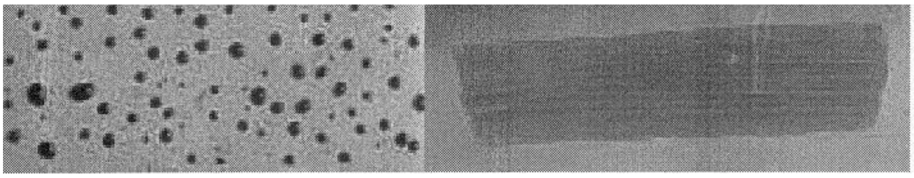
cph Deutschland Chemie GmbH • Heinz-Bäcker-Str. 33 • 45356 Essen

Wetting

Tips & Tricks No. 5

Wetting describes the behaviour of liquids on solid substrates. Good wettability of the substrate/material enables the adhesive to bond securely.



Non-wetted wetted

The differences in the way liquids behave on solid surfaces is well-known from everyday life. Thus, on greasy surfaces water forms beads (above left), while on clean (= grease-free) surfaces it forms a smooth film (above right). Water-repellent materials include all fats, waxes and, in particular, plastics which are used for the production of industrial mass-produced goods. This characteristic inhibits the bonding of plastics. Certainly solvent-based adhesives generally have way better wetting properties than water, but their wetting ability is only sufficient for polar plastics, such as polyvinyl chloride (PVC) and not for non-polar materials such as polyethylene (PE) or polypropylene (PP). If an adhesive is repelled by the substrate in the liquid state, it cannot be expected to adhere when dry. However, good wetting does not inevitably mean that adhesion will also be good.

Physically, wetting is described unambiguously by the surface tensions of both the liquid and the solid material. Wetting is improved as the surface energy of the materials increase. For bonding, a surface energy of approximately 44 mN/m is generally required. Water-soluble adhesives require somewhat higher values. Pure polyolefins, such as PE and PP, however, have values of 30-32 mN/m and thus need a pretreatment to increase their surface energy. This adjustment can take place via oxidation of the plastic surface by the oxygen radicals

Heinz-Bäcker-Str. 33
D-45356 Essen
Tel.: +49 201 81406-0
Fax: +49 201 81406-280
service@cph-group.com
www.cph-group.com

Geschäftsführer:
Dr. (RF) G. U. Schüttpelz
HR: Amtsgericht Essen
HRB 3076
St.-Nr.: 111/5730/3201
USt.-ID.: DE119 674 587

GENO Bank Essen eG
BLZ: 360 604 88
Kto.: 409975700
BIC: GENODEM1GBE
IBAN: DE23 3606 0488 0409 9757 00

Deutsche Bank AG
BLZ: 360 700 50
Kto.: 1282839
BIC: DEUTDEDEXXX
IBAN: DE17 3607 0050 0128 2839 00

National Bank AG, Essen
BLZ: 360 200 30
Kto.: 3648052
BIC: NBAGDE3E
IBAN: DE25 3602 0030 0003 6480 52

existing in a plasma of an atmospheric corona discharge. The hydroxyl (OH -) and keto (= O) groups generated on the surface form points of attack for the chemical reactions of adhesives. This normally leads to increased surface energy and improved adhesion.

Considering the surfaces, it should be noted that for wetting and adhesion, it is actually the very top layers which are decisive. Plastic surfaces are frequently coated with additives or, in the case of mass-produced items, also by mould-release agents.

The effect of silicone oils can be described very clearly with the help of the surface energy: Silicone oil has the lowest surface energy of any material. It therefore wets very well and spreads even on any material. Sprayed as an oil into seized ball bearings, it creeps over all metallic surfaces and can loosen any incrustations. If it gets on a plastic which is to be printed, a very small drop results in a large mark because of the outstanding spreading ability. However, this cannot be removed with solvent, since the higher surface energy of the solvents does not allow wetting of the low-energy siliconized surface. Printing ink or adhesive cannot bond to it. An intensive corona discharge treatment is necessary to remove these siliconized areas.

The wetting is defined quantitatively by the contact angle, which the surface of a liquid drop forms in contact with the substrate. This contact angle Θ depends only on the surface energies of the adhesive and the materials to be bonded together. The relationship is given by the YOUNG's equation:

$$\cos(\theta) = \frac{\sigma_s - \sigma_{sl}}{\sigma_l}$$

where
σ_s = surface energy of the material to be printed
σ_{sl} = surface energy of the ink or dye
σ_l = energy of the boundary surface between liquid and the material to be printed on

For practical reasons, the numerical value of the critical surface energy σc of the materials to be bonded together are combined. σc values are tabulated; they can be determined, inter alia, with test ink in accordance with DIN 53,364 or ASTM CD 2578-84. Strictly speaking, the value applies only to the test liquids concerned.