Decorative Tech Talks

Addressing decorative macrotrends at Covestro

Enhancing multi-substrate adhesion with cutting-edge resin technology

Meeting the need for coatings that stick to multiple surfaces

As the use of composites, recycled materials, and mixed substrates becomes more popular in the decorative market, there's a growing need for coatings manufacturers to deliver multi-substrate adhesion. A long-running pioneer of adhesion technology, Covestro supports its customers to achieve adhesion through several innovative resin solutions. The most recent of these is a resin that combines particle morphology control with adhesion-promoting technology – enabling both multi-substrate adhesion and excellent coating performance.

covestro

WHITEPAPER

Multi-substrate adhesion: A fast-growing need

Decorative coatings are meant to protect and beautify our living spaces. But, to be useful, the coating first has to stick to its surface – whether that's a plastered wall, a metal outdoor fixture, or a wooden floor. Adhesion is a fundamental property in decorative coatings. And, as well as ensuring that coating finishes last, adhesion can also provide additional benefits such as eliminating the need for sanding, improved outdoor durability, and greater flexibility.

With the use of multiple substrates, composites, and recycled materials in outdoor decorative applications becoming more popular, manufacturers face the additional challenge of ensuring that their coatings adhere to a wide range of substrates. Indeed, this feature is in increasingly high demand from painters and consumers alike.

Covestro: Delivering innovative adhesion solutions
Covestro helps customers meet this demand through several innovative adhesion technologies:

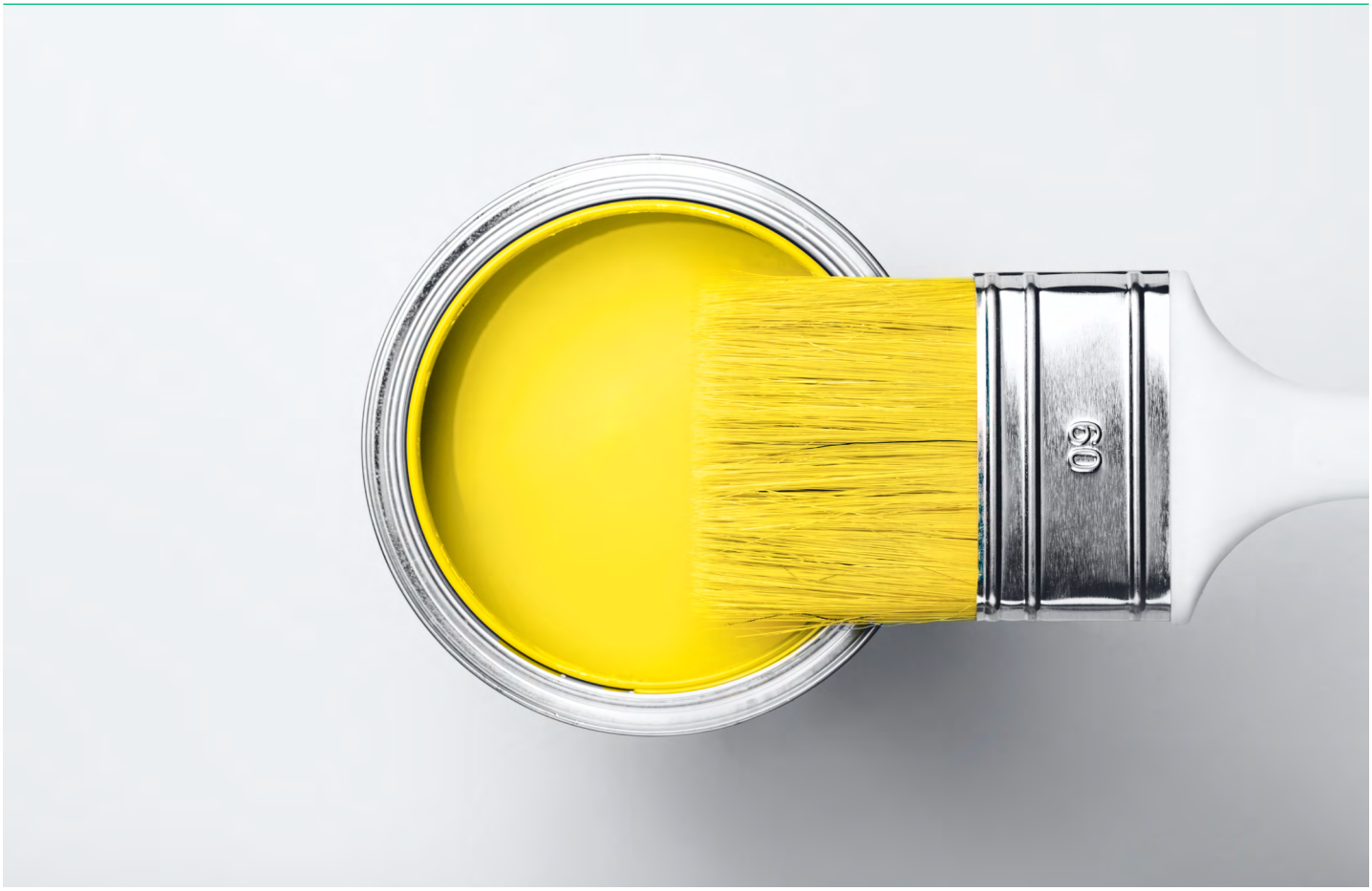
- Our proprietary adhesion-promoting technology, which we pioneered over 20 years ago
- A self-crosslinking technology that, as well as improving a coating's mechanical properties, also enhances adhesion on both wood and treated plastics
- **Cationic resins:** because these resins have a positive charge – unlike most binders – and most substrates happen to have a net-negative charge, they can adhere to almost every substrate
- **'Wet adhesion monomers':** functional monomers that act as adhesion promoters
- Urethanes produced in a way that enhances adhesion

Our proprietary adhesion-promoting technology works by optimizing binder functionalities – specifically, by introducing amine functionalities to the polymer. In this way, it improves adhesion to a variety of different substrates, including in wet conditions. An example of this technology in action today is **NeoCryl® XK-190**, a modified acrylic copolymer emulsion with dry and wet adhesion to many substrates, including aged alkyds.

Besides its excellent adhesion, **NeoCryl® XK-190**'s chemical structure also gives it low coalescent demand, strong flexibility and outdoor durability, a high gloss, and good resistance to blocking, alcohol, and water.

These properties make NeoCryl® XK-190 ideal for high-gloss interior and exterior decorative paints and wood stains, as well as for concrete floor paints, parquet lacquers, and metal and plastic topcoats.

Our self-crosslinking technology works similarly. This technology is now well established in the market and available in the form of NeoCryl® XK-237. This is an acrylic copolymer emulsion with excellent early water resistance, good blocking resistance, and a low water uptake. It's ideal for topcoats in exterior wood applications.



Fine-tuning multiple factors

Enabling strong coating adhesion is a complex task involving multiple factors. What's more, the adhesion must be achieved without compromising other key functional properties, such as sandability, low dirt pick-up, and anti-blocking. This balance is often harder to achieve than adhesion alone. To ensure adhesion, manufacturers can control six key adhesion mechanisms – typically, multiple are active in any one coating finish:

- Physical adsorption (always active)
- Chemical bonding
- Mechanical interlocking (particularly relevant for rough substrates)
- Weak boundary layers (an adhesion deteriorator)
- Diffusion
- Electrostatic

These mechanisms are influenced by two key interactions: **the thermodynamic work of adhesion (Wa)** and the **energy dissipation of a coating**. Wa is achieved through the interaction between the coating and the substrate's surface and is influenced by the binder's functionalities. Energy dissipation is related to the amount of energy the coating can absorb and is influenced by the coating's mechanical properties.

Energy absorption is important for adhesion because it helps prevent delamination from high stress, particularly on dynamic substrates such as wood.

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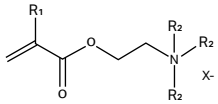
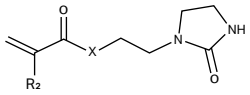
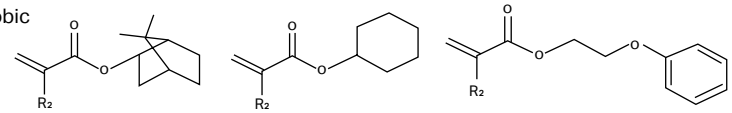
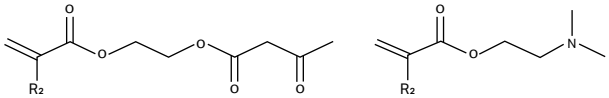
Going beyond binder functionalities

As such, to ensure good adhesion, both binder functionalities and the coating's mechanical properties must be optimized. In fact, because the amount of energy entering the coating is typically much larger than the amount involved in the interaction between coating and substrate, mechanical properties are often more important than functionalities for adhesion. Optimizing both properties is also necessary to ensure proper substrate wetting – a prerequisite for adhesion with any binder and substrate.

Achieving the right combination of functionality and mechanical properties is also a key way to enable multi-substrate adhesion. Because all substrates have different surface energies, structures, functional groups, porosities, and roughness, manufacturers traditionally use different functionalities to ensure adhesion on different substrates, as shown in the table below. By also optimizing the binder's mechanical properties, manufacturers can create very robust adhesion mechanisms that work on multiple surfaces.

Adhesion Promoting Functional Group	Substrate
Acid Primarily MAA and AA. Incorporation vs. pKa.	Metals, glass, polymers
Cationic 	Broad range since most surfaces and anionic in nature
Polymer- amine	Acidic substrates, treated plastics *BOPP, BOPET), PVC, aged alkyds
Cyclic ureido 	Acid functional substrates, plastics, aged alkyds
OH: R-OH and Si-OH	Glass, polyamides, metal
Hydrophobic 	Plastics, PVC, PET, treated Pos
Other 	Acidic substrates, wood, metal (AAEM)
Phosphate, Sulfonate	Metals, wood (coloration), basic substrates (pMMA), TiO_2
Hydrazide	(Treated) plastics, wood, aged alkyds

Adhesion functionalities for different substrates

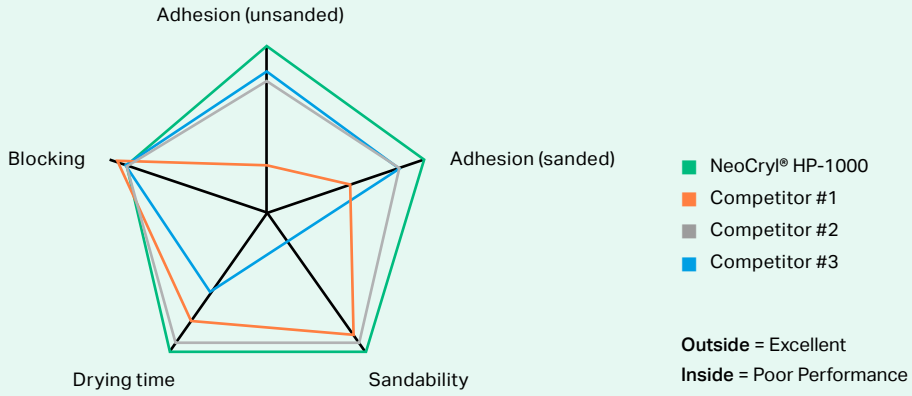
Neocryl® HP-1000: Combining Covestro's adhesion expertise

For this reason, we were keen to take our adhesion offering to the next level by developing a solution that combined adhesion-promoting technology with mechanical property optimization. By creating dispersions with multiple types of polymers, we were able to control particle morphology at nano level. In this way, we created a resin that could optimize mechanical properties and energy dissipation, as well as polymer functionality.

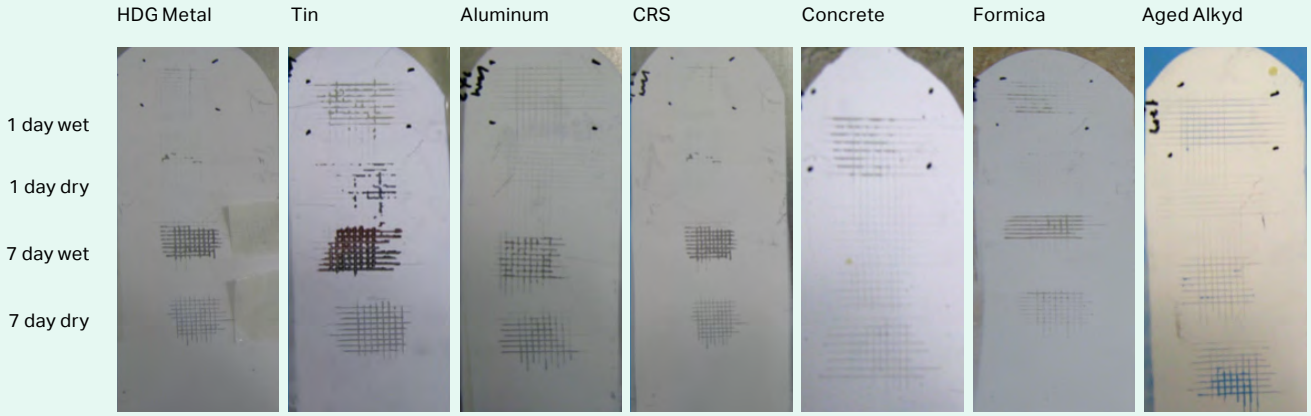
This 100%-acrylic resin is Neocryl® HP-1000, and it can be used for both interior and exterior decorative applications. Thanks to the combination of our particle morphology control and existing adhesion-promoting technology, this resin offers an excellent broad adhesion profile. It's designed to adhere very well to a broad variety of substrates, including those for which adhesion is typically difficult. This includes ceramic tiles, galvanized steel, aged alkyds, and plastics. And, thanks to its excellent adhesion profile, NeoCryl® HP-1000 eliminates the need for a separate sanding step: when the substrate's surface is free of irregularities such as cracks and blisters, only cleaning is needed.

What's more, the resin's mechanical properties deliver not only improved adhesion, but an excellent coating finish. Specifically, Neocryl® HP-1000 enables less brittle, more flexible coatings with quick drying times, strong anti-blocking, better outdoor durability, and an extended service life. The solution can also be formulated using lower levels of VOCs that reduce odor and meet the latest health and safety requirements from bodies such as the European Commission and FDA.

Functional properties of NeoCryl® HP-1000 compared with competitor resins



NeoCryl® HP-1000 adhesion on a wide variety of substrates over several days



In conclusion…

A promising adhesion future ahead

At Covestro, we're committed to developing solutions that deliver stronger adhesion – and the durability and performance benefits that this comes with. And, as substrates continue to evolve and the use of recycled substrates becomes more popular, the need for good multi-substrate adhesion will become even more urgent. As such, we aim to continue developing our adhesion technologies.

For instance, we have helped pioneer the use of controlled polymerization to optimize the placement of functional groups. By enabling manufacturers to minimize their use of adhesion promoters, this will reduce unnecessary costs and water sensitivity. As one of the first companies to apply this technology commercially for waterborne binders, we anticipate expanding its use to decorative coating binders in future.

In addition, we're exploring the use of coatings that combine primer and topcoat properties via stratification, where one part of the coating migrates to the surface and the other part to the bottom as they dry. While this already happens naturally, emerging technologies are providing the necessary tools to steer these solutions further. All in all, there are multiple possibilities ahead for us to keep developing ultra-adhesive solutions – for paint finishes that keep on sticking.

Want to learn more about how we can help enhance multi-substrate adhesion in your coatings? To find out more or to request a sample of our solutions, please contact:

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