in-adhesives 2025
Munich, February 12, 2025

Abstracts Day 2

in-adhesives
Symposium on Innovations in
Adhesives and their Applications

December 2, 2024

Wednesday, February 12, 2025

09:00 – 09:25

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.

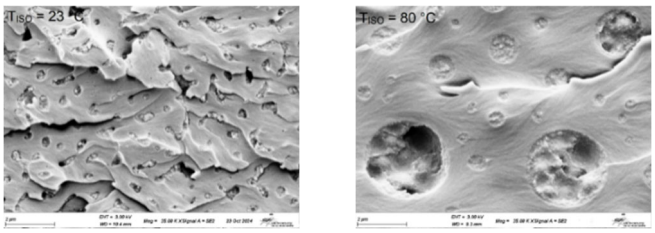

Figure 1.
CT-Fracture surface of 5 wt.-% BCP modified Epoxy after curing at T_{ISO} = 23 °C/ 120 h (left) and at T_{ISO} = 80 °C/ 4 h (right), both followed by 90 °C/ 4 h, 105 °C/ 2 h and 125 °C/ 20 h (SEM images)

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

References:

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[3] A. Klingler, M. Gilberg, B. Wetzel, U. Breuer, and J.-K. Krüger, 'Temperature-rate induced polymerization and phase separation of block copolymer toughened polymer composites', Compos. Sci. Technol., vol. 230, p. 109329, Nov. 2022, doi: 10.1016/j.compscitech.2022.109329.

09:25 – 09:50

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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09:50 – 10:15

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.

10:15 – 10:45 REFRESHMENT BREAK

10:45 – 11:10

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.

11:10 – 11:35

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.

11:35 – 12:00

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

Bodo Möller Chemie; DE-Offenbach am Main
Bernhard Vreden

Abstract:
Adhesive bonding has been contributing to the improvement of both the efficiency in production and the performance of the final product. Structural adhesive joints used to be designed only with maximum durability and resilience in mind.

While such requirements continue to increase, sustainability has become a focal point. In this regard, adhesive formulations are being measured against their impact on the environment, their CO2-footprint as well as their capability to enable circular economy. Meeting these new standards is adding a new level of complexity and demands a high level of innovation.

In this presentation we discuss innovative product solutions addressing these future trends such as eco-friendly manufactured adhesives, low-temperature-cured adhesives and debonding-on-demand technology, that allow adhesive joints to be deliberately separated.
About Bodo Möller Chemie: We believe that sustainability calls for more speed and investments to tackle the challenges the industry is facing today. We are specialized in the

technical product and application consulting of adhesives, sealants, dielectric-, thermally conductive and electrically conductive materials from leading manufacturers and their associated process solutions.

12:00 – 13:30 LUNCH

13:30 – 13:55

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.

13:55 – 14:20

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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14:20 – 14:45

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.

14:45 – 15:10

THE BEST OF BOTH WORLDS: NEW DISPERSION TECHNOLOGY TAKES ON SOME OF THE ADVANTAGES OF HOTMELT ADHESIVES

Jowat; DE-Detmold
Dr. Hartmut Henneken

Abstract:
Coming soon

15:10 – 13:30 FAREWELL
