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ELECTRON BEAM AND PLASMA TECHNOLOGY FEP

pro flex 2017

ROLL-TO-ROLL COATING OF FLEXIBLE MATERIALS

PROGRAM BOOKLET

FOCUS 2017: TECHNOLOGY SCALE UP

NOVEMBER 27–28, 2017

DRESDEN, GERMANY

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WELCOME!

Roll-to-roll processing and coating of flexible materials is a growing industry with a wide variety of important industrial products.

The different talks of **pro flex 2017** present this variety and the broad range of applications of roll-to-roll technologies. Our program is framed by two talks that highlight very interesting and even visionary applications of flexible materials: architecture and OLED lighting. Between these two talks nearly every aspect of roll-to-roll technology is covered. The program is complemented by many possibilities for discussions and networking as well as a lab tour on the second day.

At **pro flex 2017** you will meet equipment suppliers, film manufacturers, users of roll-to-roll equipment, converters, end-users of flexible materials as well as R&D institutions. Use this unique chance to start or strengthen scientific and business collaboration in the field of roll-to-roll coating of flexible materials. You may appreciate both the face-to-face atmosphere of a workshop with up-to-date presentations and the flair of an international conference.

We, at Fraunhofer FEP, are dedicated to make the **pro flex 2017** worthwhile to the audience and presenters. Our special thanks goes out to our sponsors and exhibitors who contribute to the success of **pro flex 2017**.

We are very pleased to welcome you to this event and wish you an interesting conference.

Sincerely,

Nicolas Schiller
Program Chair

Annett Arnold
Conference Management

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PROGRAM

DAY 1 | MONDAY, NOVEMBER 27

11:30 **Welcome Reception / Lunch**

sponsored by FHR

12:30 **Welcome Adress**
Dr. Nicolas Schiller, Fraunhofer FEP

Session Chair: Anika Himmler

12:35 **Innovative application of ETFE films in architecture**
Prof. Dr. Jan Cremers, Hochschule für Technik Stuttgart

12:55 **R2R processing of flexible glass substrates**
Sue C. Lewis, Corning Incorporated

13:15 **Ultra-Clean and High Performance Substrates for Large Area Flexible Electronics**
Valentijn von Morgen, DuPont Teijin Films Ltd., UK

13:35 **Roll-to-roll Nanoimprint Lithography Patterning of Polymer surfaces and using it for patterned electrodes**
Dr. Barbara Stadlober, Joanneum Research Graz

13:55 **Direct laser ablation of nanoparticle-filled polymers for microstructured print and replication master surfaces**
Dr. Ulrike Helmstedt, Leibniz-Institut für Oberflächenmodifizierung

14:15 **Coffee Break**

sponsored by VON ARDENNE

Session Chair: Michiel Top

15:00 **All-in-one Roll-to-Roll solution producing flexible devices via additive printing and laser technology**
Chris Riedel, 3D-Micromac AG

15:20 **High-performance silver interconnects prepared on thin and ultrathin flexible substrates by inkjet-printing and laser treatment**
Dr. Marco Fritsch, Fraunhofer IKTS

15:40 **R2R production of anisotropic conductive polymer films**
Dr. Henrik Hemmen, Condalign AS

16:00 **Industrial scale production of low cost, transparent, low resistance (1 Ohm/sq) flexible electrode**
Alexey Dolbunov, FunNano USA Inc.

16:20 **Atmospheric Pressure SDBD plasma treatment for printed electronics applications**
Prof. Drs. C.I.M.A. Spee, Maan Research & Development B.V.

16:40 **Resource and Energy Efficient Coating of Flexible Substrates by Roll-to-Roll Atomic Layer Deposition at Atmospheric Pressure**
Dieter Bauer, Fraunhofer IVV

17:00 **Upscaling Roll-To-Roll Atomic Layer Deposition to Production**
Dr. Dana Borsa, Meyer Burger (Netherlands) B.V.

17:20 **Roll-to-roll deposition of high performance gas diffusion barriers on polymers using a new atmospheric plasma technology platform**
Sergey Starostin, FUJIFILM Manufacturing Europe B.V.

17:40 **Closing Remarks**
Dr. Nicolas Schiller, Fraunhofer FEP

17:50 **Dinner Party**
Take part in our evening event!
Our highlights:
Dinner buffet sponsored by AIMCAL
German beer corner sponsored by PST

... and also:
Music, Networking space, Bonfire

22:00 **End**

DAY 2 | TUESDAY, NOVEMBER 28

Session Chair: Dr. Matthias Fahland

09:00 **Electronic or smart fabrics - considerations for scale-up**
Dr. Charles A. Bishop

09:20 **Compact Roll-2-Roll multipurpose coating system for DC, quasi-DC and AC sputtering**
Thomas Niederhausen, VON ARDENNE GmbH

09:40 **Application of Bipolar Pulsed Magnetron Sputtering and Bipolar High Power Impulse Magnetron Sputtering for functional coating deposition on flexible substrates**
Dr. Ioana Luciu, TRUMPF Huettinger

10:00 **Coffee Break**

sponsored by VON ARDENNE

Session Chair: Dr. John Fahlteich

10:30 **The exceptional performance of the Cascade Coater**
Moritz Graf zu Eulenburg, InovisCoat GmbH

10:50 **Intermittent Slot die coating**
Dr. Klaus Crone, Coatema Coating Machinery GmbH

11:10 **Improving the Performance of Ceramic Barrier Layers used in Packaging Materials**
Dr. Roland Trassl, Applied Materials, Inc.

11:30 **Flexible Packaging: Ressource Effeciency and Recyclebility**
Prof. Dr. Achim Grefenstein, Constantia Flexibles Germany GmbH

11:50 **Advanced R2R Metallizing For Flexible Packaging & Security**
Prof. Nadir Ahmed, Idvac Ltd.

12:10 **Lunch Buffet**

	Session Chair: Dr. Steffen Günther
13:10	**Project News on SmartEEs (Sustainable marketplace for the adoption, ramp-up and transfer of Emerging Electronics solutions)** Dr. Stéphane Cros, CEA Grenoble
13:15	**Flexible protected metallized polymeric reflector for use in „Heliotube"-solar – thermal energy conversion plants** Dr. Roland Thielsch, Southwall Europe GmbH, a subsidiary of Eastman Chemical Company
13:35	**Encapsulation technology for OLED or OPV modules** Dr. Mikihiro Kashio, Lintec Corporation
13:55	**High-Volume Solution Processed OLEDs Using a Roll-to-Roll Pilot Coating Line** Harrie Gorter, Holst Centre
14:15	**Market introduction of a bendable OLED on thin glass and industrial challenges of R2R OLED manufacturing** Dr. Wolfgang Dötter, OLED Works
14:35	**Challenges in the Design and Manufacture of OLED Lighting** Dr. Norman Bardsley, Bardsley Consulting
14:55	**Closing Remarks** Dr. Nicolas Schiller, Fraunhofer FEP
15:05	**Laboratory Tour** **Join our laboratory tour and take a look at our state-of-the-art coating equipment, featuring:** *novoFlex® 600, coFlex® 600,* atmoFlex 1250 FOSA LabX 330 Glass (Cooperated with VON ARDENNE GmbH) ILA 900, MAXI, OLED R2R Line
16:35	**End**

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Flat and flexible materials like float glass, plastic film and sheet, thin metallic foil, flexible ultra-thin glass, and membranes: The goal of our work is to provide the surfaces of these materials with custom-designed functionality.

We are continuously expanding the palette of substrate materials we work with and the coating technologies we use, thereby moving into new application areas.

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ABSTRACTS

Prof. Dr. Jan Cremers | Abstract 01 **November 27, 12:35**
Hochschule für Technik Stuttgart [DEU]

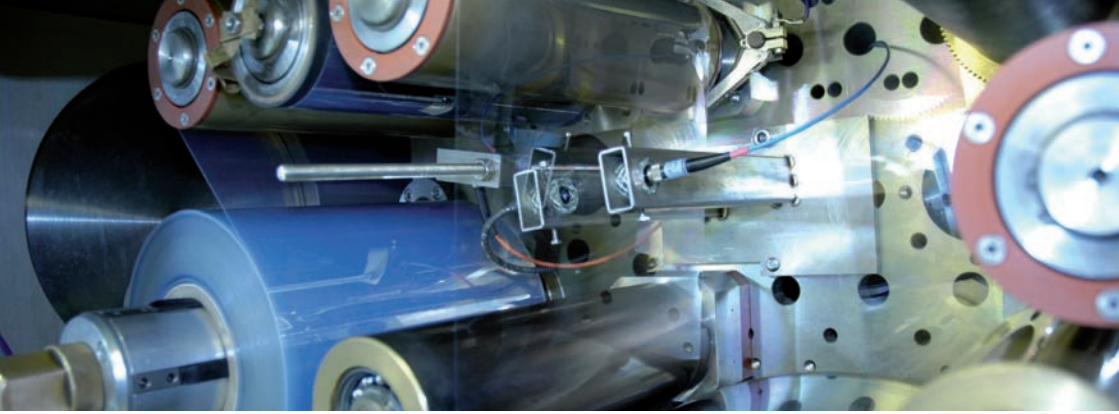
Innovative application of ETFE films in architecture

Besides glass, a variety of other transparent materials are just as highly attractive to architects: plastics, perforated metal plate and meshing, but maybe most of all membrane materials which can also withstand structural loads. Earlier applications of those soft materials have served the purpose to keep off the sun, wind, rain and snow while offering the advantage of enormous span widths and a great variety of shapes. The development of high performance films such as ETFE were milestones in the search for appropriate materials for the building envelope. The variety of projects that offer vastly different type and scale shows the enormous potential of these innovative building materials.

Sue C. Lewis | Abstract 02 **November 27, 12:55**
Corning Incorporated [USA]

R2R processing of flexible glass substrates

Glass is a preferred substrate for electronic devices because it provides thermo-mechanical stability at high temperature, transparency and the best barrier property in a transparent material. Ultra-thin flexible glass provides all those same benefits while enabling use in roll-to-roll (R2R) processes and the ability to deliver products that may be flexible. Corning® Willow® Glass is 100-200 µm thick glass that is flexible and available in spool form to be used in R2R processing. In this paper, we will highlight the advantages of this glass over other flexible substrates, discuss demonstrations of R2R devices on the glass, and the processes to scale up these technologies for manufacturing.



Valentijn von Morgen | Abstract 03 **November 27, 13:15**

DuPont Teijin Films Ltd. [GBR]

Ultra-Clean and High Performance Substrates for Large Area Flexible Electronics

DuPont Teijin Films (DTF) is recognised as the technology leader in flexible substrates for flexible electronics and PV and DTF continues to work with the community to tailor films to meet cost and performance targets.

Since DTF emerged on the flexible electronics scene good progress has been made with development of new products and enhanced properties for dimensional stability, UV absorption, thermoformability, flame retardancy, light outcoupling, low haze, clear, low iridescence and defect free surfaces.

This talk will share the journey DTF will focus on the recent breakthroughs it has made allowing the manufacture of ultra clean, scratch free and smooth surfaces needed for flawless coating of fine structures or deposition of thin layers directly on a PET surface. This is proving an enabling step for developments such as printed electronic devices with high resolution or the reel-to-reel manufacture of high performing mono barrier substrates.

Dr. Barbara Stadlober | Abstract 04 **November 27, 13:35**
Joanneum Research Graz [AUT]

Roll-to-roll Nanoimprint Lithography Patterning of Polymer surfaces and using it for patterned electrodes

R2R-nanoimprint lithography has proven as a very powerful tool to realize hierarchical structures on large areas of flexible substrates at medium to high throughput. Such roller-imprinted microstructures with nanoscale features are essential for many applications based on biomimicry and fluid dynamics. Accordingly, the drag resistance of objects moving fast in fluids can be controlled by hierarchical structures on flexible substrates attached to their surfaces and on the other hand the wettability of fluids on hierarchically patterned surfaces can be tuned from superhydrophobic to spontaneous wettability. The latter is a property that can be exploited for ink and fluid transport, microfluidics, and multilevel patterning.

This paper introduces R2R-UV-Nanoimprint Lithography for the combined micro- and nanopatterning of proprietary UV-curable liquid resist layers thus aiming for the creation of large-area film surfaces with controlled wettability. We demonstrate the fast and reliable fabrication of microfluidic devices for lab-on-chip devices and embedded metal patterns and verify our results by simulation and quantitative measurements of the fluid dynamics. In addition, large scale fabrication of freeform microoptics will be presented as well as a discussion of the long-term stability of the R2R-UV-NIL process w.r.t. durability of the applied polymer and Ni stamps and of the resist materials. Finally, new findings about pattern reproduction fidelity and UV-induced polymer shrinkage in thiol-ene imprint resist systems will be presented both for flat and roller-based imprinting. The paper is supported by the H2020 project R2R Biofluidics under the Award No. 646260 and by the national FFG project MoMiFlu@Foil (No. 844726).

Dr. Ulrike Helmstedt | Abstract 05 **November 27, 13:55**
Leibniz-Institut für Oberflächenmodifizierung [DEU]

Direct laser ablation of nanoparticle-filled polymers for microstructured print and replication master surfaces

Rotogravure printing is a high-resolution easy-to-handle printing process. It is suited for a wide range of fluid media and substrates to be print. Nevertheless the technology suffers from long pre-press times. These result on one hand from a galvanic multi-stage process for preparation of the printing surface and from the post-treatment of engraved surfaces necessary after laser ablation processes in metal.

We investigated the technological scalability of an alternative technology to provide solutions: To substitute the toxic and time-consuming galvanic print form production UV-curable acrylate based coatings are applied as alternative engraving layer. Nanoparticles are embedded within the polymeric matrix by covalent anchoring. The coating material thus shows appropriate hardness, as well as scratch- and solvent resistance for the printing process. It can be adapted for various applications by the appropriate choice of nanoscale fillers and polymeric matrices available on the market. Different laser ablation mechanisms can be used to design the laser engraving concerning process time and required resolution. Quality control of the engraving process is provided by smartWLI-Technology, a white light interferometric 3D-topographic measurement system. Thus, adaptable polymeric surfaces in combination with sharp-outlined printing structures in high-resolution might offer possibilities to open up new markets for a traditional technology.

Chris Riedel | Abstract 06 **November 27, 15:00**
3D-Micromac AG [DEU]

All-in-one Roll-to-Roll solution producing flexible devices via additive printing and laser technology

The technical process transfer from small-scale laboratory Inkjet printing to industrial production has become a main issue of debate for printed electronics in the last decade. This paper briefly discusses the challenges when up-scaling an Inkjet device from a Sheet-to-Sheet (S2S) test stand into a Roll-to-Roll (R2R) machine processing a copper nanoparticle ink and sintering the patterns with an inline laser system.

Dr. Marco Fritsch | Abstract 07 **November 27, 15:20**

Fraunhofer IKTS [DEU]

High-performance silver interconnects prepared on thin and ultrathin flexible substrates by inkjet-printing and laser treatment

Inkjet printing and millisecond diode laser processing enabled silver contacts with a low electrical resistivity (3x of bulk) on flexible substrates with thicknesses down to 2.5 µm. The interconnects were used for contacting large area arrays of magnetic field sensors. Electrical, structural and mechanical properties of the samples were studied.

Dr. Henrik Hemmen | Abstract 08 **November 27, 15:40**
Condalign AS [DEU]

R2R production of anisotropic conductive polymer films

CondAlign develops a unique technology that uses electric fields to align and structure particles in polymer matrices. The alignment is due to dielectrophoresis and induced dipole-dipole interactions, allowing a wide range of particles and matrices to be used. The particle chains are locked when the matrix is cured, enabling the production of advanced films with a wide variety of end-product features. An example application is the production of electrically conductive materials at filling fractions well below the percolation threshold, which can lower costs, improve polymer properties and enhance the functionality. The anisotropic thermal and electrical properties of the films can be optimized by both the polymer formulation and the processing condition. CondAlign has demonstrated production on a custom made in-house pilot R2R. A licence agreement for use of the technology in biomedical electrodes has been signed, with full scale R2R production expected to start in 2018.

Alexey Dolbunov | Abstract 09 **November 27, 16:00**
FunNano USA Inc. [USA]

Industrial scale production of low cost, transparent, low resistance (1 Ohm/sq) flexible electrode

Overview of FunNano electrodes: roll-to-roll process, low cost, transparent (90-95% w/o substrate), and low resistance (from 0,2 Ohm/sq in lab and from 1 Ohm/sq in R2R) flexible film with metal mesh of different metals.

Production technology:
- Main characteristics (PET substrate, roll-to-roll 2m/min, width 320 mm)
- Main production stages
- Different metals
- CNT interface

Main applications:
- Touchscreens
- OLED / OPV
- Heating

Prof. Drs. C.I.M.A. Spee | Abstract 10 **November 27, 16:20**
Maan Research & Development B.V. [NLD]

Atmospheric Pressure SDBD plasma treatment for printed electronics applications

In this paper we will describe the SDBD technology, show its advantages, and will give results on the plasma treatment of a range of foil materials, and most importantly the treatment of ITO coated PET for printed electronics applications, where contact angles below 10° are accomplished when treated in nitrogen or carbon dioxide gas, resulting in very homogeneous coatings deposited by slot-die coating on top of the treated ITO.

Dieter Bauer | Abstract 11 **November 27, 16:40**
Fraunhofer IVV [DEU]

Resource and Energy Efficient Coating of Flexible Substrates by Roll-to-Roll Atomic Layer Deposition at Atmospheric Pressure

Atomic layer deposition (ALD) is known as a technology which is superior to other coating methods in view of layer quality, homogeneity, conformity and thickness control. The conventional ALD processing is done on single sheets in vacuum chambers at low pressures (typically several hPa) using time-consuming reaction sequences. In recent years, however, a variant called "spatial ALD" has been developed, which can be performed at atmospheric pressure. Even more importantly, it is about a factor of ten to hundred faster in terms of layer growth rate compared to the conventional ALD technique and suitable for roll-to-roll processing. As a consequence, significant increase in throughput and reduction of energy consumption can be achieved. Different designs of roll-to-roll reactors have been developed which make use of this principle. At Fraunhofer IVV, a unique experimental roll-to-roll ALD coating line has been installed, which differs from the other solutions in a number of details. As a result, very low precursor and gas consumption can be realized, leading to reduced production costs. The presentation will give an insight in the design of the setup and discuss challenges and opportunities. Also, recent results obtained with this equipment will be shown.

Dr. Dana Borsa | Abstract 12 **November 27, 17:00**

Meyer Burger (Netherlands) B.V. [NLD]

Upscaling Roll-To-Roll Atomic Layer Deposition to Production

For flexible devices and their market introduction, high rate spatial atomic layer deposition (sALD) offers a unique opportunity: it combines high quality materials with competitive costs and high throughput. At Meyer Burger (Netherlands) B.V. we have paved the road to sALD mass production of flexible devices with the introduction of the FLEx R2R sALD, a fully modular platform, which integrates a sALD coating step with pre-and-post sALD steps (eg. surface treatment and activation, planarization, protective layers). The design of the R2R platform allows for a throughput of over 40 m^2/hour of uniform, 20 nm AlOx coating on 125 micron PET foil, high quality moisture barriers.

Additionally, for the deposition of functional layers on flexible substrates also conventional PECVD is of interest for various applications and we have introduced it on the market under the name FLEx R2R PECVD. Similar to the FLEx R2R sALD, this platform is fully modular and integrates multiple PECVD coating steps with pre-and post PECVD steps (eg. surface pre-conditioning or functionalization). Moreover, deposition is dual-sided and transport of foil can be non-contact throughout the whole system. Throughput of over 100 m2/hour of uniform, defect free Si-based films on metal foil is feasible.

A detailed introduction of the R2R platforms and the performance of our functional foils as well as a brief discussion on the scalability will be presented.

Sergey Starostin | Abstract 13 **November 27, 17:20**
FUJIFILM Manufacturing Europe B.V. [NLD]

Roll-to-roll deposition of high performance gas diffusion barriers on polymers using a new atmospheric plasma technology platform

Atmospheric pressure PECVD offers multiple advantages including costs reduction of the process, relatively straightforward dimensional scaling and possibility of in-line roll-to-roll production. However, tuning of plasma properties, while sustaining stability and uniformity of the gas discharge, represents both scientific and technological challenge. A technological breakthrough should be accomplished when stepping from common in-line application of atmospheric pressure plasma i.e. corona treatment towards synthesis of high quality films such as gas diffusion barriers.

In present contribution we will highlight several important aspects of the atmospheric pressure roll- to-roll PECVD process. This includes creation of the uniform plasma and gas discharge evolution at nanosecond time scale; dynamics of the thin film growth on the polymeric substrate, film roughness development; non uniform deposition rate profile within PECVD reactor. Application of the Yasuda scaling parameter concept to deposition of the inorganic gas diffusion barrier film will be also discussed.

Dr. Charles A. Bishop | Abstract 14 **November 28, 09:00**
C.A.Bishop Consulting Ltd. [USA]

Electronic or smart fabrics - considerations for scale-up

Electronic or smart fabrics covers a huge range of possible applications from fabrics that can generate and collect power, sensor fabrics that can be used for clothing that monitors heart rate, breathing rate, perspiration level and temperature, simple circuit fabrics that can be used for everything from switching to computing as well as fabrics that can produce light for safety or purely decorative purposes.

Producing a conducting fibre or fabric based on a highly flexible transparent conducting could be provide a large volume universal base material for a variety of different devices from piezoelectric, triboelectric or thermoelectric generators as well as photovoltaic devices.

The complexity of the construction of the fabrics will largely depend on the final application. A number of applications will require a conducting fabric as the starting point and this can be achieved in many different ways. Coating a roll of fabric has the attraction of producing a large area quickly. However, if the final application requires the fabric to be converted such as by cutting and stitching there needs to be the ability to bare the conducting layer and make robust connections.

The differences between coating the starting fibres or coating the final fabric will be considered.

Thomas Niederhausen | Abstract 15 **November 28, 09:20**

VON ARDENNE GmbH [DEU]

Compact Roll-2-Roll multipurpose coating system for DC, quasi-DC and AC sputtering

Today's large scale roll-to-roll coaters provide a productivity that may exceed the demand for a single product. The capability to run multiple layer stack systems for different products and applications on a coater without large efforts for reconfiguration is desired. To deposit either dielectric materials with reactive sputtering or either metals or with the same magnetron setup, new methods like bipolar power supplies offer new opportunities: reduced substrate-heat-load substrate with best the layer properties and superior process performance due to fast arc-handling [1]. The obtained results for deposited films of metals, TCO's and oxides in the Lab-scale can approve the concept of compact, anode less magnetrons for AC-MF and quasi-DC mode for roll-coaters, which is the basis of the new FOSA CX and MX design. We will finally present results from such a FOSA CX system dedicated to low-e films, combining high productivity, flexibility and superior layer uniformity, with combines Magnetrons with DC and AC, and quasi-DC technique.

[1] F. Benecke, T. Niederhausen, and H. Proehl, 60th Annual Society of Vacuum Coaters Technical Conference (SVC TechCon 2017)

Wojciech Gajewski | Abstract 16 **November 28, 09:40**
TRUMPF Huettinger [DEU]

Application of Bipolar Pulsed Magnetron Sputtering and Bipolar High Power Impulse Magnetron Sputtering for functional coating deposition on flexible substrates

Pulsed bipolar magnetron sputtering is a recognized method used for various industrial plasma processing. In the form of physical vapor deposition (PVD) it is applied for deposition of protective, decorative, anti-reflective and optical coatings. In the photovoltaic cell production it is commonly used in low frequency Plasma Enhanced Chemical Vapor Deposition (PECVD) processes to deposit Si-based passivation layers.

This contribution will focus on the application of the bipolar pulsing methods for deposition of functional coatings and plasma activation on flexible substrates.
The discussion will be opened with the analysis of operation parameters influence on the temperature load to the plastic substrates. First the effect of waveform shape modification will be compared in a frequency range from 10 to 100 kHz. The discussion will be followed by the influence analysis of synchronization of bipolar magnetron sputtering generator with bias source on the temperature profile of Ti-based functional coating deposition on aluminum items with embedded plastic parts.
As next, the comparison of the efficiency of PET (polyethylene terephthalate) polymeric foil activation in a metalizer system by standard sine AC waveform and different shapes of bipolar waveforms will be provided. The discussion will be focused on the effect of higher average power applicable with bipolar generator on the aluminum film adhesion on PET foil.

The paper will be summarized with the analysis of brass coating deposition by the bipolar High Power Impulse Magnetron Sputtering (HIPIMS) method on non-woven yarn. Coated yarn prepared with target power density up to 400 W/cm^2 demonstrating the sheet resistance down to 90 Ω/☐ will be used to discuss the potential of HIPIMS method for the future industrial production of conductive textiles.

Moritz Graf zu Eulenburg | Abstract 17 **November 28, 10:30**
InovisCoat GmbH [DEU]

The exceptional performance of the Cascade Coater

The demands of current and future products and materials are continuously increasing. Functions are to be improved dramatically with the simultaneous desire to be more economical and environmentally beneficial. To meet these requirements more effectively, enormous investment has been made in micro- and nanotechnology. Up to date, the application of chemical solutions including nanoparticles has been established for single, individual layers quite well.

Depending on application requirements, one or even more appropriate coating units have to be selected. InovisCoat, as a spin-off of AGFA Leverkusen, is specialized in multilayer-coating, which is typical for the photographic field. The coating process we use is Cascade Coating.

Dr. Klaus Crone | Abstract 18 **November 28, 10:50**
Coatema Coating Machinery GmbH [DEU]

Intermittent Slot Die Coating

Slot dies are originally designed to create homogeneous, endless, full area coatings. Any patterning was not intended.Aside from homogeneity there are some other advantages of slot dies, e.g. the intrinsic dosability and the complete enclosure of the whole system. Meanwhile in many applications one wants to keep those advantages but nevertheless enable the slot die to create downweb or crossweb patterning.

While downweb stripes are rather simple to be made by appropriate masking, crossweb stripes are much more complicated because they require a frequent and fast start and stop of the coating process, the so called intermittent coating. There are several different methods to achieve intermittent coating, which more or less work well as long as the viscosity of the coating liquid is rather high. Good examples are battery pastes. But as soon as the viscosity becomes very low (even lower than water), all those current methods fail insofar as they do not create straight, well defined edges.

Coatema in Germany and Holst Center in the Netherlands now present two new slot die designs, which provide well defined straight edges in intermittent coating even at very low viscosity.

Dr. Roland Trassl | Abstract 19 **November 28, 11:10**
Applied Materials, Inc. [USA]

Improving the Performance of Ceramic Barrier Layers used in Packaging Materials

Vacuum deposition of thin film gas diffusion barrier layers have been in high volume production for over 60 years in the food packaging industry. This has typically involved the high rate evaporation of thin Aluminum layers onto PET, polypropylene or polylactic acid based substrate materials. However, transparent barriers are also required for applications where product viewing, X-ray screening & microwaveability are of importance. Materials such as SiOx & AlOx are therefore often used but are often difficult to deposit either with the required optical transparency & barrier performance in the case of SiOx or with sufficient mechanical resilience in the case of AlOx. Recent AlOx performance advances have been made through the use of a high plasma density assisted co-oxidation process together with conventional thermal evaporation of Aluminum. This technology has resulted in a near 20% increase in layer density, a doubling in layer hardness & a near twofold improvement in WVTR performance compared with simple reactive AlOx deposition. A further benefit can be found in terms of increased strain to failure mechanical resistance prior to barrier degradation increasing process yield in downstream lamination lines. This paper will summarize these recent advances & provide insight into the technology implementation in the Al replacement barrier market.

Prof. Dr. Achim Grefenstein | Abstract 20 **November 28, 11:30**
Constantia Flexibles Germany GmbH [DEU]

Flexible Packaging: Ressource Effeciency and Recyclebility

Plastics in packaging are subject of the actual environmental discussion, last, but not-least also because of the emotional topic of marine litter. The environmental benefit of Flexible packaging, due to its resource efficiency is often not recognized. The paper describes the actual state of international initiatives to strengthen the circular economy and possibilities to increase the recycling rates. Actual developments are packaging for food and health- & personal care applications, without aluminum as barrier material and made of compatible polymers of the same material group. Another development allows to reduce the weight of the polyolefinic sealing layers by up-to 30%.

Prof. Nadir Ahmed | Abstract 21 **November 28, 11:50**
Idvac Ltd. [GBR]

Advanced R2R Metallizing For Flexible Packaging & Security

In vacuum metallizing business it is known that standard R2R metallizer mainly have the capability of metallizing various polymeric films with aluminium. However, as the market of aluminium metallized films become more mature and competitive there are always opportunities to utilize the capability of the conventional R2R metallizers for other niche products. Idvac ltd. has developed a range of innovative products that can be used for packaging, security, solar window films and pharmaceutical products. Such new products can be produced inside a standard R2R metallizer with minimum modification and without hampering the capability of the metallizer for aluminium metallizing. Idvac has been successful in technology transfer of new products from R&D into large scale industrial product. This represents a real challenge for the emerging areas where new materials and processes are required for special products.

In this presentation, Idvac will outline some of its niche products that have been done inside a standard R2R metallizer.

Dr. Roland Thielsch | Abstract 22 **November 28, 13:15**
Southwall Europe GmbH, a subsidiary of Eastman Chemical Company [DEU]

Flexible protected metallized polymeric reflector for use in „Heliotube"- solar – thermal energy conversion plants

The Heliotube power plant concept is a modular system to build decentralized power plants for use of solar energy to generate process heat and / or electricity by solar thermal energy conversion. The core components - the solar concentrator and the solar radiation absorber - are in a semi-protected environment inside a highly transparent, pressurized polymeric tube which is relative light weight and easy to transport and to assemble even in rural areas.

The system makes use of a high reflecting silver mirror sputter coated R2R onto a flexible polymeric film as a wide width solar concentrator. Even, the mirror is used in a semi-protected environment inside the pressurized tube long time functionality only can guaranteed with anti-corrosive and radiation stable measures since Ag is known to easily react with various gases especially under energetic radiation. Therefore, various technical options such as lamination with protective films and protective layer wet coating with a set of different coating formulations have been tested to find an optimal solution for corrosion protection in combination with solar irradiation stability. The paper introduces into the Heliotube concept and provides results on corrosion and solar radiation stability of various protective systems on a front surface Ag reflector.

Dr. Tatsuya Izumi | Abstract 23 **November 28, 13:35**

Lintec Corporation [JPN]

Encapsulation technology for OLED or OPV modules

Recently, flexible electronic devices have been studied with large intention for implementing bendable, fordable, and wearable devices.

Because electric devices such as OLED and OPV are easily degraded by water, they should be encapsulated to avoid water penetration. Conventional encapsulation technology is based on glass materials due to its high barrier property. However, to achieve flexibility, encapsulation technology should be changed from conventional glass based encapsulation to sheet encapsulation.

For sheet encapsulation, gas barrier films and encapsulate adhesive are needed. When normal plastic films are utilized as gas barrier films, gradual deterioration of active parts and electrodes occur because of their poor barrier property. In order to add barrier properties with plastic films, thin inorganic layers such as silicon dioxide and aluminum oxide are fabricated onto plastic surface by sputtering, CVD (chemical vapor deposition) and so on. In this study, we'll discuss about our original gas barrier film (GBF) with fewer number of layers and lower defects prepared by wet-coating and plasma surface modification technologies. Besides, we'll also discuss about thermal curable adhesive for encapsulate GBF and devices. The adhesive has not only gas barrier property but also high adhesion to prevent water penetration from edge or boundary between adhesive and active devices. The details will be discussed.

Harrie Gorter | Abstract 24 **November 28, 13:55**
Holst Centre [NLD]

High-Volume Solution Processed OLEDs Using a Roll-to-Roll Pilot Coating Line

Through the past decades, OLED production technology has made impressive progress which has resulted in devices with high efficiency, long operational lifetimes and an improved form factor. OLED panels, both rigid and flexible, are now commercially available and increasingly find applications in product design. The current status of industrial production processes is, however, still largely restricted to sheet-to-sheet and vacuum based technologies. A promising alternative approach is the roll-to-roll solution deposition of OLED materials on flexible substrates. It has the potential to increase the manufacturing scale to high-throughput, large area and high-volume production at reduced overall process costs.

This contribution will introduce a roll-to-roll pilot production line which allows the contact-free deposition of OLED materials on flexible barrier/anode films. The functional inks can be coated in long stripes of arbitrary and well-controlled width. This enables anode structuring using insulator inks as well as the production of contacting areas from metal based conductive inks. Also active OLED materials such as hole injection layers and emitters have been deposited in this way at process speeds up to 20 m/min and with good control over layer thickness and homogeneity (± 5 nm). Functional OLED devices have been produced from these processes with efficiencies of 5 – 7 cd/A at 100 cd/m2.

Dr. Wolfgang Dötter | Abstract 25 **November 28, 14:15**

OLED Works [USA]

Market introduction of a bendable OLED on thin glass and industrial challenges of R2R OLED manufacturing

OLEDWorks will introduce in 2018 a first OLED lighting product based on Corning's 100 µm Willow Glass technology. The goal is to open up the attractive market segment for bendable OLED lighting panels thus extending the OLED market based on rigid products. The first bendable lighting product is developed for the large general lighting market enabling new applications as an extreme thin light-weight panel, allowing creative luminaire designs which will further distinguish OLED lighting from conventional light sources.

The ultimate industrial goal is to build a new industry for highest volume, extreme low cost R2R manufacturing, serving the requirements for commodity production. Required are multiple technology breakthroughs throughout the value chain.

Dr. Norman Bardsley | Abstract 26 **November 28, 14:35**
Bardsley Consulting [USA]

Challenges in the Design and Manufacture of OLED Lighting

OLED lighting offers the possibility of providing innovative forms of glare-free lighting as separate fixtures or embedded in furniture, appliances and architectural structures. Many exciting demonstrations have been made, but the manufacture of OLED panels that meet performance, design and cost targets has proved very difficult. The talk will summarize the current global status and identify the manufacturing challenges that perhaps can be best addressed by R2R techniques. The presentation will include summaries of new results presented at the OLED World Summit in California and the US DOE's OLED Stakeholder meeting in Minneapolis.

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