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Edition: 2017 · Order No.: COV00082284 · Printed in Germany

Raw Materials for Flexible Packaging: Fulfilling Your Specific Needs

Baycoll® Bayhydur® Desmodur® Desmophen® Dispercoll®





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Baycoll® Bayhydur® Desmodur® Desmophen® Dispercoll®

Covestro – leading in material solutions

As the world's leading manufacturer of aliphatic and aromatic polyisocyanates, Covestro offers an extensive range of innovative products and solutions for the coatings and adhesives industries. As your customers become more demanding in their expectations for the quality, durability, workability and sustainability of your products, we can help you to turn these challenges into a competitive advantage. That is what drives us to push the boundaries of what is possible.

The key to creating added value for you, our customers, as well as for society and the environment is innovation. At Covestro we innovate not only to address the key global challenges of population growth, urbanization, climate change, digitalisation and increasing mobility; we innovate to have a sustainable business that enables us to live up to our business purpose of "making the world a brighter place". In the final analysis, this comes down to developing sustainable solutions that take the entire life cycle of a product into account. We are increasing our on-site efficiency, e.g., by recycling salt and water in our production plants. We are expanding our resource base, e.g., by turning CO₂ into a raw material in the manufacturing of plastics. And we are developing materials that are more energy-efficient and save natural resources.

In our Coatings, Adhesives, Specialties (CAS) segment we systematically develop and supply aliphatic and aromatic isocyanates and their derivatives as well as polyurethane dispersions. Our raw materials are used for coatings, adhesives, sealants and specialty products, such as elastomers, high-quality films, 3D printing products, cosmetics, textiles and medical products. The main application areas are in the automotive, transportation, infrastructure, construction, wood processing and furniture industries. In this segment our innovative efforts are focusing on enhancing efficiency, improving quality, boosting sustainability and environmental aspects such as reducing solvent content.

We are proud of over 80 years of groundbreaking innovations. But we are not defined by our past. Even with decades of experience behind us, Covestro remains a young enterprise. In a corporate world that can often be dull and uninspiring, we want to act in a curious, courageous, and colorful way: trying out new things, questioning established ways, and pushing boundaries – for your benefit.



Where the market for flexible packaging is heading

Social trends

Flexible packaging is growing as a result of several lifestyle and other social trends. One of them is the trend towards more convenience. People like to buy products that are easy-to-open and reclosable for use on the go. This situation-based convenience trend underlines the growing importance of functional integration and new solutions such as reclosing, lightweight, and easy-opening packaging.

Other lifestyle changes impacting on the industry include the increasing number of single households in developed countries, which is boosting the demand for more and smaller packaging sizes; the fast-growing market for pre-cooked meals in several regions of the world; and the need for flexible packaging to prolong shelf life and thus tackle the serious issue of food waste.

Demand for greater sustainability

The growth in flexible packaging is partly due to the fact that it is lighter than other packaging solutions like glass or metal, which makes it the more sustainable choice. This saves energy during transportation, which also makes it more cost-efficient. At the same time, the flexible packaging industry is constantly looking for solutions to make its packaging even more sustainable, i.e. through bio-based raw materials, even thinner materials, or recyclable solutions.

Stricter food safety regulations and standards

Packaged food regulations and internal guidelines of processing enterprises are becoming stricter, with new regulations and standards frequently issued. As a result, every member of the value chain from the raw material provider to the brand owner has to assess and ensure the safety of their products. The question of which raw materials are used for which individual packed product has to be considered throughout the value chain. And that is why the industry is looking for economical products that simultaneously deliver a high degree of safety and avoid risk.

Maximizing efficiency

In a competitive environment it is crucial for converters to operate at the highest possible level of efficiency. That means high lamination speeds as well as the shortest possible production-to-customer times. Since ever-faster changes in packaging design are leading to smaller order sizes, converters need to adapt their production to this changing environment with a high degree of flexibility, while at the same time maintaining a high level of efficiency.

Covestro is working on new product developments that will enable the flexible packaging industry to respond to these trends.



Our ambition – Providing you the best-in class solutions

Quality & supply security

Our products are of outstanding quality and we offer supply security – worldwide.

Covestro, the world's leading manufacturer of aliphatic and aromatic poly-isocyanates, offers an extensive range of raw materials and services for the coatings and adhesives industry. This allows the very latest technology to be used extremely effectively for a variety of applications. Our global setup enables you to increase your competitive advantage.

What we offer:

- A global network of research & development centers where our staff are dedicated to offering solutions for the coating and adhesive industry.
- A unique setup and worldwide network of state-of-the-art production sites ensuring short lead times and supply chain flexibility.
- Outstanding product quality through fulfilling the requirements of state-of-the-art quality, environmental and safety (HSEQ) as well as energy management standards; we are proud of having enjoyed ISO 9001, ISO 14001, ISO 18001 and ISO 50001 certifications for many years.

Covestro is your reliable partner for polyurethane chemistry.

Solutions to enhance your process efficiency

Nowadays, the quality demands made on industrial processes are very high. This is equally true of the cost-cutting requirements. However, both goals can be achieved by increasing process efficiency. At Covestro we have a wide range of solutions designed to enhance your process efficiency. Why not take advantage of our know-how? These solutions will benefit your bottom line.

Sustainability

Sustainability is at the heart of the Covestro strategy. We inspire innovation and drive growth through profitable products and technologies that benefit society and reduce the impact on the environment.

Renewable feedstocks, as one example, offer opportunities for developing more sustainable building blocks for flexible packaging – with significant potential for reducing the carbon

footprint of end products while also reducing our overall dependence on fossil-based resources. To make more sustainable solutions not just possible but also economically feasible, the performance of polyurethane adhesives, as the main technology for flexible packaging, needs to satisfy high industry standards. To this end, we are evaluating the use of renewable raw materials to enlarge our product portfolio with new bio-based and mid- to long-term cost-competitive products. In all these efforts we are committed to focusing on products that do not compromise performance while at same time are improving their contribution to sustainability.

Our coatings, adhesives and specialty products and solutions contribute to sustainability through:

• Saving energy – fast and smart

Polyurethane systems represent a benchmark in productivity and process efficiency in many industries. We strive to further push the limits of efficiency by developing game-changing new solutions.

• Reducing waste

We offer solutions such as innovative 1K technologies that enable our value chain partners to use materials more efficiently and reduce waste.

• Cutting emissions

Bayhydur® and Desmodur® grades are key enablers for low-emission solutions in the coatings and adhesives industries.

• Responsible management of natural resources

Highly durable PU-based coatings and adhesives significantly extend the lifetime of products applied to and thus help to prolong resource use.

• Closing the loop (circularity)

Through economically viable products made from bio-based raw materials– with no deterioration in performance – we help our customers and value chain partners to reduce their carbon footprint and offer solutions that incorporate renewable building blocks.

What we do

As a world-leading polymer and material science company, we inspire innovation and drive growth through profitable products and technologies that benefit society and reduce the impact on the environment.

Who does all this?

It's our people! And the way we work together as one global team following a set of six elementary principles – value creation, sustainability, innovation, focus on people, safety and fair play. This is our formula for success.

The right answer to your needs – our technology

Polyurethane adhesives – the main technology for flexible packaging laminates

Polyurethane (PU) adhesive polymers can be produced from a wide range of raw materials. The enormous adaptability of PU polymers allows adhesive manufacturers to provide tailor-made adhesive polymers for flexible packaging applications. PU adhesives are therefore the number one choice for producing film/film or film/foil laminates. PU adhesives are in use for all classes of laminates from general-purpose laminates for dry food up to high-performance laminates for steam sterilization processes at temperatures of up to 134°C and/or aggressive products. At Covestro we offer a broad range of raw materials for PU adhesives used for flexible packaging applications. Our product range

comprises aromatic and aliphatic diisocyanates, pre-polymers, aliphatic and aromatic cross-linkers, dispersions, as well as difunctional or polyfunctional polyether and polyester polyols. The raw materials we provide are manufactured in compliance with good manufacturing practice and fulfill the requirements of regulation (EC) 1935/2004.

The requirements for adhesives differ from market segment to market segment. Laminated film/film or film/foil composites are generally divided into three quality clusters: general-purpose, medium-performance, and high-performance laminates. The filling, the filling process, and the final use of the product determine the type of raw material to be used.

PU adhesives are in use for steam sterilization processes at temperatures of up to

134°C

Choose our raw materials suitable for your one- or two-component solvent-based, solvent-free or water-based polyurethane formulation

Solvent-based polyurethane

- Possibility to apply thick adhesive layer
- Very versatile formulations
- Mature technology
- Reaching highest performance levels

Solvent-free polyurethane

- Very high line speeds
- Typically used for general performance applications
- No need of solvent handling
- Low VOCs

Water-based polyurethane

- Initial bonding for direct slitting
- No need of hot room storage necessary
- Minimized lead times
- Lowest VOC level



General-purpose laminates

comprise film/film- or film/paper composites and are typically used to pack dry food in room-temperature storage conditions.

Medium-performance laminates

are used in fatty or acid food packaging, temperature treatment up to pasteurization temperatures, and foil laminates.

High-performance laminates

are used for boil-in bag applications, hot fillings, sterilization processes up to 134°C, pharmaceuticals, etc.

The more demanding the application, the higher the degree of resistance required against chemical degradation and heat in the adhesive polymer, and the more food safety aspects that have to be taken into account. The resistance of a polyurethane adhesive polymer can be significantly influenced by means of the polyurethane polymer building blocks, i.e. polyether or polyester polyol, the crosslinking density, and the molecular weight of the adhesive polymer. Our raw materials for polyurethane adhesives can be used to produce single- and two-component solvent-based, solvent-free and water-based adhesives.

Safe adhesives for safe food packaging

Laminated films and foils for flexible packaging need to meet demanding and very specific requirements. This is particularly true when they are being used for food or in medical applications. A polymer used in food packaging applications – in either direct or indirect food contact – has to comply with various regulations depending on the region the flexible packaging laminate is used in, for example:

- Regulation (EU) No. 10/2011
- BfR recommendation XXVIII (cross linked polyurethanes as adhesive layers for food packaging materials)
- FDA regulations in 21 CFR 175.105 (adhesives) and 21 CFR 177.1390 (laminated structures for use at temperatures of 250°F and above)
- Chinese hygienic standard GB 9685-2008

Upon request, we can provide you with a food contact use statement for suitable adhesive raw materials. Nevertheless, every adhesive manufacturer needs to make their own assessment of compliance for each particular adhesive formulation and provide a declaration of compliance to downstream users, i.e. converters and food manufacturers.

A broad portfolio to suit your needs

Building blocks for pre-polymer formation

Diisocyanates

Diisocyanates, and in particular the MDI-grades, are used in combination with polyether or/and polyester polyols for manufacturing NCO-terminated pre-polymers.

Desmodur® T, Desmodur® I and Desmodur® H are usually used to extend the molecular weight of polyether or polyester diols in order to adjust the processing window and adhesion properties of the adhesive polymer.



PRODUCT	TYPE	NCO CONTENT [%]		PROPERTIES/ APPLICATIONS
			VISCOSITY [mPa · s]	
Desmodur® 44M, liquid	4,4' MDI	33.6	4 at 40°C	Pre-polymer formation
Desmodur® LS 2424	MDI with high 2,4'-MDI isomer	33.6	12 at 25°C	Chain extender; pre-polymers with reduced viscosity or/and reduced monomer content.
Desmodur® 2460 M	MDI with high 2,4'-MDI isomer; color-stabilized	33.6	12 at 25°C	Chain extender; pre-polymers with reduced viscosity or/and reduced monomer content.
Desmodur® T 100	TDI with > 99.0% 2,4-TDI	48	3 at 25°C	Chain extender.
Desmodur® T 80	TDI with 80.5% 2,4-TDI	48	3 at 25°C	Chain extender.
Desmodur® I	IPDI	37.5	10 at 25°C	Chain extender.
Desmodur® H	HDI	49.7	3 at 25°C	Chain extender.

Building blocks for pre-polymer formation

Polyether and polyester diols

Polyester and polyether polyols can be used to produce both NCO- and OH-terminated pre-polymers for solvent-based or solvent-free one-component or two-component adhesives. Polyester polyols generally provide better adhesion to many substrates. Polyether polyols are used to reduce the processing viscosity and adjust the reactivity of the 2K polyurethane adhesives. Covestro offers a broad portfolio of polyester and polyether polyols that are suitable as building blocks for adhesives. The following table shows some selected examples.

Please see also our brochure "Resins – Polyols and Aspartics for Reaction with Polyisocyanates" for additional products.



PRODUCT	TYPE	OH NUMBER [mg KOH/g]		PROPERTIES/ APPLICATIONS
			VISCOSITY [mPa · s]	
Baycoll® AD 2047	Polyester diol	Approx. 56	Approx. 7,000 at 75°C	Hydrolysis resistance, slip agent compatibility.
Baycoll® AD 2055	Polyester diol	Approx. 56	Approx. 630 at 75°C	Hydrolysis resistance, slip agent compatibility.
Baycoll® CD 2084	Polyester diol	Approx. 84	Approx. 120 at 75°C	Compatibility, bifunctional.
Desmophen® 2060 BD	Polyether diol	Approx. 56	Approx. 310 at 25°C	Low viscosity, compatibility.
Desmophen® 1110 BD	Polyether diol	Approx. 112	Approx. 140 at 25°C	Low viscosity, compatibility.
Desmophen® 1400 BT	Polyether triol	Approx. 400	Approx. 370 at 25°C	Long pot life, short reaction time, compatibility, increase functionality.

Solutions for solvent-based adhesives



Isocyanate crosslinkers

Crosslinkers are used to crosslink solvent-based OH-terminated pre-polymers manufactured from polyether and/or polyester diols. The dosage of isocyanate crosslinker is usually in the range of isocyanate index 1.2–1.4. All isocyanate crosslinkers except Desmodur® ultra N 3300 are dissolved in ethyl acetate.

PRODUCT	TYPE	NCO CONTENT [%]		PROPERTIES/ APPLICATIONS
			VISCOSITY AT 23°C [mPa · s]	
Desmodur® L 75	Adduct of TDI/ TMP	13	1,600	Standard crosslinker for solvent-based adhesives.
Desmodur® ultra L 75	Adduct of TDI/ TMP	13.3	1,600	Crosslinker for solvent-based adhesives; low monomeric TDI content (< 0.1%).
Desmodur® HL EA	TDI isocyanurate	10.5	1,100	Highly functional crosslinker with partly aliphatic NCO groups for solvent-based adhesives.
Desmodur® ultra N 3300	HDI isocyanurate	21.8	3,000	Highly functional crosslinker with aliphatic NCO groups for solvent-based adhesives. Low monomeric HDI content (< 0.1%).
Desmodur® ultra N 3600	HDI trimer	23.0	1,200	HDI isocyanurate. Low monomeric HDI content (< 0.1%).



Solutions for solvent-free adhesives



NCO-terminated pre-polymers and polyfunctional isocyanates

NCO-terminated pre-polymers are reaction products of aromatic or aliphatic isocyanates and polyols, such as polyethers or polyesters. Thanks to the wide variability of the isocyanate content and functionality, the viscosity of the pre-polymers and the mechanical properties of the finished products can be precisely adjusted. NCO-terminated pre-polymers can be used as the isocyanate components of 2K solvent-free adhesive. The pre-polymers can be used individually or in combination with other pre-polymers, e.g., to adjust the processing viscosity or crosslinking density of the adhesive polymer.

Pre-polymers

PRODUCT	TYPE	NCO CONTENT [%]		VISCOSITY AT 23°C [mPa · s]	PROPERTIES/ APPLICATIONS
			MONOMERIC DIISOCYANATE		
Desmodur® E XP 2726	MDI pre-polymer	6.0	ca. 15%	4,500	Pre-polymers for solvent-free adhesives.
Desmodur® E 23	MDI pre-polymer	15.4	ca. 40%	1,800	Pre-polymers for solvent-free adhesives.
Desmodur® XP 2617	HDI pre-polymer	12.5	≤ 0.5%	4,250	Pre-polymers for solvent-free adhesives.

Crosslinker

PRODUCT	TYPE	NCO CONTENT [%]		VISCOSITY AT 23°C [mPa · s]	PROPERTIES/ APPLICATIONS
			MONOMERIC DIISOCYANATE		
Desmodur® ultra N 3600	HDI trimer	23.0	≤ 0.25%	1,200	HDI isocyanurate. Low monomeric HDI content (< 0.1%).
Desmodur® ultra N 3300	HDI trimer	21.8	≤ 0.15%	3,000	HDI isocyanurate. Low monomeric HDI content (< 0.1%).
Desmodur® ultra L 75	Adduct of TDI/TMP	13	< 0,1%	1,600	Standard crosslinker for solvent-based adhesives.



Solutions for water-based adhesives

Dispersions

Our water-based dispersions enable adhesive solutions that are both highly efficient and more sustainable. Laminates made from water-based adhesives can be immediately processed and thus help to optimize and reduce costs in a converter's production process.



PRODUCT	NON-VOLATILE CONTENT [%]		PROPERTIES/ APPLICATIONS	
	TYPE	VISCOSITY AT 23°C [mPa · s]		
Dispercoll® U XP 2643	Polyether-based PU dispersion	39–41	< 1,000	Dispercoll® polymer containing carboxyl groups in the polymer chain; can be crosslinked.
Dispercoll® U 2824 XP	Polyester-based PU dispersion	38–41	50–400	Dispercoll® polymer containing carboxyl groups in the polymer chain; can be crosslinked with isocyanate and polycarbodiimide.
Dispercoll® U 42	Polyester-based PU dispersion	48–52	150–800	Dispersion polymer can be crosslinked with isocyanate.
Dispercoll® U 2682	Polyester-based PU dispersion	49–51	< 1,000	Dispersion polymer can be crosslinked with isocyanate for formulation of industrially compostable adhesives.

Polyfunctional isocyanates

PRODUCT	ACTIVE INGREDIENTS	VISCOSITY AT 23°C [mPa · s]	PROPERTIES/ APPLICATIONS
Bayhydur® ultra 304	18.2% NCO	Approx. 4,000	Isocyanate crosslinker for water-based adhesives + higher functionality. Low monomer content (< 0.1%).
Bayhydur® ultra 3100	17.4% NCO	Approx. 2,800	Isocyanate crosslinker for water-based adhesives. Low monomer content (< 0.1%).
Desmodur® XP 2802	Approx. 1 mmol/g -N=C=N-	Approx. 30	Carbodiimide crosslinker for 1 component water-based adhesives containing carboxyl groups in the polymer chain; with long pot life (6 months) & very fast curing, direct slitting after lamination.



Safeguard your market position with our latest innovations

We regularly innovate to serve our customers with raw materials for adhesives that deliver on industry trends. Modern PU adhesives for flexible packaging applications ideally combine the benefits of easy handling, good process ability, fast curing, safe use by consumers, and the lowest possible environmental impact.

Process efficiency

Maintaining high converting line speeds, even under tough packaging performance requirements, is key to maximizing profitability. As our Dispercoll® U types for water-based adhesives enable sufficient curing directly after application on laminate substrates, direct downstream processing (e.g. slitting) is possible. This enables direct and food-safe delivery of reeled laminates to brand owners. Furthermore, our Desmodur® XP 2802 crosslinker can be incorporated into

water-based adhesives to produce a one-component system with the performance of a two-component system. Easy handling is ensured as mixing errors are prevented. Moreover, the long pot life of up to six months prevents adhesive waste.



Safe packaging

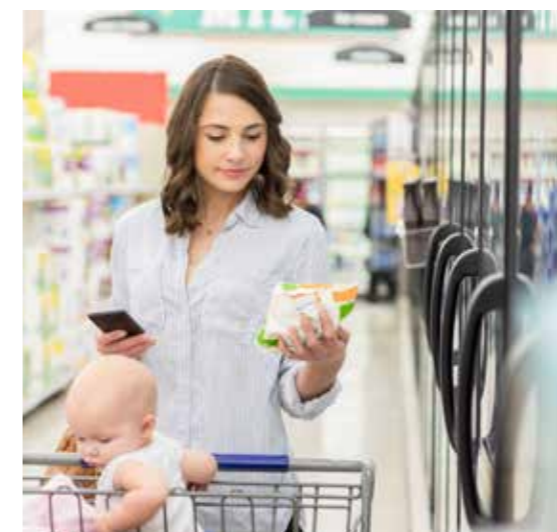
There is no compromising on safety. Our ultra line crosslinkers (e.g. Desmodur® ultra for solvent-based and solvent-free adhesives or Bayhydur® ultra for water-based adhesives) maximize safety for packed food. Thanks to their aliphatic structures there is no risk of polymeric aromatic amine formation. Additionally, workplace hygiene is maximized as monomeric content has been reduced to a minimum level (<0.1 %).



Sustainability

Flexible packaging already contributes to sustainability by preserving nutrients, extending the shelf life of food, and thus preventing food waste. At same time, material usage is minimized.

Nevertheless, the impact on the environment of plastic waste that is not correctly disposed of makes the news almost every day. So through our research and in close cooperation with our customers we are striving to improve flexible packaging with regards to sustainability in several ways. For example, we are improving its environmental footprint through the increased utilization of bio-based feedstocks, such as our Desmodur® eco line products. Moreover, Dispercoll® U 2682 is used for the formation of industrially compostable water-based adhesives (according to DIN EN 13432 and ASTM D 6400-04). And we are already working on the next step forward: raw materials for biodegradable adhesives. Together with our partner network along the value chain, we are further assessing adhesive-related potentials to improve sustainability aspects of multi-layer laminates.



Fast-lane access to polyurethane innovations

At Covestro, innovation is in our DNA. Ever since Otto Bayer discovered polyurethanes in 1937, we have been driving polyurethane innovations in coatings and adhesives as well as in other application areas. As our partner, you enjoy fast-lane access to polyurethane innovations, and can help us in developing the next generation of polyurethanes to meet the industry's upcoming challenges and needs. What can we offer you?

- Powerful know-how on both established and new polyisocyanates, as well as on new polyurethane hybrid technologies.
- The prospect of new application technologies to enable efficient processes.
- More sustainable, biomass- or CO₂-based materials that do not sacrifice high performance.

Join us to shape the future!

