Advancing into the fine art of hot melts at the 35. Munich Adhesives and Finishing Symposium, October 25–27, 2010

Successful Bonding Systems are a Work of Art

Once again the organizers (Dr. Michael Gerstenberger and Stephan Hinterwaldner, MKVS GbR) of the Munich Adhesives and Finishing Symposium have provided three days filled with exciting and in depth information, both due to the programme as well as due to the more informal exchange of news in the conversations buzzing during the breaks. This year's feature was on hot melts – hot melts PSA – extrudable films, covering base materials, converting and applications. The number of participants was up to the previous year's level and in the breaks they kept the exhibitors (BYK-Chemie GmbH, Kienzle-Prozessanalytik GmbH, Evonik Goldschmidt GmbH, Plasmatreat GmbH, Honeywell Belgium NV, Keyser & Mackay, as well as the Munich University of Applied sciences) quite busy explaining their products and services.

In his paper on mega-trends of the coming decade, and their impact on adhesives and sealants, Dr. Jürgen Wegner from Chemquest, in Düsseldorf, Germany, shared his vision of adhesives that would shape or rather build our world, be it communication, automotive or printed electronics.

Hot melts are playing an ever more important role in the application of prepregs. As the hot melt's physical properties influence how well it can soak and cover the fibre, Coatema Coating Machinery in Dormagen, Germany, developed innovative coating methods to solve the problem. Jürgen Hanel from Coatema shared these flexible machine concepts using practical examples from Coatema's research.

However, hot melts are also of growing importance in other areas of the industry, as Jens Vollpott from Maschinenfabrik Max Kroenert in Hamburg, Germany, showed in his paper on the development trends for hot melt-application systems. The market demands better performance, flexible application, reduction of product cost and permanent development of industrial safety and environmental protection. Mr. Vollpott showed how Kroenert's rollers deal with these issues.

Ronald Buerger from Nordson Deutschland in Erkrath, Germany, introduced various processing techniques for melting and processing thermoplastic adhesives such as tank solutions, drum melters or a combination of both, or extruders amo. and, focussing on high and low melt and flow rates, presented the influence of melt processing capacities, evaluating the pros and cons of each system.

Prof. Dr. Dr. h. c. Franz Durst from FMP Technology in Erlangen, Germany, presented new ways of determining how best to coat hot melts, a paper he had written together with his colleague, Dipl.-Ing. J. Kluge. Going from the illustration of the common practice of using heated slot dies equipped with slot width adjustment devices to reach the required precision, he presented FMP's innovation of a coating die with a novel diffuser making adjustments of the slot width a thing of the past. He then went on to describe the process of determining the rheological properties of hot melts and showed how, using a software FMP had created, the calculation of coating windows will lead to the best choice of application method, eliminating the need for costly trials and errors.

In his paper on trends and developments regarding corona and plasma treatment and nano-coatings, Hans-Peter Krukenberg from AFS Entwicklungs + Vertriebs GmbH in Horgau, Germany, went from the basics to a glimpse of the future promising higher speeds and thinner coats of 50–100Nm!

Jumping right into a field of practical application for hot melts, Holger Nenstiel from Zecher in Paderborn, Germany, showed hot melt applications have become an essential part of packaging technology, more especially for flexible packaging. He explained that Hotmelt application for flexible packaging can be included inline in a print production process immediately after printing in a rotogravure like coating unit. The adhesive area will then be activated again in a packaging machine later on. The hot melt coat weight required for flexible packaging lies between 4g/m^2 and 12g/m^2. The standard hot melt coat weight is about 8g/m^2. The weight necessary is achieved by coarse

Fig.1: Dr. Michael Gerstenberger and Stephan Hinterwaldner

rotogravure laser engraving of only the areas of ceramic coated hotmelt-cylinders that are supposed to transfer hot melt.

Manuel Bendeich, from the University of Applied Sciences in Munich presented the results of his research together with his colleagues, S. Gläsner and Prof. Dr. Dirk Burth, regarding the die cutting behaviour of SBS/SIS based pressure sensitive adhesives during processing on a rotary die. The focus of their trials was on the influence of HMPSA on the 25 adhesives tested. They were based on SBS/SIS block polymers and different tackifiers.

In recent years, the demand for elastomeric films has grown significantly especially for baby diapers. Focusing on reducing costs while maintaining high levels of elastic performance, Ande J. Uzee from Dexco Polymers, US-Houston/TX, went from an overview of the various types of SBCs used in the production of elastomeric films, to examples of typical film compositions, the different types of films and nonwovens used in diaper ears and tabs, as well as of diapers using elastomeric film/nonwoven laminates, and included a snapshot of the types of block copolymers found in diapers in the US market. Co-authors of the paper were his colleagues William J. Grigar, Brian G. Witt.

Arkema has developed a range of new acrylic copolymers, the so-called Nanostrength® line, with block structures and controlled functional group placement, thanks to an innovative and proprietary controlled radical polymerisation process (CRP). They bring a good balance of tack and creep properties, in the absence of cross-linking, which enables their application as acrylic hot-melt or solvent borne adhesives. Additionally, these materials can be functionalized in a controlled manner. In his paper Jean-Pierre Disson from Arkema, Pierre-Bénite, France, presented his findings on these new structures for the first time ever.

In general hot melt adhesives for tape and label (i.e. PSA) applications are formulations of a base polymer (typically a block copolymer), one or more tackifiers, a diluent/plasticizer and protecting compounds (anti-oxidants) to create the visco-elastic and specific adhesion-, the coating- and the stability properties required. Changes in properties accordingly require changes in formulation. How more sustainable adhesives can be made for tape and label applications by adding (liquid) resins from renewable resources derived from pine trees was shown by Dr. Evert Smit from Arizona Chemical, Almere, The Netherlands.

Dr. Wim Stevels from Eastman Chemical, Kingsport/TN, USA, presented various ways of researching the effect of basic polymer/tackifying resin characteristics on poly(olefin) hot melt adhesive systems and their properties. Co-authors of the paper were Machteld Kirchner-Paree and Edze Tijsm from the same company. Compatibility in the amorphous phase was assessed by dynamic mechanical analysis (DMA), cloud points, and differential scanning calorimetry (DSC) using Gordon-Taylor modelling. It was found that this last approach was widely applicable and useful for quantitative determination of compatibility. Interactions in the crystalline phase were studied using Nishi-Wang modelling for the semi-crystalline EVA, m-PO and OBC

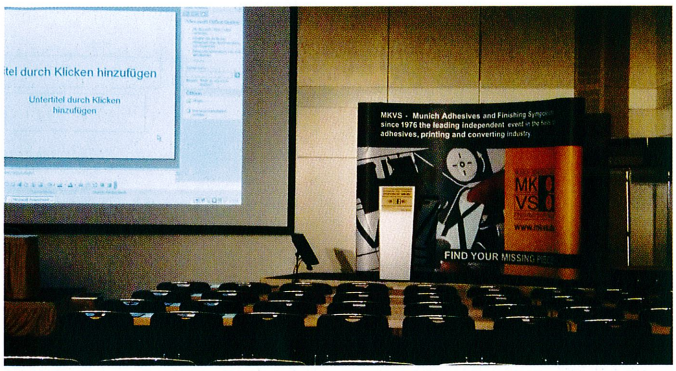
systems. The study of basic polymer/resin properties was shown to be a useful tool in designing and formulating hot melt adhesives: targeting specific properties as required by the application is facilitated.

Recent work has been done on EVA, APAO & mEO adhesives demonstrating boosts in adhesion using functionalized low molecular weight polyethylene and polypropylene additives. This is especially true for cold temperature conditions. Mike Jablon from Honeywell, Morristown/NJ, USA showed the findings of his work in cooperation with his colleagues Kurt Severyns and Ernie Ballester regarding adhesion performance, viscosity, clarity and open and set time modifications of these adhesives.

Since many adhesive formulations contain a significant amount of plasticizer, which in turn contains oil, Anna Eriksson and her colleague Katrin Rabe from Nynas, Nynashamn, Sweden, researched whether varying types of oil used in a plasticizer can influence the performance of specific adhesive systems. Their research pointed to the affirmative. Mineral oil consists of a mixture of different hydrocarbon molecules with different chemical characteristics and in addition to the molecular distribution the oil can be more or less refined. All of these factors influence the performance of the oil in the adhesive. The study was conducted on a simple SIS based adhesive. Adhesives with oils of both naphthenic and paraffinic character (with varying degree of refining) were evaluated. The adhesive characteristics were evaluated using standardized tests such as peel adhesion, probe tack, SAFT and viscosity.

Often curing times of elastic adhesives such as polyurethane or silane-modified polymers are not short enough to achieve an initial strength within the cycle time of modern production lines. Prof. Dr. Christian Lammel from IFF GmbH, Ismaning, Germany, has accordingly developed a new handling method to solve the problem: Hot melt sticks are placed beside the bond line. With the help of special induction equipment it is possible to achieve an initial strength of bonding within ten seconds. Another advantage of this method is that a standard (unaccelerated) adhesive can then be used as a main adhesive for elastic bonding. This makes the fabrication process cheaper and easier to process and leads to a better adhesion quality particularly on difficult surfaces.

There is increasing use of double side adhesive coated mounting tapes with polyethylene (PE) foam in numerous industries. However, coating of PE foam with PSAs remains a challenge,



even after decades of experience, as PE has a low surface tension. This causes the adhesive to detach itself from the foam surface, which often makes surface treatment of the foam unavoidable. As sometimes processing aids migrate to the surface of the foam, where they build up a weak boundary layer between foam and adhesive, the adhesive will sometimes not stick properly even on a treated surface. Furthermore the properties of PE foam tapes coated with rubber hot melt pressure sensitive adhesives (PSA) or modified acrylic PSA adhesives can deteriorate with time. More thorough investigations have highlighted that the ageing of the adhesives can also be affected by processing aids in the PE foam. Dr. Lukas Berger from Sekisui Alveo, Lucerne, Switzerland explained how his company's new PE foam range, the so-called adhesive friendly foam range, deals with these issues: The processing aids preventing adhesion were eliminated.

Prof. Dr. Zbigniew Czech from West Pomeranian University of Technology at Szczecin, Poland, introduced the findings he and Agnieszka Butwin made in their endeavour to replace UV-cross linkable acrylic pressure-sensitive adhesive hot melts applicable at 140 °C, by warm melts and low viscosity systems coatable at room temperature or temperatures ranging from 50 to 80 °C. The balance between UV- and PSA-technology is a very important factor in manufacturing novel photoreactive acrylic PSA systems. The solvent-free low viscosity acrylic PSAs are still in their infancy and therefore a lot remains to be discovered. However, the recent developments in the acrylic warm-melts have shown that low viscosity acrylic PSAs coatable at room temperature and UV-synthesized syrup-PSAs provide final PSA products with excellent performance.

As in our modern life almost every product in our household is packaged, Wolfgang Aufmuth from Collano Adhesives in Sempach-Station, Switzerland, showed the importance of special adhesives for functional packaging using the example of reclosable packaging for wet wipes. His findings were that UV-crosslinking adhesives work best, as they are the only type of adhesives that fulfil all requirements made. By mixing polymers with special additives, various adhesive profiles can be set according to the different grades of removability required by the customer.

Participation in radiation curing by the merchant tape market has traditionally been minimal as the specialized equipment used by the captive market is expensive and difficult to use. Nonetheless, in recent years demand has increased. This is due to a variety of reasons, including cost efficiency, environmental pressure and potential coating speed improvements over solvent/water based systems. Based on its experience in formulation, polymer design and polymer technologies, not only the acrylic technology, but also the rubber, hybrid and cationic technologies, Henkel in Düsseldorf, Germany, came up with new UV-hot melt PSAs using different polymer chemistries. Dr. Sophie Klein, Henkel, Slough, UK, presented them. Her colleague Peter Palasz co-authored the paper.

In the synthesis of thermoplastic polymers the use of metallocene catalysts has opened up totally new possibilities of polymer design. The potential for substitution not only applies to the classical basic polymers like EVA and APAO, but also to block copolymers such as SIS. Dr. Carola Gantner from Jowat in Detmold, Germany, revealed the potential of modern hot melts based on metallocene-catalyzed polyolefines in comparison to the current state of technology and provided practical examples from experiences made both by her and her co-authors, Dr. Christian Terfloth, Martin Naumann. PO hot melts used for wood, furniture and construction, paper and packaging, and textile bonding had often proved better performance than conventional systems.

In modern manufacturing construction units are increasingly made up of complex geometries made of surface-improved metal sheet materials attached to each other by lap joint welding. The spring back behaviour during welding processes, particularly for medium to higher strength steel grades increases the demands in the clamping technique especially in maintaining a precise exhaust gap. Marcus Weber from the Institute of Joining and Welding in Braunschweig, Germany presented the findings he made together with his institute colleagues Prof. Dr.-Ing. Klaus Dilger and Dipl.-Ing. Michael Mavany and Prof. Dr.-Ing. Uwe Reisgen from the Welding and Joining Institute in Aachen, Germany, in the research project IGF Nr. 15.965N / DECHEMA: Clamping technology based on pressure sensitive adhesives can fulfil the application needs. They offer high adhesion to oil contaminated surfaces and freedom in geometrical design.

Aluminium honeycomb panels used in ship-building, railway construction and the building industry in general have an essential advantage over plastics and cardboard-honeycomb panels, in that they provide better fire resistance. Adhesives used in their construction play an important role as the adhesive weight and its specific heat have a major role in the caloric effect, fire propagation and fume density and toxicity. Dr. Kurt Jud from Collano Adhesives in Sempach-Station, Switzerland, showed that with a suitable adhesive formulation, such as provided by Collano, a specific processing technique and the use of untreated aluminium alloys, regardless of temperature, humidity or salt spray, a 5-fold increase of peel resistance can be reached in a drum peel configuration as compared to the currently available standard performance and into the bargain only at least half of the standard adhesive consumption is necessary.

Dr. Roland Milker from POLY-CHEM in Bitterfeld-Wolfen, Germany, gave a paper he had prepared in cooperation with Zbigniew Czech and Agnieszka Butwin from West Pomeranian University of Technology in Szczecin, Poland, describing produc-

tion, properties, and applications of hot melt pressure-sensitive adhesives with a focus on photo reactive polyacrylate hot melt pressure sensitive adhesives (HMPSA) as they are expected to become established in the PSA market within the next decade. Their cohesive properties with low photoreactivities need improvement. Otherwise they feature good tack, good adhesion, and excellent shear strength in the cross-linked state. Moreover, they have high light, air, moisture, and solvent resistance. The solvent employed in the polymerization process described may be recycled.

Silicone elastomers are high performance materials of choice for a series of industrial bonding, sealing and potting applications when exceptional high demands exist on thermal and chemical resistivity, and if minimum water uptake or constant mechanical and dielectric properties as well as distinct damping behaviour and minimization of thermal stress (low e-modulus) are required under conditions such as temperature changes and mechanical stress. Dr. Marcus Jandke from Wacker Chemie in Burghausen, Germany, introduced the new UV active addition curing silicone elastomer encapsulation grades SEMICOSIL® UV as a solution providing a combination of a long pot-life and a very fast curing time that is adjustable to each application. This makes them interesting for highly-automated and fast mass production processes (automotive electronics) and basically for applications, which need to avoid oven processes for the acceleration of the curing reaction.

Reactive hot melt adhesives belong to one of the fastest growing adhesive groups in the market due to the wide range of opportunities in the field of industrial bonding. The adhesives have to meet growing demands on the quality of adhesive bonding, on environmental compatibility as well as industrial safety, but also demands on the efficiency of the processes. Dr. Roland Heider from Adtracon in Hilden, Germany, showed that the development of multifunctional hot melts is a challenge for adhesive manufacturers and can only be achieved using high concentrations of the functional chemicals – up to 20–40% – in the polymer compound. They can meet various requirements while providing consistent high quality bonds and thus provide a solution for the economic manufacturing of flameproof products with outstanding properties.

Metallized films consisting of thin, vacuum-deposited inorganic layers are used for a wide range of packaging applications and other technical purposes. They are made as laminates. One major quality indicator is the metal adhesion strength between the inorganic layer and the substrate. Esra Kucukpinar from Fraunhofer Institute for Process Engineering and Packaging in Freising, Germany, shows the weaknesses of the current EAA-peel test for better adhering aluminum layers he and his colleagues Klaus Noller, Marius Jesdinszki, Carolin Struller, Norbert Rodler, and Horst-Christian Langowski as well as Valerio Cassio and David Blondin from MET-LUX Vacuum Metallizing in Rodange, Luxembourg, have encountered. He thereby demonstrated the need for further research on the improvement of the available metal adhesion tests for thin layers deposited onto flexible polymeric materials.

Before lunch and again before the end of each day, time was set aside for questions and answers to the papers described above. The panels were chaired by experts in their fields: Mike Schätzler from megapak in Hilden, Germany, Dr. Karl-Heinz Schumacher from BASF, Ludwigshafen, Germany, Jacques Lechat from Exxon-Mobil Chemical, Machelen, Belgium and Jens Vinke from Ter Hell, Hamburg, Germany. More opportunity for interaction between audience and experts was given in the panel discussion regarding state of the art and future trends of coating in converting applications. Chaired by Dr. Gerstenberger expertise was available from all aspects of the subject, ranging from the application method, (Michael Schmalz from Kroenert) to drying (Dr. Schweizer from Polytype) to application heads (Christina Fuchs from Nordson), to the final product (Bernd Dietz from Tesa and Werner Burschil from VPF).

Winding up the successful event, the organizers pointed out that this year's event will be taking place from October 24–26, 2011. This year's feature is on «printing, gluing, and finishing» with a focus on development trends, new base materials, formulations and applications. The call for papers and previews is on-going until April 29 this year.

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