bekk)
- Air permeability (Bendtsen)
- Air permeability (Gurley)
- Kappa number
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- Alkali reserve
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Further information can be found at: **cepi-cts@ptspaper.de**

PTS Events 2022: Online & Live

Event	Type	Date	Place
Introduction to Compliance Work and Quality Assurance for Paper and Board in Contact with Food (FCM)	Workshop	01.02.22	Online
Microplastics and Single-Use Plastics Directive (SUPD)- definitions, regulations,analytics, alternatives	Workshop	01.02.22	Online
Recyclability of Paper & Board based Packaging	Workshop	02. - 03.02.22	Online
Surface Functionalization of Paper & Board based Packaging	Workshop	03. - 04.02.22	Online
Papierherstellung im Überblick	Basic course	08. - 09.02.22	Online
Introduction to Compliance Work and Quality Assurance for Paper and Board in Contact with Food (FCM)	Workshop	01.03.22	Dresden
★ Paper & Board for Food Contact	Conference	02. - 03.03.22	Dresden
Introduction to Paper manufacturing	Basic course	15. - 16.03.22	Online
Qualitätskontrolle und -sicherung durch mikroskopische Prüfung von Papier, Fasern & Füllstoffen	Basic course	05. - 06.04.22	Dresden
Recyclinggerechte Gestaltung von faserbasierten Lebensmittelverpackungen	Basic course	13. - 14.04.22	Dresden
★ Altpapier im Fokus – Recovered Paper Conference	Conference	17. - 18.05.22	Dresden & Online
PTS Netzwerktag 2022	intern	31.05.22	Heidenau, Dresden
Materialprüfung von Haftetiketten	Basic course	13. - 14.06.22	Online
Sicheres Kleben bei der Verarbeitung von Papier und Karton	Basic course	07. - 08.06.22	Online
Papier und Karton im Lebensmittelkontakt – Aktuelle Entwicklungen	Workshop	21.06.22	Dresden
Recyclability of Paper & Board based Packaging	Workshop	22. - 23.06.22	Dresden
Surface Functionalization of Paper & Board based Packaging	Workshop	23. - 24.06.22	Dresden
★ Biobased Solutions for Papermaking	Conference	27. - 28.09.22	Dresden
Einführung in die Papiererzeugung – Modul 1: Faserrohstoffe der Papierindustrie, Faserstofferzeugung und -aufbereitung	Basic course	10. - 11.10.22	Dresden
Einführung in die Papiererzeugung – Modul 2: Konstantteil, Papiermaschine, Mess- und Regeltechnik	Basic course	11. - 12.10.22	Dresden
Einführung in die Papiererzeugung – Modul 3: Wirkung und optimaler Einsatz chemischer Additive	Basic course	12. - 13.10.22	Dresden
Einführung in die Papiererzeugung – Modul 4: Streichtechnologie – Von der Dispersion zum fertigen Strich	Basic course	13. - 14.10.22	Dresden
★ PTS Corrugated Board Symposium 2022	Symposium	23. - 24.11.22	Dresden
Auswahl und Bewertung von Altpapier	Advanced course	29. - 30.11.22	Dresden

Registration, information & programme:

www.ptspaper.de/veranstaltungen

Some of the events may become online events, depending on the Corona regulations as revised from time to time.

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PTS Academy: New formats & highlights

PTS Conferences

Our conferences are focused on the wish to gather and present most recent scientific findings as well as experiences and innovations coming from all sectors networking with the paper industry. The conferences give you the opportunity not only to inform yourselves about latest trends but also to expand your network.

PTS Conference „Paper & Board for Food Contact“
02.03.22 - 03.03.22 · Dresden

PTS Fachatgung „Altpapier im Fokus – Recovered Paper conference“ · 17.05.22 - 18.05.22 · Dresden

PTS Conference „Biobased Solutions for papermaking“
27.09.22 - 28.09.22

PTS Insights

The team of PTS have organised a PTS Insight session every month since the end of 2020. PTS Insight is a one to two-hourlong online session where PTS experts present current research topics, projects and methods and are available for questions by participants. This format is intended for you and us to exchange views in order to encourage innovations and project ideas. The PTS Insight sessions are free of charge.

FEM in der VAT – Materialparametrisierung per Krümmungswiderstandsmessung
25.11.21 · Online

For a list of current events please visit www.ptspaper.de/veranstaltungen.

PTS Corrugated Board Symposium 2022
Dresden – 23.11. bis 24.11.2022

The PTS Corrugated Board Symposium 2022 offers a platform for the exchange of knowledge and experience regarding the manufacture and processing of corrugated board for packaging, construction and specialised applications. Attendants are comprehensively informed about the state of the art, innovations across industries, future trends and political market aspects.

PTS eLearning Plattform “Papermaking at a glance”

Formats of learning are versatile. In future, PTS will hold their “Papermaking at a glance” seminars and “Introduction to papermaking” training modules, in parallel with face-to-face training sessions in Heidenau, also on a blended learning eLearning platform for flexible learning schemes following the time resources of the participants. Each of the teaching units will be divided into 5 to 10-minute modules and will include interactive elements striving for eureka moments.

Innovative topics and discussions at the 30th PTS Coating Symposium 2021

After the symposium is before the symposium – and so the preparations for this year's edition of the coating symposium started as early as at the end of 2019. Since it would be the anniversary edition and there was huge international response, the symposium was planned to be entirely held in the English language. We had hoped for an improvement of the pandemic situation and for being able to welcome our guests in person, but unfortunately this hope did not come true so that we decided in spring 2021 to take all steps necessary to organise a successful online symposium.

On 07/09 and 08/09/2021, Ina Greiffenberg (functional coatings project leader) and Dr. Marcel Haft (functional coatings line manager) moderated the programme of the 30th PTS Coating Symposium 2021 under the headline „Functional coatings for fibre based packaging".

During two course of two days, the attendants and participants were given the opportunity to follow 16 interesting presentations and take an active part in the discussions during the Questions & Answers sessions. The programme was divided into 5 sessions which were presented to the attendants by means of video sequences.

After the welcoming address of the hosts, new trends in "Application techniques" for coatings were explained. Dr Mohammed Krouit from the Centre Technique du papier (CTP) was the first speaker presenting the chromatogeny method. Then, Tom Larsson (UMV Coating Systems) gave a paper on "direct application" for strength and barrier improvements, followed by Dr. Janet Preston (Imerys) who emphasised the significance of the base coat for the performance of the top coat. Eventually, Henri Vaittinen from Valmet Technologies enlightened the audience on the effect of "hard nip sizing with spray and curtain application" before Andrea Glawe from Kroenert discussed coating and lamination processes under the aspect of sustainability.

There is a great interest in new biobased materials for battery coatings within the sector as could be seen from the vivid response to the second session entitled "new barrier feedstocks". Pieter Samyn (SIRRIS Smart Coatings Lab) introduced polyhydroxyalkanoates as potent barrier materials, Dr. Samir Kopacic (TU Graz) presented new results of biobased barriers and how to increase their performance, and Tilman Bauer (Bauer Verfahrenstechnik) showed a way of enzymatic modification of native starch to prepare it for its use e.g. as a co-binder.

The first speakers on the second day were Vesa Kukkamo (ACA Systems) and Kimmo Huhtala (CH Polymers) with their paper on rheology control in the "Analytics and Process" session.

Then, Marcus Stein (Watttron) showed ways of how to use accurately controllable and configurable heater elements for sealing and drying papers with appropriate coatings. Eventually, Dr. Sabine Genest (PTS) presented research findings from ageing tests carried out on paper coatings.

In the second half of the day, Tom Larson (FibreLean Technologies) inspired the audience with his presentation on microfibrillated cellulose as a barrier material, and Janja Juhant Grkman (Pulp and Paper Institute) showed ways of how to use nanocrystalline cellulose in barrier coatings.

The final session entitled "Closing the loop" was dedicated to sustainability and Recycling. Phil Greenall and Sabina di Risio (EcoSynthetix) shows ways of how to make product designs more sustainable before Mari Ojanen (Kemira) presented new findings from repulping dispersion-coated papers.

Altogether 150 symposium attendants seized the opportunity to inform themselves on new developments and exciting topics.

We hope to welcome our guests again in 2023, preferably in person, and are

looking forward to another multifaceted lecture programme combined and enriched with networking opportunities. ■

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Online workshops on microplastics and single-use plastic items (SUPD) are very popular

The Green Deal of the European Commission has very ambitious environment goals including but not limited to less plastic waste in our environment and less intentionally added plastic materials in the form of microplastics. The latter is also known as primary microplastics. However, small plastic fragments that result from the gradual breakdown of larger plastic items due to mechanical stress and UV light are referred to as secondary microplastics. Both contamination sources are intended to be largely reduced at EU level. One instrument for this purpose is the existing Single Use Plastic Directive (SUPD) which we have already covered in detail in the PTS News issue 1/2021. Secondly, a limitation proposal made by the European Chemicals Agency in January 2019 is currently being discussed within the scope of the Regulation (EC) 1907/2006 (REACH) for the marketing of primary microplastics. Details on the current state of the procedure and consultations are available on the ECHA website. According to ECHA, the proposal is designed to avoid a release of 500,000 tons of microplastics over a period of 20 years. The paper industry also uses materials that would be classified as "microplastics" according to the currently discussed definition, e.g. in the form of synthetic polymer fibres. Also the Single Use Plastics Directive and the national German single-use plastic ban and identification regulations in force since July 2021 comprise plastic coatings on paper packaging items. So the new statutory rules have caused quite some uncertainty within the paper industry. PTS organises a new online workshop in order to clarify and explain in detail what the consequences of the two EU-level legal instruments are for the paper industry, which grey areas do exist and need clarification and which alternatives are conceivable for the design of the materials. Apart from the legal regulations, the experts of PTS also provide insight into analytical possibilities for the determination of microplastics and the layer structure of paper products. The two courses in June and August were each time fully booked. Therefore, the course was offered once more in October as an additional course combined with the workshop on the design of food-grade recyclable packaging – again with very good level of attendance. The subject areas remain exciting and so PTS will continue to follow very closely the trends and developments also in the future in order to keep their customers best informed. ■

Next event on 01/02/2022:
PTS Online Workshop
"Microplastics and Single-Use Plastics Directive (SUPD) – definitions, regulations, analytics, alternatives"

Registration at:
www.ptspaper.de/veranstaltungen

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