



PREPOLYMERS: PRODUCTS AND APPLICATIONS

POLYISOCYANATES

PREPOLYMERS

DISPERSIONS

UV SYSTEMS



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BAYER MATERIALSCIENCE

SCIENCE FOR A BETTER LIFE



Bayer MaterialScience – the name stands for the materials that the company develops and produces. Bayer MaterialScience also stands for the know-how and expertise of its employees all over the world. With growth products, excellent technologies and a well-stocked innovation pipeline, Bayer MaterialScience aims to extend its market leadership. In pursuing this goal, our employees, society as a whole and the environment are accorded just as much importance as the well-being of the company.

Material: The materials we develop. For new products and new markets. With our expertise as innovator in polymer materials, we know how to turn innovations into real-world applications for our customers.

Science: The knowledge on which our work is based. Our intuitive feeling for research with perspective has developed over several decades. Together with a global network of interdisciplinary thinking, it provides the driving force for leading-edge, innovative and sustainable solutions.

BUSINESS UNIT CAS

CLOSE TO THE CUSTOMER



The Coatings, Adhesives, Specialties Business Unit (BU CAS) offers a comprehensive range of raw materials for system solutions in these sectors.

Our products are based primarily on polyurethane chemistry. Its outstanding expertise and long years of experience make Bayer MaterialScience one of the world's leading suppliers in this field.

CAS raw materials are used in wide range of applications. Products formulated with these materials protect aircraft, railcars, ships and even oil platforms against the effects of weather and corrosion. They also help ensure that red wine, cleaning agents and other "attackers" cannot harm furniture or parquet flooring. CAS raw materials can even be used to provide concrete with lasting protection against abrasion and weathering.

Another area of application for BU CAS products is the formulation of adhesives, in particular in the shoe, furniture, automotive and construction industries. We also offer sealant raw materials for use primarily in the construction industry.

In all the activities of the **Coatings, Adhesives, Specialties Business Unit (CAS)**, the customer is key. To enable it to offer the right solution for every field of application, CAS is focused on the

strategic segments: Polyisocyanates and Prepolymers, Dispersions and UV systems. In each of these segments, customers can benefit from our wide-ranging experience and long-standing know-how. For us as technology leaders, the development of innovative solutions for and with our customers is one of our core competencies.

Thanks to our great innovative strength, we are not only naturally focused on the demands of existing markets, but also want to create and tap into new markets. Our success in this respect is based on intensive research work in our own modern laboratories and constant dialogue with our customers. Even though we discovered polyurethanes and are the technology leader for polyurethane-based coatings and adhesive raw materials, we are constantly working to expand and improve our unrivalled expertise.

We are wholeheartedly committed to developing solutions for and with our customers, and to delivering tailor-made products and pioneering process innovations.

This brochure contains a wealth of information about the wide variety of potential applications and products from BU CAS's line of prepolymers.

PREPOLYMERS:

IT'S ALL IN THE MIX



Innovation is our tradition. With the breakthrough discovery of the polyisocyanate-polyaddition process in 1937 by Otto Bayer, Bayer became a pioneer of polyurethane chemistry. 50 years ago, Bayer AG developed the first applications using polyisocyanates for the coatings and adhesives sectors. Polyurethane systems – also known as “DD coatings” – have established themselves in a number of applications. We work closely with our customers to systematically advance the state of polyurethane technology. Using market-oriented research and development, we specifically adapt our product portfolio to the increasingly stringent requirements of our customers. We want to continue our successful journey along this path with you.

Our product range comprises aromatic and aliphatic NCO-terminated prepolymers based on HDI, TDI, MDI and IPDI, as well as silane-terminated prepolymers for adhesives, sealants and coatings. Our customers use these products as NCO or silane-functional components in the formulation of solvent-free and water-free adhe-

sives, sealants and coatings, and as the isocyanate components in two-component formulations. Of course we also supply you with our well established solvent born prepolymers.

The properties of the finished coatings, adhesives and sealants can be varied over a wide range by selecting the right prepolymer and adapting the formulation. Examples include adhesion properties, in particular when using silane-modified prepolymers, mechanical properties, and also application behavior, which can be controlled by varying e.g. parameters as reactivity and viscosity. Prepolymers with a low fraction of non-polymer-bound constituents open up formulating options for the production of reactive polyurethane adhesive and sealants that are not subject to labeling requirements.

Areas of application already exhibiting strong growth include elastic bonds in transportation, in the construction sector (parquet adhesives, engineered wood construction), for flexible film lamination, high-performance bonding applications and in sealants.

 **DESMODUR®**

 **DESMOSEAL®**

APPLICATIONS
HIGHLIGHTS



... Sealant applications



... Flexible adhesives



... Corrosion protection coatings



... Adhesives for modern
timber constructions



... Floorings



... Coatings for bridges



... Parking decks



... Parquet coatings



... Marine coatings


DESMODUR®

DESMODUR® AND DESMOSEAL® M prepolymers are the reaction products of aromatic or aliphatic isocyanates and polyols such as polyethers or polyesters. Due to the wide variability of the building blocks, isocyanate content and functionality, the viscosity of the prepolymers and the mechanical properties of the finished products can be precisely adjusted.


DESMOSEAL®

PREPOLYMERS BASED ON MDI

| Product | NCO [wt.%] | NCO deviation [wt.%] | Viscosity [mPas] | Viscosity @ temperature [°C] | Viscosity deviation [mPas] |
|--|------------|----------------------|------------------|------------------------------|----------------------------|
| Desmodur® VH 20 N | 24,5 | 0.5 | 280 | 25 | 80 |
| Desmodur® VKP 79 | 24.3 | 0.5 | 700 | 25 | 200 |
| Desmodur® E 29 | 24.0 | 1.0 | 220 | 25 | 80 |
| Desmodur® PF | 23.0 | 0.5 | 600 | 25 | 100 |
| Desmodur® E21 | 16 | 0.7 | 5,400 | 25 | 1,300 |
| Desmodur® XP 2665 | 15.8 | 0.7 | 5,250 | 25 | 1,250 |
| Desmodur® XP 2521 | approx. 16 | - | approx. 1,200 | 25 | - |
| Desmodur® E 20100 | 15.7 | 0.5 | 1,100 | 23 | 400 |
| Desmodur® E XP 2727 | 15.25 | 0.25 | 800 | 23 | 200 |
| Desmodur® E XP 2723 (formerly Desmodur® VPPU38IFo4) | 15.4 | - | 1,500 | 25 | - |
| Desmodur® E 23 | 15.4 | 0.4 | 1,800 | 23 | 250 |
| Desmodur® E XP 2715 | 15.1 | 0.3 | 910 | 70 | - |
| Desmodur® XP 2505 | 13.2 | 0.7 | 6,500 | 25 | 1,200 |
| Desmodur® E 2200/76 | 9.85 | 0.25 | 2,750 | 25 | 750 |
| Desmodur® E 22 | 8.6 | 0.3 | 2,800 | 23 | 400 |
| Desmodur® E XP 2726 | 6.0 | - | 4,500 | 23 | - |
| Desmoseal® M 280 | 2.1 | 0.3 | 33,000 | 23 | 7,000 |
| Low free monomer product | NCO [wt.%] | NCO deviation [wt.%] | Viscosity [mPas] | Viscosity @ temperature [°C] | Monomer content [wt.-%] |
| Desmodur® VPLS2397 | 5.6 | 0.3 | 10,000 ± 2000 | 50 | ≤ 0.15 |



| Approx. functionality | Molecular weight [g/mol] | Applications & Properties |
|-----------------------|--------------------------|---|
| 2.1 | 350 | Gymnasium floors, storage stable at low temperatures |
| 2.2 | 380 | Based on polymeric MDI |
| 2.2 | 380 | Primer for flooring applications, binder for corrosion protection |
| 2.0 | 370 | Hot melts, modified monomeric MDI, liquid at room temperature, storage stable at low temperatures |
| 2.8 | 720 | Wood bonding, binder for corrosion protection |
| 2.7 | 720 | Wood bonding, higher reactivity compared to Desmodur® E21 |
| 2.0 | 530 | Hydrophobic prepolymer 1K and 2K adhesives |
| 2.0 | 540 | Injection resin for sealing water-conveying cracks in structures above and below ground |
| 2.0 | 550 | 1K and 2K binder for corrosion protection and adhesives |
| 2.3 | 620 | 1K and 2K adhesives |
| 2.1 | 560 | Wood bonding, flexible packaging, binder for corrosion protection |
| 2.0 | 560 | Intermediate for binders or hardener for coatings and adhesives. Raw material for the formulation of low monomer containing reactive PUR hot melts. |
| 2.8 | 870 | 1K and 2K adhesives |
| 2.0 | 850 | Flexible packaging |
| 2.0 | 950 | Bonding of granulated rubber |
| 2.0 | 1,400 | Elastic 1K and 2K coatings, sealants and adhesives |
| 2.5 | 5,000 | Sealants, elastic adhesives |
| Approx. functionality | Molecular weight [g/mol] | Applications & Properties |
| 2.0 | 1,500 | Flexible packaging hot melts, polyether-based prepolymer |



DESMODUR® prepolymers are reaction products of aromatic or aliphatic isocyanates and polyols such as polyethers or polyesters. Due to the wide variability of the isocyanate content and functionality, the viscosity of the prepolymers and the mechanical properties of the finished products can be precisely adjusted.

PREPOLYMERS BASED ON TDI

| Product | NCO [wt.%] | NCO deviation [wt.%] | Solids content [wt.%] | Solvent | Monomer content [wt.-%] | Viscosity [mPas] | Viscosity @ temperature [°C] |
|---------------------------|------------|----------------------|-----------------------|---------|-------------------------|------------------|------------------------------|
| Desmodur® E 15 | 4.4 | 0.2 | 100 | - | < 0.5 | 7,000 | 23 |
| Desmodur® E 14 | 3.3 | 0.2 | 100 | - | < 0.5 | 6,800 | 23 |
| Desmodur® E 1361 MPA/X | 6.8 | 0.3 | approx. 61 | MPA/X | < 0.5 | 500 | 23 |
| Desmodur® E 1361 BA | 6.8 | 0.3 | approx. 61 | BA | < 0.5 | 250 | 23 |
| Desmodur® E 1160 | 5.4 | 0.3 | approx. 60 | MPA/X | < 0.5 | 550 | 23 |
| Desmodur® E 1750 PR | 5.4 | 0.4 | approx. 50 | MPA/X | < 0.5 | 375 | 23 |
| Desmodur® E 1660 | 5.3 | 0.3 | approx. 60 | BA | < 0.5 | 1,600 | 23 |
| Desmodur® E 1750/1 PR | 5.0 | 0.3 | approx. 50 | BA/X | < 0.5 | 500 | 23 |
| Desmodur® E XP 2605 | 4.5 | 0.3 | approx. 50 | BA | < 0.5 | 220 | 23 |
| Desmodur® E 1240 | 3.4 | 0.3 | approx. 40 | MPA/X | < 0.5 | 160 | 23 |
| Desmodur® E 1340 PR MPA/X | 3.3 | 0.2 | approx. 40 | MPA/X | < 0.5 | 95 | 23 |



| Viscosity deviation [mPas] | Color index [Iodine] | Approx. Functionality | Molecular weight [g/mol] | Applications & Properties |
|----------------------------|----------------------|-----------------------|--------------------------|---|
| 1,000 | ≤ 2 | 2.0 | 1,900 | Polyether based prepolymer for flexible coatings and membranes, |
| 1,200 | ≤ 2 | 2.5 | 3,100 | Polyether based prepolymer for flexible coatings and membranes, flexibilization in anti-corrosion protection |
| 250 | ≤ 3 | 2.8 | 1,700 | Fast drying 1K moisture-curing coatings, good resistance |
| 150 | ≤ 3 | 2.8 | 1,700 | See E 1361 MPA/X |
| 200 | ≤ 3 | 3.0 | 2,300 | 1K moisture-curing coatings with good resistance properties |
| 75 | ≤ 2 | 2.5 | 1,950 | See E 1361 MPA/X |
| 800 | ≤ 3 | 2.0 | 1,600 | 1K moisture-curing coatings in combination with other Desmodur® E types: good resistance properties and very fast drying |
| 50 | ≤ 2 | 2.5 | 2,100 | TDI-prepolymer for 1K moisture-curing coatings |
| 50 | ≤ 2 | 2.0 | 1,870 | Very fast drying 1K moisture-curing clear coatings, good resistance, wood and furniture applications |
| 80 | ≤ 3 | 3.2 | 4,000 | 1K moisture-curing coatings, good resistance |
| 45 | ≤ 2 | 2.8 | 3,650 | Ready-to-use product for 1K moisture-curing coatings, good resistance |



DESMODUR® prepolymers based on aliphatic isocyanates like HDI or IPDI show good weather stability and are color stable. These unique properties are important for applications such as corrosion protection or non yellowing coatings and adhesives.

PREPOLYMERS BASED ON ALIPHATIC ISOCYANATES

| Product | NCO [wt. %] | NCO deviation [wt. %] | Solids Content [wt. %] | Solvent | Monomer content [wt.-%] | Viscosity [mPas] | Viscosity @ temperature [°C] |
|-------------------------|-------------|-----------------------|------------------------|-----------|-------------------------|------------------|------------------------------|
| HDI PREPOLYMERS | | | | | | | |
| Desmodur® E XP 2747 | 16.9 | 0.4 | 100 | - | < 0.5 | 2,600 | 23 |
| Desmodur® E 305 | 12.8 | 0.5 | 100 | - | < 0.5 | 4,000 | 23 |
| Desmodur® XP 2617 | 12.5 | 1.0 | 100 | - | < 0.5 | 4,250 | 23 |
| Desmodur® XP 2599 | 6.0 | 0.5 | 100 | - | < 0.5 | 2,500 | 23 |
| Desmodur® E 3265 MPA/SN | 10.4 | 0.4 | 65 | MPA/SN100 | < 0.5 | 1,200 | 23 |
| Desmodur® E 3370 | 10.0 | 0.5 | 70 | MPA/SN100 | < 0.5 | 1,400 | 23 |
| IPDI PREPOLYMERS | | | | | | | |
| Desmodur® VPLS 2371 | approx. 3.7 | - | 100 | - | < 2.0 | approx. 11,000 | 23 |
| Desmodur® XP 2406 | approx. 2.8 | - | 80 | MPA | < 0.5 | approx. 7,000 | 23 |



| Viscosity deviation [mPas] | Color index [Iodine] | Approx. functionality | Molecular weight [g/mol] | Applications & Properties |
|----------------------------|----------------------|-----------------------|--------------------------|---|
| 500 | n. m. | 4.0 | 1,000 | Highly crosslinked PUR-material |
| 700 | n. m. | 2.0 | 680 | Polyether based prepolymer |
| 1,250 | n. m. | 2.0 | 680 | Polyether based prepolymer |
| 500 | n. m. | 4.0 | 2,800 | Fast tack free flooring coatings |
| 400 | ≤ 4 | 4.2 | 1,700 | Anti corrosion coatings, good weather stability, non yellowing, 1K application |
| 300 | ≤ 80 [Hazen] | 4.0 | 1,680 | Anti corrosion coatings, good weather stability, non yellowing, 1K application |
| - | n. m. | 2.0 | 2,200 | Polyether based prepolymer |
| - | ≤ 200 [Hazen] | 2.0 | 3,000 | Elastic coatings and sealants with very good weather stability |

Desmocap®



DESMODUR®

DESMOCAP® is a special form of prepolymers in which the isocyanate group is blocked, reducing the reactivity of the product. As a result, very fast reactions can be slowed or the reaction temperature can be increased. Blocked isocyanate prepolymers are used primarily in flexible coatings and sealants and for the flexibilization of epoxides.

BLOCKED ISOCYANATE PREPOLYMERS

| Product | Blocked NCO content [given as NCO wt. %] | Solids Content [wt.%] | Plasticizer | Free isocyanate content [wt.-%] | Viscosity [mPas] | Viscosity @ temperature [°C] |
|-------------------|---|--------------------------|-------------|------------------------------------|---------------------|---------------------------------|
| TDI-BASED | | | | | | |
| Desmocap® 11 | approx. 2.4 | 100 | - | < 0.2 | 100,000 | 23 |
| Desmocap® 1190 | approx. 2.2 | 90 | Adimoll® DO | < 0.2 | 30,000 | 23 |
| Desmocap® 12 | approx. 1.6 | 100 | - | < 0.2 | 40,000 | 23 |
| Desmocap® XP 2540 | approx. 2.5 | 100 | - | - | approx. 65,000 | 23 |
| HDI BASED | | | | | | |
| Desmodur® XP 2626 | approx. 3.0 | 100 | - | - | approx. 8,000 | 23 |



| Viscosity deviation [mPas] | Approx. functionality | Equivalent weight [g/mol] | Apparent epoxy equivalent weight | Applications & Properties |
|----------------------------|-----------------------|---------------------------|----------------------------------|--|
| 25,000 | 2.6 | 1,750 | approx. 930 | Elastic coatings and sealants, flexibilization of epoxy resins |
| 5,000 | 2.6 | 1,910 | approx. 1,030 | Elastic coatings and sealants, flexibilization of epoxy resins |
| 12,000 | 2.0 | 2,630 | approx. 1,500 | Elastic coatings and sealants, flexibilization of epoxy resins, stronger flexibilizing effect than D'cap 11 |
| | 2.0 | | approx. 1,200 | Elastic coatings and sealants, flexibilization of epoxy resins, free of nonylphenol |
| | 2.0 | 1,400 | | Elastic coatings and sealants, flexibilization of epoxy resins, split off free deblocking |



DESMOSEAL®

DESMOSEAL® S are silane terminated polyurethanes (STPs) which combine properties of polyurethanes with those of silicones to give a new class of prepolymers. These prepolymers are primarily designed to act as binders for moisture-curing sealants and elastic adhesives. They are high molecular weight prepolymers consisting of a polyurethane-backbone and a trifunctional silane end group.

SILANE-TERMINATED POLYURETHANES

| Product | Solids content [wt.%] | Plasticizer | Viscosity [mPas] |
|----------------------|-----------------------|-------------|------------------|
| Desmoseal® S XP 2636 | 100 | - | approx. 35,000 |
| Desmoseal® S XP 2458 | 90 | Mesamoll | approx. 35,000 |
| Desmoseal® S XP 2749 | 100 | - | approx. 6,000 |



| Viscosity @ temperature [°C] | Molecular weight | Applications & Properties |
|------------------------------|------------------|--|
| 23 | High | Sealants & adhesives, soft, low modulus prepolymer for sealants, good elastic recovery, high elongation at break |
| 23 | Medium | Sealants & adhesives, medium to high modulus prepolymer for elastic adhesives, high cohesive strength, good elongation at break |
| 23 | Low | Adhesives & coatings, medium to high modulus prepolymer for adhesives, primer, waterproofing membranes, good elastic properties, low elongation at break |

- BA = Butyl acetate
- HDI = Hexamethylene diisocyanate
- IPDI = Isophorone diisocyanate
- MDI = Diphenylmethane diisocyanate
- MPA = 1-Methoxypropylacetate-2
- SN = Solvent naphtha
- TDI = Toluene diisocyanate
- X = Xylene

INNOVATIONS

TAPPING FUTURE MARKETS



In addition to marketing our well-known product lines, CAS is also focused on tapping new areas of business.

The overall trend to further miniaturize and the need to continuously develop more cost efficient production processes down the value chain show significant growth potential for films applications and technologies. This is the focus of our newly established activities in the area of **Advanced Surface Technologies**. Be it polyurethane-, thermoplastic polyurethane- or polycarbonate-based applications. Co-extruded films, soft- or hard-coated films, formable by deep drawing or specialized with features like heat or scratch resistance – the variety of films are broad and they all are state of the art. Markets are high end electronics, displays, ID-cards and automotive, where they can serve with new functionalities and new design elements. Holographic films based on a unique class of easy-to-process materials will allow a wide range of applications such as 3D imaging or optical data storage and open the door to new light guiding concepts.



In the field of printed electronics our research focuses on semi-finished and integrated electro-active films. Developing highly integrated and multi-layered films with new functionalities like light, sensors, actuators and antennae in one part is one of our targets.

In addition, we use our existing know-how and competences to tap into new markets like **medical technology, cosmetics, nanotechnology** and **hybrid coatings**.

In the **medical device** market, we want to deploy our know-how in the field of polyurethane coatings and adhesives to improve existing medical products and develop completely new ones – to enhance medical treatment for patients and benefit our customers at the same time. Current activities involve new kinds of wound dressing materials and innovative coatings for implants.



In the **cosmetics and body care** market, polyurethane-based raw materials have so far played only a minor role, but we are convinced that our developments have significant potential and offer benefits that will give them access to a larger market.

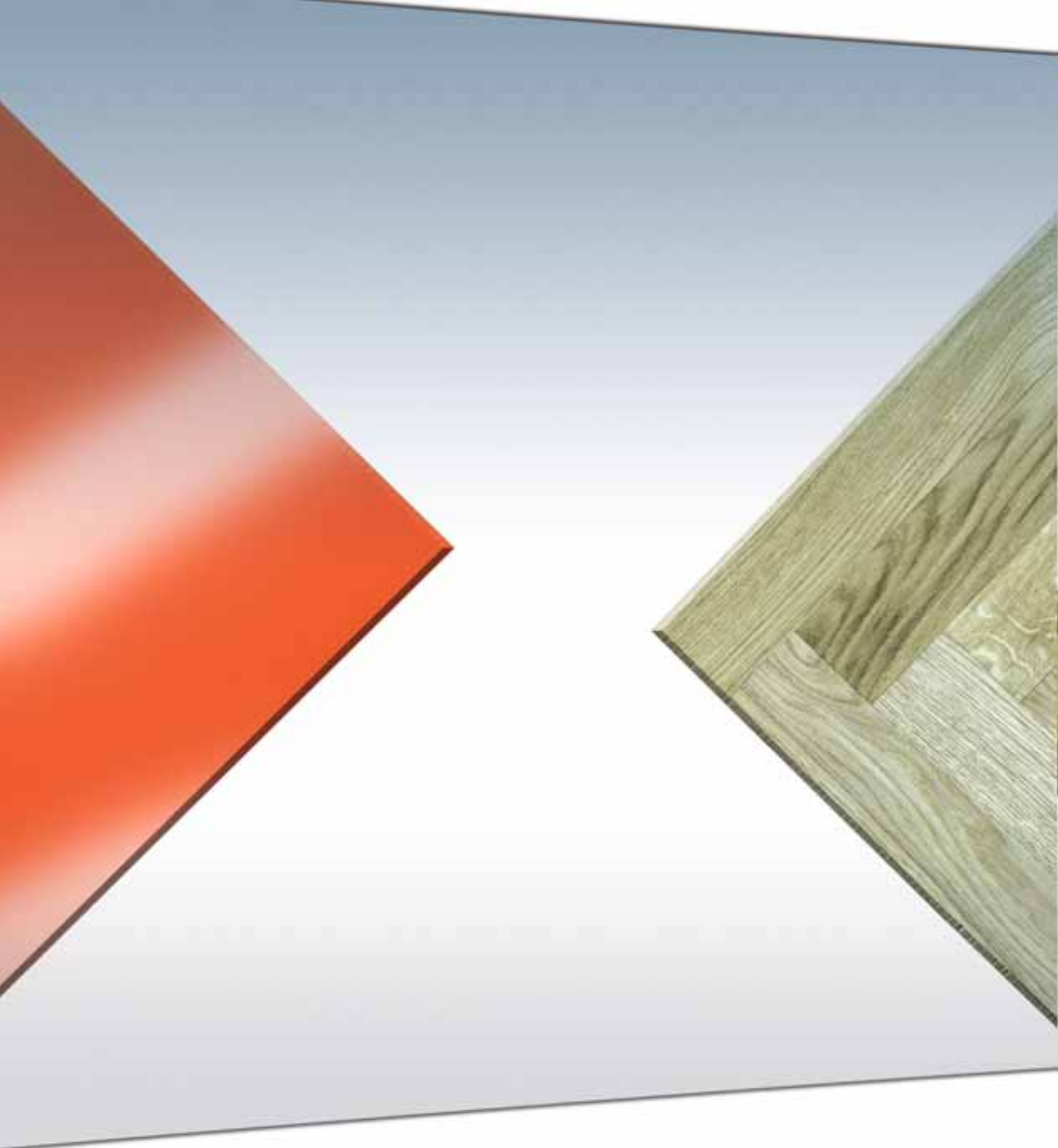
Our new waterborne aliphatic polyurethane dispersions and polyurethane-based powders, for example, are ideal for a wide range of hair-care, skin-care and make-up products. For hairsprays, mascara or facemasks, our materials guarantee optimum solutions for your products – whether hydrophobic or lipophobic, water-resistant or water vapor-permeable, elastic or rigid. Whatever the case, they are both practical and functional. By carefully combining the raw materials, we can develop a wide range of new product properties for our customers, offering unique possibilities and plenty of scope for innovation.

Nanotechnology is turning out to be an important sector with plenty of potential for coating applications. At CAS, we refine coating, adhesive and sealing raw materials using the nano- and sol-gel technology with the aim of offering our customers improved properties and opening up new applications. Raw material manufacturers and end-users expect the greatest technological advances to be made in scratch resist-

ance, and in self-cleaning and easy-to-clean coatings, but there will certainly also be improvements in resistance properties, antimicrobial properties, UV protection, water resistance, adhesion and photo catalysis. One example is the development of a technology platform that allows the haze-free dispersion of nanoparticles in our raw materials such as polyisocyanate hardeners or aqueous binders yielding products that exhibit a greatly improved performance profile. They are particularly scratch-resistant, weather-stable, chemical resistant and anti-adhesive. Polyurethane coatings that are used in high-tech applications because of their already outstanding performance can be improved even further through the use of this nano-modification technology.

Bayer MaterialScience is one of the few companies that can produce carbon nanotubes of consistently high quality on an industrial scale. Baytubes® – the brand name for Bayer's carbon nanotubes – are already being used to produce tough, extremely strong, lightweight and electrically conductive materials. In this way, rotor blades for wind turbines are more energy-efficient, transport containers weigh less and sports equipment can be made more robust. New possibilities include electrically conductive, antistatic and abrasion resistant coating systems.





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