in-adhesives 2025
Munich, February 11-12, 2025
Submitted papers with abstracts

in-adhesives
Symposium on Innovations in
Adhesives and their Applications

November 26, 2024

BIO-REFINERY DERIVED FURANIC HUMINS AS BASIS FOR SUSTAINABLE THERMOSETS

Avantium Renewable Polymers; NL-Amsterdam
Tom Claessen

Abstract:
Furanic humins are by-products obtained from carbohydrate valorization processes. Given the large amount of the carbon input that they can contain, they need to be considered as potential new bio-based feedstock. In addition, all these product streams, when marketed at their highest value, deliver an economically viable technology for sustainable biochemicals production. However, only limited valorization options are available; in fact, these materials are nowadays often simply considered as waste and mainly burnt as fuel for their heating value.

Furanic humins, are formed during acid-catalyzed (hydro)thermal conversion of the carbohydrate fractions of biomass, e.g. for the production of furfural and levulinate derivatives. At Avantium, they are a side product of the YXY® process. The YXY® technology catalytically converts plant-based sugar (fructose) into FDCA, the key building block for a wide range of plant-based chemicals and plastics such as polyethylene furanoate (PEF). The furanic humins are by-products of YXY® process currently producing FDCA at the pilot plant in Geleen (NL) and larger quantities are expected from the FDCA Flagship Plant in 2024 in Delfzijl (NL).

Humins are heterogeneous and polydisperse macromolecules, mainly constituted by furanic rings and aldehydes, ketones and hydroxyls as main functional groups. For many years, scientists focused on finding a way to avoid humins formation during biorefinery processes but that appears to be almost inevitable. The attention is now shifting towards ways to make high value-added products from humins to further improve the process economics of biorefineries.
An extensive analysis of the structure and physico-chemical properties of humins was performed to demonstrate that it is possible to obtain a thermoset polymer with different properties based on the treatment used. With the upscaling of the YXY® process, furanic humins as a new bio based side-stream, will become available in large volumes. Having the potential to form thermoset polymers furanic humins are a valuable fully biobased feedstock for thermoset formulations.

TRACKING AND DOCUMENTATION OF BONDING PROCESSES – WHY IT IS IMPORTANT TO FOCUS SENSORBASED DATA

B.A.T. BetterAdhesiveTracking GmbH; DE-Frankfurt am Main
Marco Rodriguez

Abstract:
In most automated productions, many parameters of the bonding processes are recorded and perhaps also analysed.

But what about the many manual and semi-automated production processes? Unfortunately, process parameter monitoring is neglected here, perhaps also because there is no sensible monitoring option.

We should also play it safe in these areas and record and analyse the process-relevant data. A good way is to monitor the adhesive chain...from dispatch to application. One possibility is NBIOT or LoRaWAN sensors that transmit data to a cloud in near real time. Errors and warning limits can now be used to react to possible influences.

If this is then recorded in a document, the issue of traceability can be solved.
We need to find new and safe ways of bonding that enable us to detect errors at an early stage so that we can learn from our mistakes.

DEBONDING ON DEMAND AND INNOVATIONS IN MODERN ADHESIVE BONDING FOR BATTERY AND MOBILITY APPLICATIONS

Bodo Möller Chemie; DE-Offenbach am Main
Bernhard Vreden

Abstract:
Coming soon

REVOLUTIONIZING CYANOACRYLATE ADHESIVES: A BREAKTHROUGH IN PERFORMANCES, DURABILITY AND SUSTAINABILITY

Bostik, Part of the Arkema Group; ES-Bellaterra (Barcelona)
Patxi Garra, PhD

Abstract:
Bostik, part of the Arkema Group, has been pioneering advancements in cyanoacrylate adhesive technology, fundamentally rethinking both production processes and performance capabilities. This presentation delves into the technical development of Born2Bond Ultra K85 MV, a groundbreaking adhesive made with 65% biobased heptyl cyanoacrylate (ASTM D6866). Sourced from renewable feedstock and synthesized through a patented crackless monomer process, this innovative product offers a unique combination of properties that distinguish it from traditional cyanoacrylates. Key advantages include significantly reduced odor, minimized blooming, and high hydrophobicity, resulting in unprecedented durability under harsh environmental conditions, such as 85°C/85% relative humidity testing—where it has achieved 1000 hours of performance compared to the previous standard of 170 hours. Additionally, this adhesive provides enhanced flexibility, positioning it as a highly sustainable and high-performing alternative. This session will also cover critical tradeoffs and comparisons with conventional cyanoacrylate monomers, including n-butyl, 2-octyl, ethyl, and methoxyethyl variants, illustrating how Born2Bond Ultra K85 MV reshapes expectations in the cyanoacrylate domain.

UTILITY OF CNSL EPOXY RESINS AND CURING AGENTS: DESIGNING HIGH PERFORMANCE AND SUSTAINABLE ADHESIVES

Cardolite Specialty Chemicals Europe[1]; BE-Mariakerke-Gent and
Cardolite Corporation[2], US-Bristol, PA
Tom Berckmans[1]*, Yun Mi Kim[2], Andu Natesh[2]

Abstract:
Cashew nutshell Liquid (CNSL) is an annually renewable, non-food chain bio-based feedstock found in the honeycomb structure of the cashew nutshell. CNSL-based epoxies and curing agents have been widely utilized in epoxy formulations to balance strength and flexibility while improving aging

resistances such as thermal, chemical, and anti-corrosion in coatings and adhesives. However, it has been challenging to replace petro-based epoxy resins with CNSL epoxies fully due to shortcomings in glass transition temperature and strength. Cardolite has designed multifunctional CNSL epoxies and CNSL curing agents to address those limitations.

This study investigated the benefits of incorporating CNSL epoxies and curing agents in 1K and 2K epoxy. CNSL epoxies cured with amine curing agents offered improved hydrolytic stability, increased adhesions, and allowed the formulator to create flexible epoxy adhesives. CNSL-based curing agents were tested with CNSL epoxies to achieve higher bio-contents and understand added benefits.

NOVEL RECYCLED BASED POLYOLS, RAISING THE BAR FOR MORE DEMANDING POLYURETHANES ADHESIVES

Cargill; BE-Gouda
Erwin Honcoop

Abstract:
As the industry shifts towards sustainable raw materials, the demand for recyclable materials is on the rise. In response, Cargill has redesigned its polyol product line, introducing offerings that contain up to 100% recycled content specifically for adhesive applications.

These advanced polyols deliver both durability and performance in polyurethane adhesives. They are crafted from recycled plastics and diacids sourced from natural oils, resulting in a liquid polyol with a crystalline structure that enhances adhesion to steel and aluminium while maintaining flexibility.

The hydrocarbon composition of the bio-based diacids and polyols provides water repellency and a balanced combination of strength and elongation.

Furthermore, the integration of recycled and bio-based materials in these innovative polyols creates a unique formulation that offers excellent hydrolytic, thermo-oxidative, and chemical resistance, making them ideal for demanding applications such as sealants, sportswear, and automotive components.

CLEANING WITH LASER LIGHT - SUSTAINABLE AND LONG-TERM STABLE SURFACE PREPARATION OF METAL PARTS ON FUNCTIONAL AREAS FOR ADHESIVE BONDING

clean-Lasersysteme; DE-Herzogenrath
Tobias Weichert

Abstract:
Partial cleaning and pre-treatment of the surface is an important prerequisite for a high- quality adhesive surface. In the laser process, dirt particles, oxide layers and other impurities are vaporized by focused light alone. The laser pre-treatment frees the metallic surface from impurities and prepares it well for bonding. The substrate is not damaged by the laser light. If required, micro-roughness or surface modifications can also be produced. Metallic materials can be "modified" within the upper boundary layer with appropriately enhanced laser parameters to also achieve suitable surface tension values. The modified surface is able to match the bonding mechanisms of different bonding systems with different viscosities.

Light metal components, such as aluminum, are particularly well suit ed for laser processing. Numerous studies have found that extremely high, particularly long-term stable bond strength is

achieved with certain parameters. Due to the reduced corrosion, the element results are up to five times better than with wet chemical treatment. Stainless steel can also be treated with the laser to achieve better adhesion results. After pre-treatment, inline bonding is possible. Both processes, laser cleaning and bonding, can be combined in one machine to optimize the process chain. With this process and automation possibility, a wide range of bonding applications from different industries can be realized, e.g. in the automotive or aircraft industry.

The presentation will show more details about the laser cleaning process and its mechanism and effect on the surface of light metals and stainless steel. Its influence on the adhesion of adhesive systems will also be a topic. In addition, concrete and latest application examples from research and development will illustrate the mode of action. Finally, automation concepts for laser cleaning and bonding will be presented for a better understanding of feasibility and versatility.

BOOST BY COLLANO: NOVEL HYBRID ADHESIVE TECHNOLOGY AS A REPLACEMENT FOR RUBBER IN SKI

Collano; CH-Sempach Station
Dr. Worarin Meesorn*, Dr. Raphael Schaller, Dr. Heiko Jung

Abstract:
Collano has developed and introduced BOOST, a novel hybrid adhesive technology for ski construction, replacing traditional rubber sheets with advanced adhesive films that enhance performance and reduce environmental impact. Rubber sheets have long been used in skis to improve flexibility and provide vibration damping. Hence, they also add weight and can limit design variation for high-performance skis. In contrast, hybrid adhesive films offer a lighter, more versatile alternative, allowing for a stiffer ski structure without compromising damping or flexibility characteristics. This new approach leverages the unique bonding properties of hybrid adhesives, which combine elastomeric and thermo-setting components to optimize adhesion, durability, and vibration control.

By using hybrid adhesive films, the overall stiffness of the ski was significantly improved compared to conventional rubber-based designs. Enhanced stiffness contributes to better energy transfer from skier to snow, improving edge control and stability at high speeds. This construction also reduces material weight, enhancing maneuverability without sacrificing performance in terms of vibration damping. Field tests in the winter season were conducted to evaluate the skis under varied real-world conditions. The tests revealed that the hybrid adhesive films provided a noticeable improvement in stability, responsiveness, and control, particularly in high-speed conditions.

Collano’s hybrid adhesive films boost ski performance and simplify the manufacturing process by reducing the required curing steps. Hybrid films facilitate precise alignment and shorter production times, supporting process and materials efficiency by lowering adhesive use energy consumption and improv-ing recyclability compared to traditional rubber-based skis.

In summary, Collano’s hybrid adhesive technology substantially advances in multilayer ski construction, enhancing stiffness and performance while supporting efficient, eco-friendly production processes. These findings indicate that hybrid adhesives are a promising solution for next-generation skis, aligning with industry demands for both high-performance and sustainable design.

TBA
Jowat; DE-Detmold
Dr. Hartmut Henneken

Abstract:
Coming soon

ENHANCING EPOXY ADHESIVES WITH KANE ACE™ MX CORE-SHELL RUBBER TOUGHENING SYSTEM

Kaneka Belgium N.V.; BE-Westerlo-Oevel
Stefan Van Loy

Abstract:
This presentation highlights the use of Kane Ace™ MX, a Core-Shell Rubber (CSR) toughening system developed by Kaneka. Key topics include the unique characteristics of Kane Ace™ MX, its effect on fracture toughness & Tg, and its easy integration into 1K and 2K adhesive systems. Comparative data on adhesion properties, such as T-peel strength, lap shear and impact peel strength, showcasing its advantages across varied conditions over conventional toughening systems. The analysis also underscores the wide cure window stable toughness improvement effect regardless of curing temperature, positioning it as a key solution for demanding applications like electric vehicle (EV) battery adhesives. Additionally, the newest grade will be introduced, emphasizing its potential for optimizing the performance of 1K and 2K adhesives.

ADVANCING CIRCULARITY USING MS POLYMER™ - SUSTAINABLE FOIL ADHESIVE FOR THE BUILDING ENVELOPE

Kaneka Belgium N.V.; BE-Westerlo-Oevel
Tom Leemans

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. In the latest trends regarding more sustainable developments, MS polymers can play a key role to provide high performing solutions in different markets. With this technology a continuous progress is achieved both in polymer design and practical applications.

In the view of a more greener future, fast improvements in the current construction market are needed to get new & refurbished buildings more energy efficient, and even carbon neutral. In this respect, a foil adhesive will be presented that is part of the building envelope to create a barrier to reduce the energy losses within buildings. The design of the MS polymer™ grades are done in a way that they can be combined with different other raw materials as well. The permanent tackiness of such products allows for a circular way of building. 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.

ADHESIVE BONDING IN THE CIRCULAR ECONOMY – CONTRADICTION OR OPPORTUNITY

KLEBTECHNIK Dr. Hartwig Lohse; DE-Breitenberg
Dr. Hartwig Lohse

Abstract:
While in the past the most important question when deciding for or against an adhesive bond was whether it would hold, the proven durability of adhesions is now being used as an argument against bonding. Since adhesions are proven to hold, it is often concluded that adhesions cannot be removed and are therefore not suitable for a circular economy because they supposedly prevent or complicate recycling and reparability.

That this is not correct is shown by a multitude of examples from various fields and not least by the standard DIN/TS 54405 Construction adhesives – Guideline for separation and recycling of adhesives and substrates from bonded joints, which was published in December 2020 and is currently being transferred into an ISO standard with the addition of an appendix with examples from practice.

Furthermore, it must be pointed out that circularity should not be reduced to recyclability and reparability. The basic concept of the circular economy is built on nine so-called R-strategies. Recyclability and reparability are ranked quite low in the hierarchy of R-strategies, at 8th and 7th position respectively.

Furthermore, it must be emphasised that circularity must not be reduced to recyclability and reparability. The basic concept of a circular economy is based on nine so-called R-strategies. Recyclability and reparability are ranked rather low in the hierarchy of R-strategies, at 8th and 7th place respectively. The R-strategy ‘Reduce’, i.e. increasing resource efficiency in the manufacture or use of a product, comes in third. Extending the lifespan of a product contributes to the more intensive and prolonged use of products e.g. via new business models like product-as-a-service (R-strategy Rethink, position 2). The assessment of circularity thus requires a holistic consideration and evaluation, taking into account all 9 R-strategies, but also the other requirements placed on a product, in order to ultimately achieve the optimum.

In European and international standardisation, various standardisation projects are ongoing or have already been completed to provide users in a wide range of industries with support in product development... but there is still a long way to go.

AMBIENT-CURABLE, CRASH TOUGHENED STRUCTURAL ADHESIVES WITH PROPERTIES CLOSER TO HEAT-ACTIVATED ADHESIVES

L&L Products; US-Romeo, MI
Dr. Yuan Lu

Abstract:
Crash toughened structural adhesives have been widely used in various industries, particularly the automotive industry. These adhesives have been used to increase the stiffness of the car body for driving comfort and allow the use of lightweight materials for fuel efficiency. When used in combination with mechanical fastening including welding and riveting, these structural adhesives improve crash worthiness of a vehicle due to even distribution of the load and the toughened bonding. Typically, these adhesives require heat to activate the curing chemistry. High heat generally facilitates high crosslinking density and improved adhesion to lubricant contaminated surface, both of which contribute to bond durability upon exposure to harsh conditions. Additionally,

phase-separation toughening mechanism of carboxyl-terminated butadiene-acrylonitrile rubber and urethane-based tougheners also relies heavily on curing at high temperatures.

This performance dependence on cure temperature explains the property gap between ambient-curable adhesives and heat-activated adhesives. Ambient-curable adhesives in the market often suffer from inferior toughness, poor adhesion to contaminated surfaces, and chemical resistance. In this paper/presentation, L&L Products' ambient-curable adhesives will be showcased as examples with properties closer to heat-activated counterparts. By utilizing a proprietary combination of chain extenders, phase-separating tougheners, high-molecular weight polymers, and flexibilizers, L&L Products' ambient-curable adhesives demonstrate increased plastic nature, improved toughening, and matrix flexibilization for high peel and impact resistance. The unique selection of the above-mentioned ingredients enables reduced shrinkage upon curing, superior chemical resistance, and improved adhesion, providing a durable bond against harsh conditions. These adhesives are characterized by high lap shear strength (>20 MPa), wedge impact peel strength (> 30 N/mm), T peel strength (> 9 N/mm), superior adhesion to lubricant and mold release contaminated surfaces, and excellent resistance against exposure to humidity, salt spray, and highly caustic media.

TWO-COMPONENT, FLAME-RESISTANT ADHESIVES AND FOAMING ADHESIVES, REINFORCING FILLERS AND SEALANTS

L&L Products; US-Romeo, MI
Hamid Mortazavian, PhD

Abstract:
In the race for electric vehicle manufacturers and suppliers to launch innovative and safe battery designs with increased range and reduced cost, diversity of thought and exploration has led to greater variation in design and material choices. A plethora of metals, polymers, composites and inorganics has created unique assembly and bonding challenges. The necessity for novel fire-resistant adhesives, foaming adhesives, and sealants has increased to bond and seal new types of joints.

The market for fire-resistant, ambient-cured adhesives has been dominated by chemistries (mercaptan and amine cured epoxies and urethanes) that fail to provide durable structural bonding on diverse substrates. Most of these chemistries require significant surface treatments to bond to common substrates in the EV market. More importantly, they fail to provide a combination of both high lap shear and high T-peel resistance. This deficiency makes them ill-suited for use as structural assembly adhesives where bending, peeling, and off-axis loading occurs in their applications. Fire-resistant adhesives with effective multi-material bonding, without surface treatment, and a combination of high lap shear and T-peel resistance are a versatile and necessary tool for today's EV manufacturers.

L&L Products has innovated a series of fire-resistant, two-component structural adhesives, sealants and low density encapsulating foaming products. These products provide durable adhesion to a wide range of substrates, notably those that commonly are used in the EV market, with minimal to no surface treatment and high peel strength. This L&L developed technology is also VOC and isocyanate free, especially important with increasingly stringent emission standards and workplace chemical safety requirements.

The L&L developed technology is inherently flame resistant in absence of any fire-retardant additives, typically UL 94 HB. The flame resistance performance results from the novel curative side. The inclusion of fire-retardant additives improves the already-present fire-resistant properties of the material to UL 94 V0 level. These two-part systems require small amounts of fire-retardant additives (as low as 10%) to pass the UL 94 V0 test. The inclusion of small ratios of fire-retardants compared

to competitor's products (where 30-50% flame-retardant additives are needed) helps increase the mechanical and physical properties of L&L's technology over other market options.

This L&L fire-resistant technology permits simultaneous curing and foaming, with tunable densities as low as 0.25 g/cm3. This enables bonding of substrates with imperfect alignment and variable gaps. Additionally, these adhesives can be soft or rigid. This enables a variety of products including those designed with high modulus for load transfer and reinforcement in battery packs, tough assembly adhesives, and flexible sealants or encapsulants. A greater variety of substrates can be joined with a singular adhesive, and problem areas can be reinforced or sealed selectively as needed. The balance of fire-resistance, mechanical properties, safety benefits, multi-substrate compatibility, and product classes enhances design flexibility for EV and battery manufacturers in today's evolving market.

BLOCK COPOLYMER PHASES IN EPOXY - FORMATION, STRUCTURE AND PROPERTIES

[1]Leibniz-Institut für Verbundwerkstoffe; DE-Kaiserslautern
[2]University of Kaiserslautern-Landau RPTU / AWOK; DE-Kaiserslautern
Claudius Pirro*[1], Sarah Karazma[1], Andreas Klingler[1], Jan-Kristian Krüger[1], Paul-Ludwig Geiß[2], Ulf Breuer[1], Bernd Wetzel[1]

Abstract:
Whether used as an adhesive or as a matrix material in composites, epoxies are widely used because of their low weight, high specific strength, high stiffness, low shrinkage and low water absorption [1]. However, a major drawback is their brittleness. The addition of block copolymers (BCPs) is one way to increase the fracture toughness of epoxies, while having only a marginal effect on the glass transition temperature of the material [2]. BCPs are able to self-assemble into different phases during the curing process. Using temperature modulated optical refractometry (TMOR), it is possible to follow the phase separation process in situ [3]. It is observed that the phase separation process and the first vitrification are directly related in time. Depending on the process conditions (temperature and time), the block copolymers phase separate into nano- to micron-sized phases during the curing process. Nanoscale phases are formed by very slow vitrification at 23 °C, while microscopically small structures occur at higher temperatures, e.g. at 80 °C (see Figure 1).

Fracture mechanics tests show that the critical stress intensity factor K_{1c} can be increased from a value of 0.6 ± 0.1 MPa $m^{0.5}$ of the unfilled epoxy system to up to 1.4 ± 0.07 MPa $m^{0.5}$ by the addition of 5 wt.-% BCPs. In this context, the formation of nanoscale phases leads to a much higher fracture toughness compared to the micro-phases.

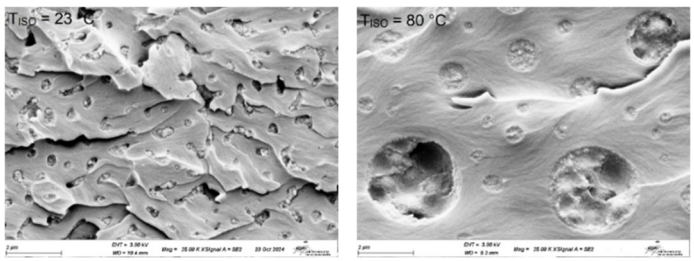

Figure 1.
CT-Fracture surface of 5 wt.-% BCP modified Epoxy after curing at T_{ISO} = 23 °C/ 120 h (left) and at T_{ISO} = 80 °C/ 4 h (right), both followed by 90 °C/ 4 h, 105 °C/ 2 h and 125 °C/ 20 h (SEM images)

Acknowledgements: We would like to thank Arkema S.A. for providing materials.

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COMPREHENSIVE MULTI-SAMPLE ADHESION TESTING OF HIGH-END COMPONENTS FOR THE ENERGY SUPPLY OF TOMORROW

LUM GmbH; DE-Berlin
Stefan Küchler

Abstract:
Batteries are the heart of electrical vehicles (EV) and most electronic devices as well as core components of aircraft or handheld medical devices. Huge efforts are spent to increase their capacity, life time and safety, while reducing production costs employing new materials and technologies. A crucial role in battery development plays the cohesion inside the electrode material as well as the adhesion between the electrode base (Cu, Al) and its coating. Both defines essentially the battery performance and lifetime under real world conditions.

With the LUMiFrac Adhesion Analyser we introduce a robust and reliable high throughput tool for fast screening of battery and fuel cells. Selected results from recently finished projects will be presented. Selected case studies demonstrate the high potential of the analyzer for tensile and shear strength determination of electrode preparations for batteries and fuel cells.

In a second topic we present results focussing on state-of-the-art lightweight components for renewable energy generation. Blades of wind turbines require high end coatings to resist to harsh operation conditions. Layers of different functionality are employed and have to adhere to the basic structure and to each other. The case study illustrates the challenges and chances of the Centrifugal Adhesion Testing method for this more than ever ongoing topic.

REPLACEMENT OF SOLVENT-BASED PRIMERS USING OPENAIR-PLASMA® FOR ADHESIVE BONDING

Plasmatreat; DE-Steinhagen
Klaus Kresser

Abstract:
The transition from solvent-based primers to Openair-Plasma® technology represents a significant advancement in bonding applications across various industries. Openair-Plasma® offers an environmentally friendly alternative by eliminating volatile organic compounds (VOCs) associated with traditional solvent-based primers. This technology enhances surface energy, thereby improving wettability and adhesion properties of substrates such as plastics, metals, and composites.

Openair-Plasma® operates under atmospheric pressure, making it suitable for inline integration into existing production processes. This results in increased production efficiency, reduced manual intervention, and lower operational costs. Additionally, the technology's ability to uniformly treat complex geometries and large surface areas ensures consistent quality and performance.

The adoption of Openair-Plasma® not only aligns with stringent environmental regulations but also meets the growing demand for sustainable manufacturing practices. By replacing solvent-based primers, industries can achieve superior bonding strength, enhanced durability, and overall improved product quality. This abstract highlight the potential of Openair-Plasma® to revolutionize surface treatment processes, paving the way for more sustainable and efficient industrial applications.

THERMAL AND MECHANICAL PROPERTY OPTIMIZATION OF 2C EPOXY ADHESIVES USED IN NAVIGATION SYSTEMS VIA DOPING

Roketsan;TR-Ankara
Eray Humali*, Kübra Doğan

Abstract:
Inertial navigation systems are highly sensitive electronic and optical systems that measure position and orientation in the global 3-axis. For performing precise measurement, micron to centimeter-sized parts which are composed of sophisticated and various material types must work in harmony with each other. 2-component (2C) epoxy adhesives are used for bonding these parts due to their uniform stress distribution, planar force transmission, and corrosion resistance. In order to maintain measurement accuracy at different temperatures, materials with a low coefficient of linear thermal expansion (CTE) are preferred. Special glass and invar alloys with CTE of 0.02-0.05 ppm/ºC and 0.4-1.6 ppm/ºC, respectively are frequently used. Invar is the general name of an iron-nickel alloy with a nickel content ranging between 32-36%.

While 2K epoxy adhesives are chemically, thermally, and mechanically stable, they are far from the mentioned values regarding the CTE due to their polymeric nature. Mechanical stress occurs at the interfaces of bonded parts exposed to temperature variations. This stress distribution directly depends on the CTE of the parts and the adhesive used. In order to obtain a low and homogeneous stress distribution, the CTE of the 2C epoxy adhesive used should be well determined.
Moreover, the adhesive used can cause residual stress at the interface after curing, which also affects sensor performance. Therefore, residual stress optimization of physically rigid adhesives is crucial for sensor performance.

In the present study, CTE and residual stress optimization were carried out by doping micro/nano-powder to Loctite EA9412, Loctite EA0151, and Loctite EA3430 adhesives used in glass-glass and glass-metal bonding processes. Within the scope of the study, silicon dioxide (SiO2) and hexagonal boron nitride (h-BN) particles were doped into the relevant adhesive matrix at different ratios by mass according to the application area. In order to examine the effect of particle size on thermal and mechanical properties, powders with particle sizes of 15 µm and 44 µm for SiO2 and 70 nm for h-BN were used.

At the end of the study, mechanical, thermal, and stress distribution characterizations of the prepared specimens were completed by lap-shear tensile test, dilatometer, and polarimeter measurements, respectively. The achieved results were compared with the predetermined requirements. Afterwards the appropriate doping ratio, material, and particle size were decided for each application.

Keywords: 2C Epoxy, Doping, Coefficient of Thermal Expansion (CTE), Stress Distribution

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NEW ADHESIVE DRY FILMS

Surfactor Germany; DE-Schöppenstedt
Dr. Vladimirs Biziks

Abstract:
Surfactor has more than 75 years' experience on different type of prepreg production based on thermosetting resins. Usually, prepreg consist of two basic elements: fibrous, flexible tissue material (resin carrier) and different molecular size of thermosetting resin oligomers (resin). During the first step of prepreg production, carrier is fully or partly soaked with resin oligomers which are mixed in water. In the next step, the wet carrier material in gently manure is dried to remove the large amounts of the water until prepreg contains, depending on application area, several percent's of moisture. During this stage oligomers of thermosetting resin growth and are advanced to the B-stage (partly

polymerized). After that the impregnated or coated material (prepreg) can be stored for reasonable length of time under normal storage conditions. At the appropriated time, it can be laminated and hot pressed into a desired form under conditions which effect cure of the adhesive (full polymerization), known as a C-stage. All our products we could divide into two big groups: coating films for different type of wood based panels and dry glue films.

At Surfactor the majority of adhesive systems used are waterborne formaldehyde-based curing formulations, such as urea formaldehyde (UF), melamine formaldehyde (MF), phenol formaldehyde (PF), co-condensates of melamine-urea-phenol formaldehyde (MUPF) or mixtures of all above mentioned resins. However, products made with these adhesives emit formaldehyde, phenol and melamine, causing environmental pollution, health problems to the human body, and the like. In order to solve such problems, Surfactor invests energy to find new thermosetting resin system for new glue films.

The aim is to develop new adhesive system with broad adhesion spectrum to different type of substrates, such as, wood, carbon, metal, metal-polymer reinforcement wovens, polymers (PC or ABS) etc., and could be used for different application areas, such as, glue films for wood backed decorative veneers or such as, dry glue films for plywood assembling, etc. The new adhesive system must full fill at least three main criteria, listed as follow:

1) Free of phenol, melamine and formaldehyde and contain no or very low amount of volatile organic compounds (VOC);
2) Water based system with broad viscosity range
3) Curable in temperature range between 100-180 °C and during short time of heat application.

In this presentation the introduction with our existing glue films and few steps and findings on the development of new dry glue films will be presented

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VARIETY OF LASER BASED SURFACE TREATMENT – FROM CLEANING TO FUNCTIONALIZATION

TRUMPF Laser- und Systemtechnik; DE-Ditzingen
Volkan Yavuz

Abstract:
TRUMPF Laser & Systemtechnik SE is a high-tech company with a very broad product spectrum ranging from industrial laser sources to system solutions to optical sensor to novel products using quantum technology. Especially with the product portfolio of our industrial lasers we address solutions for various industries such as mobility and e-mobility, aerospace, medical, consumer electronics, energy, and data storage.

In particular, pulsed ns, ps and fs laser sources are becoming increasingly interesting for laser-based surface treatment, including cleaning, ablation, micro- and nano-structuring. The advantage of the laser as a surface treatment tool is that the workpiece is treated selectively, reproducibly, contact-free, without chemical additives and with minimal energy input. The laser is often used for pre-treatment for subsequent processes, such as bonding, welding, coating, sealing, or painting of workpieces, e.g. to increase the adhesive strength or improve welding quality. Moreover, laser surface structuring can be used to significantly improve or alter the properties of materials significantly, such as hydrophilicity and hydrophobicity, by creating micro- and nanoscale patterns. Furthermore, the requirements for surface preparation, e.g. the cleanliness of components and the absence of chemicals, have increased in sectors such as e-mobility or the semiconductor industry and are diverse and complex.

In this paper, we present the principles, mechanisms and recent advances in laser cleaning, ablation and structuring. We aim to demonstrate their potential for industrial applications, with a focus on e-mobility.

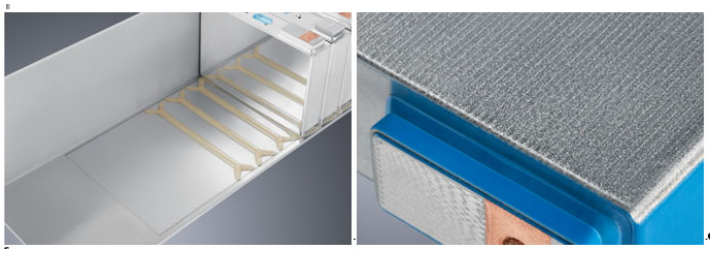

Figure 1:
right: Cleaning of the battery pack for adhesive preparation (cell-to-pack technology).
left: Cleaning of a prismatic battery cell as surface preparation for (a) coating and (b) welding (terminals).

ENHANCING ALUMINUM-ADHESIVE BONDING FOR AUTOMOTIVE USE VIA ATMOSPHERIC PLASMA POLYMER PRIMERS

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Abstract:
Improving the adhesion between aluminum and amine-based fast curing adhesives is crucial for automotive applications, where strong and durable joints are essential. We introduce a novel approach that replaces traditional primers with nanometer-thin plasma polymer layers deposited via atmospheric gliding arc plasma (AGAP) technology. This plasma polymer acts as an effective primer replacement, significantly enhancing the lap shear strength of adhesive bonds from 3-6 MPa on untreated aluminum to 15-20 MPa when combined with the amine-based fast curing adhesive. Changing the failure mechanism from adhesive to cohesive (see Figure 1).

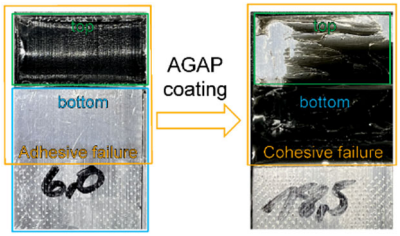

Figure 1:
Post-shear images of aluminum lap shear samples, showing uncoated (left) and AGAP-coated (right) surfaces.

Atmospheric gliding arc plasma deposition offers a rapid, solvent-free, and environmentally friendly method that can be seamlessly integrated into existing production lines and scaled up for industrial use. The process requires only electricity, benign and readily available gases, and minimal amounts of monomer precursor, eliminating the need for noble gases or toxic chemicals.

Comprehensive characterization of the plasma-polymerized aluminum surfaces was conducted using X-ray Photoelectron Spectroscopy (XPS), Confocal Scanning Laser Microscopy (CSLM), and ellipsometry to elucidate changes in sur-face chemistry and roughness induced by the plasma polymer. Mechanical evaluations, including lap shear and peel tests, confirmed the substantial improvement in adhesion strength when using the plasma polymer primer with the amine-based adhesive. Aging studies following PV1200 and PV1210 standards test the long-term durability of the adhesive bonds, exploring the technique's suitability for auto-motive applications.

Our findings establish that gliding arc plasma polymer primers are a viable and effective technique to enhance adhesion between aluminum and amine-based fast curing adhesives, offering significant implications for bonding applications in the automotive industry and beyond.

We would like to thank the Innosuisse agency for funding this project (102.681 IP-ENG)

References: https://www.plasmatreat.com/plasma-treatment/plasma-pretreatment/plasma-coating_nano_coating.html

FIBER-REINFORCED ADHESIVES - ANALYSIS, SIMULATION AND MODIFICATION OF THEIR ANISOTROPIC PROPERTIES

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Abstract:
Short-fiber-reinforced adhesives are essential for the production of very large and at the same time highly stressed adhesive layers, also with regard to the resulting adhesive layer volumes and the common tolerances. One example of such an application is the manufacturing of rotor blades for wind turbines, which are mainly produced by bonding prefabricated half-shells, webs and spars using large quantities of adhesive. In the context of in-depth experimental investigations on adhesive tensile specimens made of short-fiber-reinforced adhesives, significant fluctuations in stiffness and strength were determined in mechanical characteristic value determinations. The cause of this behavior was identified as a systematic alignment of the short glass fibers due to the adhesive bead application and the subsequent flow process in the adhesive joint caused by the joining process. This identified anisotropy offers the possibility of specifically influencing the properties (in particular strength and stiffness) of the bonded joint (possibly even locally) in order to adapt it to specific requirements.

Non-destructive micro-computed tomography (µ-CT) is used for analysis to gain an understanding of the cause and effect of the alignment of short fibers in structural adhesives resulting from the application process. On the one hand, the three-dimensional structure of the adhesive layer in the volume is examined in order to be able to carry out further mechanical tests on specifically isotropically or anisotropically produced adhesive samples and investigate the adhesive properties. On the other hand, an algorithm for fiber reconstruction is used to determine the fiber orientation and the corresponding orientation tensors. Using adhesive samples from various parameterized application processes, the specific orientation tensors as well as flow-related fiber orientations are analyzed. The results from the investigations of the process-related influencing variables on the fiber orientation via µ-CT serve as experimental calibration data for the validation of models of numerical flow simulations for the prediction of local fiber movements and orientations depending on the adhesive application and the joining process.