# Adhesives and finishing: All you need to know about hot melts, hot melt PSAs, extrudable films

Hot melts, hot melt PSAs and extrudable films are a constantly evolving permanent issue, and consequently they drew quite a crowd to Munich for the 38. Munich Adhesives and Finishing Symposium from October 28–30 last year. «In last year's event we put the special focus on all issues related to hot melts in order to accommodate current trends and growth potential in the market and, last but not least, to also «give wings» to necessary innovations in the global adhesives market. We feel that this has worked out quite well with our program consisting of 29 technical papers. This is also reflected in the number of participants (270) from 13 different nations», Mr Stephan Hinterwaldner, Hinterwaldner Consulting GbR, one of the event's organizers, explains. Aside food for thought plenty of occasions were provided for discussions and to ask questions. Topics of the papers given ranged from an overview of the development of hot melts (Dr Hermann Onusseit; Onusseit Consulting) to new developments, machinery, formulations and applications, and trends in the industry. Arizona Chemical, Keyser & Mackay, CNP Polmer GmbH, Krahn, Dr Hönle UV Technology, Lawter and Lion Consult topped off the scope of information available with table top presentations. Mr Hinterwaldner concludes, «MKVS is really getting more and more global. Aside the plenary talk, the lively podium discussion with experts from science and industry on the extremely hot topical issue «sustainability in raw materials for hot melts» led by Dr Smit (Arizona) were met with good response».


From left to right: Eva-Lena Hult Mori (VTT Technical Research Centre, FIN-Espoo), Chris Schaekens (Corbion Purac, NL-Amsterdam), Dr Evert Smit (Arizona Chemicals, NL-Almere), Erwin Honcoop (Croda, NL-Gouda), Eric Appelman (Perstorp, S-Perstorp) Jason Anderson (Novomer, US-Waltham, MA)

**SUSTAINABILITY – A TREND IN THE INDUSTRY.** The buzzword on everybody's mind is sustainability. Dr Peter Barth (CreativeNetworkConsulting, D-Celle) pointed out in his paper that sustainability already starts with the adhesives' product design. Under the lead of Dr Evert Smit (Arizona Chemicals, NL-Almere), a panel of experts consisting of Paul Cordfunke (Corbion Purac, NL-Amsterdam), Erwin Honcoop (Croda, NL-Gouda), Eric Appelman, (Perstorp, S-Perstorp), Jason Anderson (Novomer, US-Waltham, MA) and Eva-Lena Hult Mori (VTT Technical Research Centre, FIN-Espoo) controversially discussed what makes raw materials for hot melts sustainable. Not only must they be derived from renewable resources. Here, examples of such available «green building blocks», derived from wood, cellulose and starch were presented. However, also other aspects of the life cycle were considered: energy used for production, the end-of-life as well as, generally speaking, how adhesives contribute to making a final product more sustainable. The implications of most consumers not being willing to compromise in performance and/or price of the product were an issue, too. As a solution to convince consumers to become a stronger force in moving along developments, marketing was put in play. However, there are already endeavours to provide sustainable solutions in place: According to Dr Jan Spitzley (cph Deutschland, D-Essen and Hochschule Niederrhein, D-Krefeld) until now, raw materials for hot melts are mainly based on crude oil derivates, and hot melts based on natural or renewable raw materials are generally unknown to the market. He introduced recent R & D activities to formulate an industrial hot melt adhesive based on natural raw materials by cph Deutschland Chemie GmbH. Up to now, he is very pleased with how the project is progressing and backed by recent results he feels that it is only a matter of time before such a hot melt can be made industrially available. Also Erwin Honcoop (Croda, NL-Gouda) is searching for hot melt ingredients that are sustainable: he showcased new biobased solutions for tailoring reactive polyurethane hot melt properties: among other things the CRODA Priplast™ polyol building blocks provide bioplastics with hydrolic and thermo-oxidative stability, good water resistance and excellent adhesion to numerous substrates. Dr Klaus Noller (Fraunhofer Institute for Process Engineering and Packaging IVV; D-Freising) presented his findings on biopolymer coatings to make paper and paperboard packaging materials more sustainable while at the same time providing the same or better functionalities than their petrochemical counterparts.

**NEW DEVELOPMENTS.** Kicking off the event, Prof. Dr Karin Jacobs, Saarland University – Experimental Physics, Saarbruecken, Germany, revisited what actually happens for adhesion to occur in her paper «Is adhesion superficial?» Usually, only the surfaces of the substrates to be joined are taken into consideration. However, she showed with her findings in experiments with proteins, bacteria and geckos that adhesion is by no means such a superficial phenomenon: the forces caused by the chemical composition of the interacting materials up to a depth of 100 nm also play a significant role.

The new developments presented provoked lively discussions.

R & D has focused on carbon-nanotubes (CNT) these past 10–15 years, as they provide excellent electrical and thermal conductivity as well as exceptional mechanical (tensile) strength. The issue was to incorporate them in materials and how to then process these materials. Using previous projects of CNT doped adhesives as an example, Dr Tim Schubert (FutureCarbon, D-Bayreuth) and Dr Volker Erb (Krahn Chemie, D-Hamburg) showed how CNT can become manageable components and which analogies can be drawn to hot melts in order to generate new functionalities in composite materials.

Curing polymers with UV light is not new. What is new, are the high performance UV-curable hot melt PSAs introduced by Dr Jurgen van Holen (Henkel, B-Drogenbos): the technology was adapted e. g. to yield solutions for cationically cured high performance tape applications or free radically curing new polyacrylics. When these are formulated with various additives such as UV curing monomers and oligomers, tackifiers and crosslinkers, a solvent-free, radiation curable product with the required adhesion and improved high temperature cohesive strength is obtained. And, there are also advances in the curing process. More especially, Wolfgang Aufmuth (Collano; CH-Sempach-Station) investigated the energy savings possible in using energy efficient low-pressure amalgam bulbs with integrated reflector systems rather than the usual medium pressure mercury bulbs. Not only did he come up with specialized adhesives formulations to meet specific adhesion/cohesion needs, but he also showed in his example that the significant energy savings were possible.

**MACHINERY.** Hot melt solutions have become quite a trend. In part this can be chalked down to the hot melt's performance (optimal adhesion) as well as their process behaviour (no drying). The downside is their viscosity, which can be quite high. This means that both viscosity and the required film thickness mainly define the application system. Backed by findings in the company own technology centre, Andrea Glawe (Kroenert, D-Hamburg) whisked the audience through the choice of coating technology for hot melt application (Heated multi-roll systems, knife technologies and slot die coating process technologies) to match the optimal solution to different viscosities from low to high. That the adhesive dictates which applicator is appropriate, was also shown by Jens Dornis (Bühnen, D-Bremen) using pneumatic hand applicators as an example. This tool has a very wide range of application: it can apply EVA, PO, PA, UR, POR, TK as a spray or a film, and delivery is possible as slug, granulate, pillow or cartridge.

However, not all applicable solutions will also be economically viable in every instance. Thomas Ramel (TSE Troller, CH-Murgenthal) gave an example for an economically viable solution, a premetered system such as the TSE die-design consisting of a «dual chamber fluid distribution system», which will apply adhesives with the necessary precision even at high temperatures to economise on resources and since this also reduces drying time lower cost are the result. Further advantages are that multiple layers can be coated simultaneously and that downtime for job-changes is minimized on account of the die being self-cleaning and not requiring any adjustment. With today's trend towards shorter run times for highly customized films, minimizing product changeover time has become a key design criterion for modern extrusion dies. With this in mind, Luc van Verstraeten (Nordson EDI, B-Temse) introduces Contour™ dies as a solution. The film thickness uniformity can be tuned in much less time, even after a major change in production rate. Less downtime and less scrap are further advantages.

**LABEL PRODUCTION.** Prof. Dr Dirk Burth (University of Applied Sciences, D-Munich) is conducting research on how die cutting is influenced by tackifier resins. Primary findings show that die cutting during label production is a complicated process and that the adhesive employed is a game-changer. There is a correlation between how well an adhesive can be die cut and its filament formation properties. In order to understand how raw materials influence filament formation, adhesives based on different tackifiers were employed to investigate the influence molecular weight, molecular weight distribution and Vicat temperature have on die cuttability. However, when labels are tearing when they are removed, it is the «fault» of the release liner, who does not separate from the reverse, adhesive side of the label. Incomplete coating of the release liner with the releasing material (i. e. silicone), insufficient thickness of the releasing coating layer, deformation (e. g. wrinkles) of or holes in the release liner, defective label material showing scratches, wrinkles or general insufficient thickness are often behind this phenomenon. Based on practical examples Hans Örley (Dr. Schenk Industriemesstechnik, D-Planegg) showed how the producers of labels stand a chance to overcome these defects: modern optical inspection systems (AOI) based on digital line cameras and featuring specially designed LED line illumination control the label quality by monitoring and measuring material and coating properties and thus provide process control via automated feedback to the operator to permit him to optimize the production process.

**FORMULATIONS AND APPLICATIONS.** How to generate the best hot melt? This greatly depends on the functionality desired. The new functionalities and extended means of processing newly developed styrenic block copolymers (SBC) can give to high performance adhesives were shown by Martine Dupont (Kraton Polymers, B-Mont St. Guibert). Reducing melt viscosity or application temperature are currently important issues in the hot melt market. Cutting back on application temperatures can result in


Paul Dalley explains low melt viscosity hot melt adhesives based on radial styrenic block copolymers

less thermal warping or distortion of substrates in the production of disposable articles. Lower melt viscosities can allow more options for adhesive application and higher production line speeds. Paul Dalley (Dexco Polymers Dexco Polymers; US-Plaquemine, LA) showed that HMA's based on radial SBC products with 3–4 arms or branches per molecule can be formulated with significant reductions in adhesive melt viscosity while retaining acceptable properties. His findings in developing this type of formulation were that the structure (linear versus radial) and composition of SBC's affects the balance of properties. Where the desired functionality is a re-closable application, Stefano Pasquali (Basell Sales & Marketing Company; NL-Rotterdam) showed that what had hither to been a hot melt application can also be achieved using polybutene-1 in the formulation. As a matter of fact, it has the advantage of being easy to handle as it can be used in normal film extrusion machines at standard process conditions. First peel open force and re-open peel force are well balanced. Where the goal is cost savings, Shrikant Athavale (Prathith Consultants, IND-Pune) showed in examples of the technical developments in India, an emerging market, how cost can be saved in producing surgical tape, waterproof, with hypo allergic HMPSA and PVC insulation tape, using HM PSA. Where the desired functionality is water absorption, as is the case for bonding wet substrates or as wound-dressing materials, polymeric networks including hydrophilic groups, so-called hydrogels, are the material of choice. Prof. Dr Zbigniew Czech (West Pomeranian University of Technology, PL-Szczecin) studied self-adhesive hydrogels based on acrylics that were synthesized by radical polymerization of selected acrylic monomers and crosslinked using selected multifunctional propylene imines and metal chelate. The resulting hydrogels manufactured by modifying acrylic pressure-sensitive adhesives using ethoxylated amine and neutralization agents (NaOH) are characterized by good tack and good peel adhesion, excellent shear strength at room temperature and at (70°C), very high elongation in form of polymeric films and very interesting run of water absorption. After absorption of water they are characterized by good mechanical stability. Another issue discussed, was acrylic hot melts. Peter O'Loughlin (Omicron Adhesive Materials; UK-Cheltenham) discussed his novel approach to extending the possibilities of their formulation. Dr Dirk Wulff (BASF, D-Ludwigshafen) showed specialty tapes using acrylics. Jason Anderson, Novomer, debated new $CO_2$-based polycarbonate polyols for high performance polyurethane hot melt adhesives.

Another big issue is bonding with an optically clear, UV-curing adhesive. Dr Eric Arnoldi (Lanxess; D-Leverkusen) explored in how far ethylene/vinyl acetate copolymers (EVM) can be formulated as transparent and translucent compounds that can be cured with typical UV-systems. He found that this was possible. Bonded composites can also be generated by laminating transparent plastic films with EVM-layers using UV-curing. However, the peel adhesion of EVM on thermoplastic depends on the layer interaction. Optical bonding and optical lamination using UV-curing adhesive technology is also a technology used in the modern assembly of displays as Dr Belinda Berns (Dymax Europe, D-Wiesbaden) showed. Furthermore, hot melts are used in construction industry (Christian Ottow, Henkel, D-Düsseldorf), graphic industry and bookbinding (Dr. Martin Weller, Planatol Adhesive, D-Rohrdorf). Packaging trends provide new challenges on the market. Marie-Laure Daigniéres (Cray Valley; F-Verneuil-en-Halatte) explores ways in which these can be addressed by additives in HMAs.

New polymer designs are being generated using metallocene catalysts for the synthesis of thermoplastic polymers. The resulting advantages are increasingly applied for hot melts. The use was, however, limited due to the small variety of metallocene catalyzed polyolefins on the market. Based on a few examples, Dr Carola Haider (Jowat, D-Detmold) demonstrated that metallocene catalysed polyolefins provide further tools to tailor high quality hot melt adhesives to meet the market's ever rising quality and performance demands. Optimised processes as well as material and energy efficiency are also targets.

Asked about the seminar scheduled for this year, Mr Hinterwaldner points out. «This year the Munich Adhesives and Finishing Symposium is scheduled for October 20–22, 2014. The 39th event will be devoted to gluing, printing and converting. We intend to cover innovations, on-going developments and trends in machine technology, raw materials, adhesives and coating technologies and applications for solvent based, hot melt, waterborne and reactive systems used in gluing, converting and printing. The according Call for Speakers is running until April 25, 2014. We are granting an attractive discount for early bird registrations until July 31, 2014 – best done online on our redesigned bilingual website!»

MKVS GbR
D-85614 Kirchseeon
www.mkvs.de