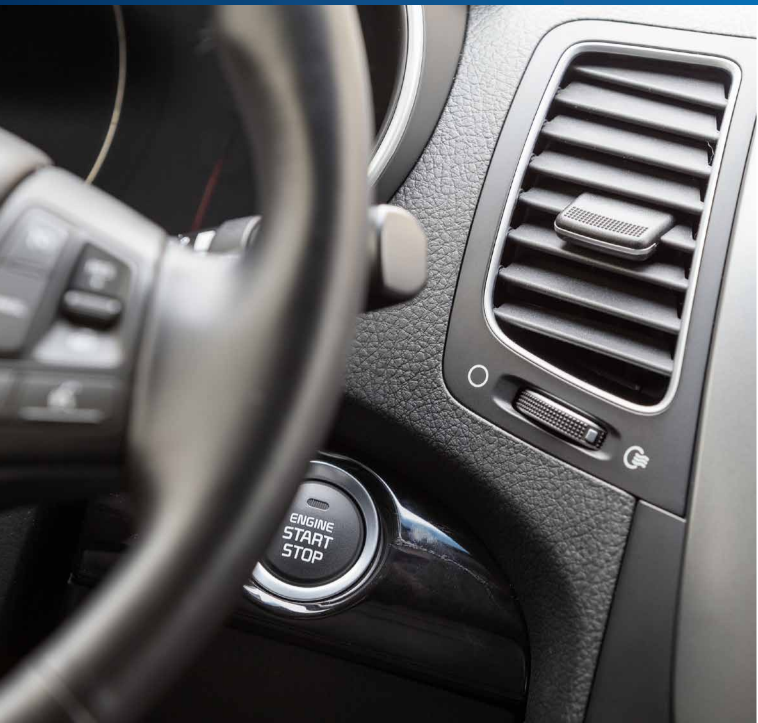
ADHESION ON POLYMERS



ACHIEVING GOOD WETTING AND ADHESION WITH SCIENTIFIC ANALYSES

KRÜSS

Advancing your Surface Science

USING SCIENTIFIC ANALYSES FOR OPTIMIZING PRETREATMENT AND COATINGS OF POLYMERS

- **Bonding plastics, e.g. in packaging and automotive engineering**
- **Printing on films**
- **Plastic coatings**
- **Hydrophobic coatings**

Polymers are part of virtually every area of life, and they owe their success story to their versatility. Coating applications on plastics, such as painting, printing or bonding, place considerable demands on material and coating development. Analytical methods based on interfacial chemistry play an important role in optimizing the quality of surfaces and pretreatment processes.

Aqueous coating materials do a poor job of wetting polymers

Adhesive strips that do not stick to plastics, inks that bleed on a film – the poor wetting properties of polymers which are familiar from day-to-day experience also pose a major challenge to the plastics processing industry. Poor wetting and adhesion in bonding, coating and printing processes are attributable to the low surface tension (SFT) of polymers, which is also referred to as the surface free energy (SFE). The low SFE is particularly unfavorable for the contact with aqueous adhesive and coating materials, which, owing to their high surface tension, are incompatible with polymers and tend to form droplets instead of wetting the surface.

Generally, adhesion is dictated by mutual polar and nonpolar (disperse) interactions between the polymer and the coating material. The greater the similarity between the solid material and the liquid coating in terms of their polar and disperse components, the better wetting will be and, as such, the stronger the adhesion. Many coating materials are based on the highly polar liquid water, making them unsuitable for interacting with predominantly disperse polymer surfaces.

Pretreatment and cleaning increase wettability

Improving wetting and adhesion on polymer surfaces means having to increase the SFE and its polar interactive component. This is accomplished through the application of high levels of electrical or thermal energy, as is done in corona, plasma, and flame methods, or through the use of reactive gases such as ozone. These treatment methods are based on oxidation processes, which introduce polar groups into the chemically nonpolar surface structure.

Since fat or oil impurities also lead to poor wettability, cleaning the surface thoroughly in advance is just as important as pretreatment.

Analyses of the solid and the liquid allow predicting adhesion

Knowing the polar and disperse interactions – each of which are responsible for the SFE and SFT – makes it possible to estimate the anticipated adhesion. Interfacial tension can also be calculated, which gives information about the long-term stability of a coating. In this way, separate analyses of the solid and the liquid provide a great deal of knowledge for optimizing both components for a coating process.

Still test inks are frequently used for testing surfaces. However, test inks do not take the interaction components of the SFE into account, as they do not differ between polar and disperse interactions. Therefore, for many materials, test inks cannot detect the actual effect of a pretreatment.

Wettability is characterized comprehensively by means of contact angle measurements

DIN 55660 recommends the contact angle method for determining the SFE of a solid. The contact angle, which reflects improvements to wettability achieved through pretreatment, describes the shape of a drop on the surface: the better the wetting, the flatter the drop will be, resulting in a smaller contact angle. Young's equation holds that the contact angle is a function of the SFE of the solid, the surface tension of the liquid, and the interfacial tension between the two phases.

In order to determine the SFE and its polar and disperse components, contact angles are measured using multiple liquids for which the interactive components of the surface tension are known. Water, which is highly polar, and diiodomethane, which is a purely disperse liquid, are two frequently used test substances.

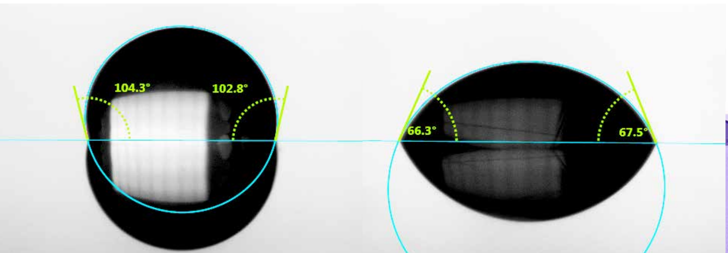
Not only do contact angle measurements yield information on the overall surface, they also detect differences in wettability across a single sample. Thus, position-dependent measurements (mapping) reveal whether the surface has been cleaned, activated or coated uniformly.

MEASUREMENT METHODS

There are a number of analytical methods that characterize the surface of plastics, and, in so doing, provide important information for optimizing coatings and adhesives:

- Taking optical measurements of the contact angle (drop shape analysis), static and dynamic
- Taking mechanical measurements of the contact angle using a tensiometer
- Determining surface free energy and its polar and disperse components
- Measuring surface tension of liquids
- Calculating adhesion and interfacial tension
- Measuring the roll-off angle of drops on hydrophobic surfaces

Contact angle of water on PP before (l.) and after plasma treatment (r.)



KNOW-HOW FOR YOUR APPLICATION

If you would like more detailed information about your application, just get in touch with us. Our scientifically trained customer representatives have excellent knowledge of interfacial chemistry and process technology and share their expertise – comprehensively and competently.

We would also be happy to assist you with professional contract analyses from our laboratories. In addition, we provide scientific application reports on various topics which cover specific issues in research, development and quality assurance. With offers like these, we pass on a great deal of know-how for your application.



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