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Molecular Plasma Group

Kevin Braun

MOLECULAR PLASMA – SOLVING BONDING CHALLENGES WITH SOLVENT-FREE FUNCTIONAL COATINGS

Abstract

Molecular Plasma Group's unique MolecularGRIP™ technology uses cold atmospheric plasma as a vector to covalently bond a wide range of organic precursors onto any kind of substrate, thus generating a permanent nanocoating. By doing this, the surface can be functionalized in various ways, one of which is the significant improvement of the adhesive properties of former inert or sensitive materials by grafting reactive chemical groups such as amines, epoxies, acrylics, hydroxyls, isocyanates, etc.

The technology works in a single-step, solvent-free and dry process at room temperature and atmospheric pressure. Besides materials such as polymers, metals, ceramics and glass, it also allows the treatment of temperature-sensitive substrates such as bio-based materials and ultra-thin films. Since the chemical is covalently bonded to the surface, the technology offers significant operational advantages in terms of open time. It replaces conventional solvent-based primers by a very eco-friendly and efficient process while realizing even better adhesion and also goes far beyond the possibilities of a standard plasma surface activation technology.

The industrial plasma systems are scalable, fully automated and fully traceable, enabling also the in-line inspection and quality control of the generated layer through the simultaneous deposition of tracer molecules and the subsequent determination of the coating thickness. The systems can be installed as a standalone machine or integrated into any production line. Besides the PlasmaSpot® system to treat rather smaller surfaces, 3D shapes, fibres or powders, the PlasmaLine® is the only atmospheric plasma system in the market that is able to homogeneously treat large surfaces up to a width of 1600 mm in a continuous process.

Plasmatreat

Klaus Kresser

OPENAIR-PLASMA® IN SEMICONDUCTOR MANUFACTURING

Abstract

Why is it beneficial to use OpenAir® technology in Semiconductor Manufacturing? For these applications a lot of different substrates made of metals and plastics are used for gluing and coating applications. This means that for the actual function - such as adhesion, corrosion protection, etc. efficient and environmentally friendly inline treatment solutions are needed. In addition, new chip and PCB designs are established and new legislations must be considered. For this a universal and flexible treatment system is preferred especially when it is about to change from low pressure plasma batch processes to in-line suitable atmospheric pressure plasma processes.
Here, OpenAir®-Plasma technology simplifies the processes. All different types of materials like plastic, metals like aluminum or copper, etc. can be treated with OpenAir®. Plasma. This process is already being used successfully for surface treatments in many different electronic market applications and for other industries and applications. Herewith OpenAir®-Plasma technology assure long-term adhesion and corrosion protection.

In the paper, the following topics will be introduced and discussed:
Explanation of the basic principle of the OpenAir®-Plasma treatment on plastic and metals
Distinction between different plasma technologies: Activation of surfaces and coating of surfaces via PECVD (Plasma Enhanced Chemical Vapor Deposition).
Examples of substrate/adhesive combinations, where PECVD can be used for electronic applications.
Examples of successful implementation and industrialization of green processes and new materials with PECVD technology
Examples Lean pre-treatment solutions for bonding & coating which are industrialized.

ZHAW - Zurich University of Applied Sciences
Prof. Dr. Christof Brändli*, Roman Günther

MOLECULAR BONDING AND DEBONDING THROUGH THE USE OF PLASMA AND METAL IONS

Abstract
A novel technique has been developed to bond polymer surfaces without leaving any residue, thereby facilitating polymer recycling and enabling the bonding of polymers that are normally incompatible. This technology involves altering the polymer surfaces to create functional groups that facilitate reversible bonding through intermolecular interactions between two solid polymer surfaces. Specifically, surfaces were modified using oxygen plasma (both low-pressure and atmospheric plasma technology) and acrylic acid grafting through a wet chemical process. These modified surfaces were then treated with copper(II) ions to investigate the impact on adhesive strength and separation. Key factors for successful bonding include surface roughness, surface modification, the presence of surface ions, and bonding temperature. When these parameters are appropriately combined, they allow for strong, reversible bonding between polymers, which can be easily separated using specific chemicals.

University of Braunschweig / Institute of Joining and Welding (ifs)
Michael Griese*, Elisabeth Stammen, Prof. Dr. Klaus Dilger

CONSIDERATION OF THE VISCOUS FINGERING EFFECT IN NUMERICAL SIMULATIONS OF STRUCTURAL ADHESIVE BONDLINES UNDERLYING CTE-MISMATCH EFFECTS

Abstract
The joining of dissimilar materials is a key advantage of adhesives and is increasingly used in automotive body structures. It is a common technology to join materials such as aluminum and steel in order to take advantage of their specific properties regarding weight, stiffness and strength. However, influences of the automotive production process have to be taken into account to determine the performance of the resulting adhesive bondline. Production related influences arise from the surrounding conditions during the automotive production process such as the oven temperatures. When joining dissimilar materials, adhesive bondlines are subjected to strains caused by the mismatch of thermal expansion coefficients (CTE), which can cause the bondline to show the viscous fingering effect when the gelpoint is not yet reached, and therefore reduce the adhesives performance due to a diminished cross-section of the bondline [1]. When the curing state exceeds the gelpoint and the bondline becomes a solid material, CTE-related stresses can even start to damage the material, which is still quite weak in terms of mechanical properties due to the low degree of cure and the high temperatures [2, 3].

To take these effects into account, the viscous fingering effect is investigated using linear butt-bonded specimens and TDCB-specimens to determine the resulting cross sections and the remaining strength of a structural epoxide adhesive commonly applied in the automotive industry. Furthermore the strain related effects during the adhesive curing process are examined using a dissimilar joint of a steel hat profile and an aluminum sheet and the remaining joint performance after the curing process is experimentally determined and compared to numerical results from a cohesive zone model.

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Luiz G.M. Lise[2*], **Francis M.G. Ramírez[1], Fabian Nowacki[2] and Joachim Hausmann[1]**

BONDLINE THICKNESS EFFECT ON THE TENSILE FRACTURE TOUGHNESS OF ADHESIVELY BONDED JOINTS

Abstract
The bondline thickness can deeply affect the fracture behavior of composite joints. The present work intends to experimentally and numerically evaluate the bondline thickness effect

on the fracture behavior of adhesively bonded glass-fiber reinforced polymers (GFRP). Four bondline thicknesses, 0.2, 0.8, 1.4 and 2.0 mm, were evaluated under pure tensile loading (mode I). A two-component epoxy-based adhesive system SikaPower® 880 was used to join the GFRP plates. Double cantilever beams (DCB) specimens were used to conduct the mode I quasi-static tests. The load displacement (P-δ) curves were obtained and the critical fracture toughness (GIc) was estimated in terms of the strain energy released rate (SERR). To determine the SERR, a data reduction scheme based on the crack equivalent method was considered. This method estimates the SERR only as a function of the compliance, which is a parameter measured during the tests. A two-dimensional finite element model was used to validate the experimental results. The model was developed using ANSYS Parametric Design Language (APDL). A linear softening law was considered to simulate the fracture degradation behavior. A good agreement was found between the GIc of the numerical simulations and experimental results. Moreover, the model was use to analyze a larger spectrum of thicknesses.

Keywords: adhesively bonded joints; bondline thickness effect; fracture behavior; double cantilever beam specimens.

Schill+Seilacher "Struktol"
Sven Wiemer

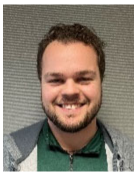
SUSTAINABILITY - TWO PROJECTS / THOUGHTS

Abstract
Sustainability has now found its way into many areas of everyday life, including technical products and processes. Today's talk takes a closer look at two R&D projects at SuS that are linked to this topic.

The first part provides an update on the article from 2023: Here it was shown that a biobased UPE (Struktol VP 3830) had also shown fundamentally positive approaches when used as a toughener, which is why we at SuS have taken this as an opportunity to develop a new toughener family. This is not based exclusively on the idea of sustainability but should also consider the combination possibilities in chemistry.

The second part deals with the first steps at SuS using AI and machine learning to support the development work on partially bio-based, multi-component epoxy resin systems. The motivation here is that finding the optimal mixing ratio for multi-component systems through trial and error can be time-consuming and expensive. In the first step, a compromise between lower environmental impact, high glass transition temperature and overall high mechanical performance was achieved by blending bio-based and conventional epoxy resins and hardeners by optimizing the mechanical performance of epoxy resin systems through machine learning. The resin system determined is suitable for resin transfer molding and prepreg applications, among others. This work was carried out in cooperation with the Technical University of Bayreuth at the Chair of Polymer Materials.

L&L Products
Kevin Cox



TWO-PART BIO-BASED FOAMING THERMOSET POLYMER

Abstract
Petroleum-derived materials are becoming less attractive for a number of reasons including cost and resource scarcity. In addition, one can expect growing regulation related to manufacture and consumption of petroleum-derived products in coming years. This provides an incentive for alternative renewable sources with comparable or better properties and cost. Researchers and manufacturers have recently relied on bio-based resins synthesized from glycerol-based epichlorohydrin, bio-based polyols, bio-based acids, epoxidized oil resins, and others. Some well-known sources of epoxidized oil resins include unsaturated oils such as vegetable, nut and seed oils. These epoxidized oils typically contain aliphatic, disubstituted oxirane rings which are nearly unreactive with traditional epoxy curative systems, such as amines and polyamides. These materials tend to have plentiful feedstocks, can be produced easily and safely, are low cost, and tend to have attractive handling and health and safety profiles. Given the advantages that these ingredients offer, it would be useful to have a way of using these materials more broadly than what has been possible to date due to limited reactivity of these epoxides with conventional epoxide curatives. The use of highly reactive acidic compositions including phosphoric acid, phosphoric acid derivatives, phosphate esters, and other acids, allow for the ring opening of these disubstituted oxirane rings, and furthermore, allows for the usage of previously mentioned sources of bio-based resins at high levels including the possibility of it being the sole epoxide in the composition. Though curing speed, open time and foaming speed are tunable, the use of phosphoric acid, phosphoric

acid derivatives and phosphate esters allows for systems containing polyfunctional aliphatic glycidyl ethers and polyfunctional peroxyacid epoxies that cure in under an hour, whereas traditional curatives may take well over 24 hours. The current teachings relate to a two-component system with one side containing epoxide functional constituents and one side containing acidic materials, where one or both components are comprised of one or more bio-based constituents. The resulting polymeric composition is an optionally foaming adhesive that may contain over 90% renewable organic carbon content. Foaming materials are used in applications such as sealing and noise, vibration and harshness reduction where low density, adhesion to multiple substrates, and accounting for variable gap thickness may be beneficial or required. As an additional benefit, the phosphorous in the curative imparts a degree of flame retardancy in the systems. Potential uses include seals, gaskets, closure strips, isolators, damping materials, and general gap filling.

Elantas Europe
Dr. Giulia Mannoni

BIO-BASED EPOXY ADHESIVES: HIGH PERFORMANCE WITH AN EYE ON THE PLANET

Abstract:
The topic of environmental sustainability and climate change has become crucial in every sphere of economic development.
Biobased materials enable the possibility to move toward a more sustainable society, due to the independence from petroleum resources that comes with their use.
In many industries, such as automotive, marine and racing, the demand for bio-based products is constantly increasing. In these sectors, adhesives play a key role in structural and non-structural applications. They allow strong bonds, even between different materials such as metal and composites, reducing weight and thus fuel consumption.
The purpose of this lecture is the presentation of the new bio-based epoxy adhesives that can be implemented as drop-in replacements for existing technology. The right selection of bio-based raw materials makes possible to achieve the same properties as corresponding adhesives of petroleum origin and with a lower environmental impact.
The development of this new generation of adhesives confirms the effort of Elantas in the high-performance products with a focus on sustainability

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Kaneka Belgium
Tom Leemans

MS POLYMER BASED ALTERNATIVE FOR CEMENTITIOUS POWDER ADHESIVES

Abstract
Through the years Kaneka has developed several types of silane terminated polyethers (known to the market as Kaneka MS Polymer™). A special and exclusive group within this polymer range are the acryl modified MS Polymer™, a blend of silyl modified polyacrylates and silane terminated polyethers.

The combination of polymers with a different chain composition and structure allows strict control on morphology, compatibility and even glass transition temperature (Tg). It results in polymers with unique properties like adhesion to plastics and dissimilar materials, combined with a high-strength level adhesion. An overview of the latest developed low viscosity high strength polymers will be shown, together with their unique properties. With this technology a continuous progress is achieved both in polymer design and practical applications.

A range of specific case studies will be presented (e.g. tile adhesives, stone strip application,…).
The continuous development of these new polymer grades shows that Kaneka MS Polymer™ remains a key technology for the future and provides solutions for changing applications.

AGRANA Research & Innovation Center

Dr. Bernhard Seidl

MODIFIED STARCHES: SUSTAINABLE INNOVATIONS FOR WATER-BASED ADHESIVES

Abstract

Modified starches, derived from abundant and renewable sources, have emerged as versatile biopolymers capable of enhancing adhesive properties across various industries.

This presentation will address potential challenges associated with the use of starches in adhesive formulations, including stability and moisture sensitivity. Strategies to overcome these hurdles will be discussed: The possibilities of starch modification ranging from physical treatments, chemical treatments to enzymatic processes and combinations thereof are shown.

Case studies will be presented, showcasing successful applications of modified starch-based adhesives in industrial applications. These examples will underscore the adaptability and efficacy of modified starches in meeting the specific demands.
Furthermore, the presentation delves into the environmental benefits of starch-based adhesives, such as biodegradability, renewable sourcing and increasing bio-based carbon content.

Overall, this presentation will provide a comprehensive overview of the transformative potential of modified starches in adhesive formulations. Attendees will gain valuable insights into the diverse applications and sustainable advantages of utilizing modified starches, supporting adhesive industry towards a more eco-conscious future.

Elementis Services

Anja Baumann

RHEOLOGY FOR FUTURE - OUR JOURNEY TOWARDS MORE SUSTAINABLE SYSTEMS AND GREATER PERFORMANCE

Abstract

Formulators, producers and users of adhesives, sealants, paints and coatings are focusing more and more on sustainability. Key for differentiation is the choice of raw materials that support a company's sustainability strategy while maintaining high performance. Our goal in ELEMENTIS is to raise awareness for the selection of additives, based on a comprehensive 5-point sustainability approach, which is marked by clear, evidence-based, systematic, risk-based, and collaborative targets and mechanisms. An approach contributing to a seamless transition towards a more sustainable adhesives industry with regard to sustainable ingredients, sustainable processing, sustainable application and sustainable use.
This presentation will focus on ELEMENTIS' product highlights to achieve: **Rheology for future.**

Medmix Switzerland

Joachim Schöck

SUSTAINABILITY IN THE MIXING PROCESS – HOW IS IT POSSIBLE?

Abstract:

In recent decades, the use of 2K adhesives has increased in various industries. Due to the increased use of plastics and the ongoing challenges of disposal, the search for more environmentally friendly materials and reliable dispensing systems is unreduced.

As a leading manufacturer of 2K component mixing and application systems, medmix has already implemented sustainability into its development processes to meet this goal. This article discusses how optimal mixing technology can contribute to a sustainable mixing process.

One approach is to use sustainable materials. However, the question arises whether the use of these materials makes sense when disposable mixers are involved. Another approach is to miniaturize our mixers by selecting the best mixing technology for each application. A smaller

mixer results in less plastic waste, but also reduces the amount of raw material that remains unmixed in the mixer.

Related to this, the potential of dynamic mixing systems is discussed.
The selected technologies will be discussed based on LCA- (Life Cycle Assessment) analysis.
