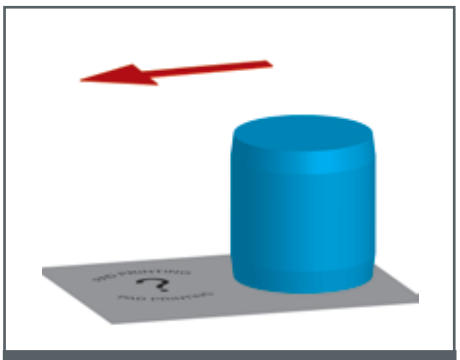
Gravure printing

Pad printing has supplemented the family of gravure printing methods since the 1960s. The technical basis of pad printing originates in the Decalcier process that was, e.g., used to decorate clock faces. From what was a niche at the beginning, pad printing developed into a standard for printing small-size motifs on irregular surfaces, above all of moulded parts made of plastic. The field of application of pad printing covers the world of merchandising products or model making, but also the automobile or electronics industry. Pad printing is an indirect gravure printing process. The printing principle differs from doctor-blade based gravure printing and recess printing. The motif is transferred into a small-size printing plates made of steel or plastic. The cups etched into the printing plate are flooded with ink and then doctored. Ink metering is by squeegeeing the surface of the printing plate. Afterwards the pad takes up the ink from cups as an intermediate carrier and transfers them to the surface of the substrate. The pad is a soft-elastic intermediate carrier made of silicone rubber. The shape of the pad depends on the motif to be printed as well as the printing surface. The variants are manifold and the right selection requires careful planning of the printing job and quite some experience.

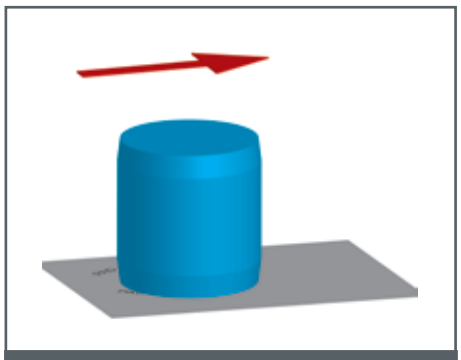
A decisive factor for the print result is the shape of the surface and the elasticity and/or hardness of the pad. The pad is partly considerably deformed during the printing process. If the wrong one is chosen, there is a risk that the printed image is distorted and the print result becomes blurred. Multi-colour printing wet-on-wet is possible, however, requires ink drying to be adjusted in order to prevent smearing in the following printing unit.

For printing plate inking, there are two different systems. The original variant is the open ink well system. The ink is transferred from a storage pan to the printing plate by means of a flood bar (scraper). Then a steel blade (knife) is used to remove the excess printing ink and to transport it back into the storage pan. The ink that remains in the cups is taken up by the pad and printed. After that, the cycle starts again.

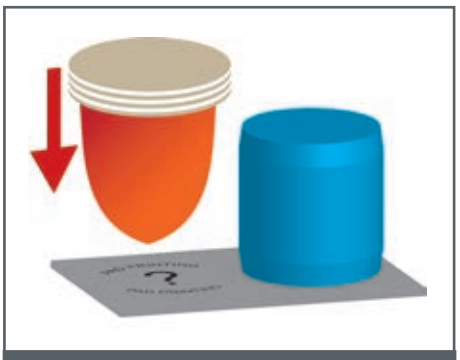
As an answer to the demand for higher cycle rates in printing, the closed ink cup system was developed. For that, the storage pan and the scraping device were united in a so-called doctoring cup. This cylindrical container holds the printing ink; it is closed at its head and open at its foot. The foot is equipped with a doctor ring all around. The doctoring cup is slightly pressed against the printing plate and thus prevents the ink



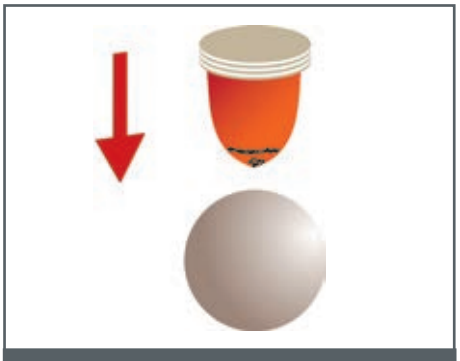
The cup is filled with ink.



Excess ink is removed.



The ink adheres to the pad.



The ink is transferred onto the object.

The 2D image is on the 3D object.

from escaping. For the closed system, an additional "parking zone" must be planned for the doctoring cup in addition to the proper motif surface on the printing plate. Inking of the printing plate is carried out by travelling over the motif area with the doctoring cup. The closed system protects the ink from evaporation of the solvents and contaminations. The doctoring cup remains in the parking zone while the pad takes the ink from the cups and prints. Then this cycle begins again.

Printing plate production for pad printing

In pad printing, several printing plate materials are used. For short runs and normal requirements as regards the quality of the printed image, photopolymer plates are preferred. A photopolymer layer on a metal sheet carrier is exposed by means of a film and UV light and hardens at the non-printing areas. For the production of a wall/cup structure, double exposure is needed. At first the printing motif is exposed, a second exposure is made with a fine approx. 80 L/cm film. The second exposure produces small wall structures in the printing image which prevent the blade from dipping into the motif during printing. After the exposure, the parts that have not been exposed are washed out with a solvent and the printing plate is dried. Finally, post-exposure ensures that the plate surface is sufficiently hard.

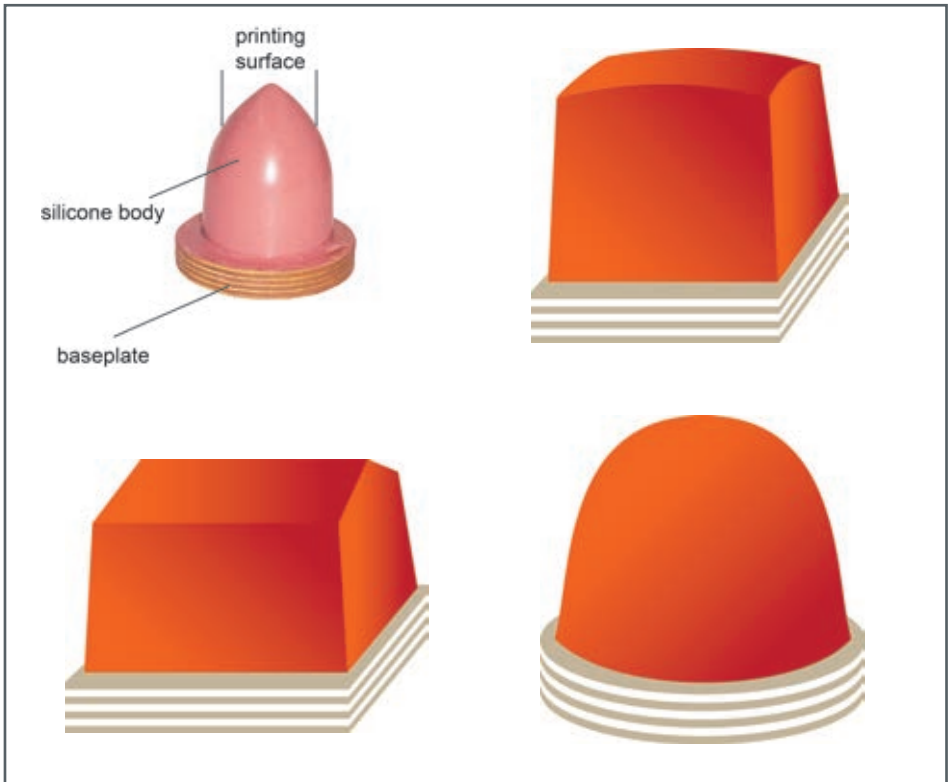
Depending on the plate type, organic-based or water-based solvents are used for washing out. When handled carefully, photopolymer plates can perform runs of several thousands. For longer print runs and special requirements as regards the precision of the printed image, etched and lapped steel plates are preferred. Steel plates feature a long service life. The printed image is etched into the surface. Before the etching process, the steel plate is coated with a light-sensitive emulsion and dried. This process is followed by the imaging process with the printing motif and screening. Finally, the photo emulsion is washed out and dried. The etching process is carried out with nitric acid or iron (III) chloride. The hardened photo emulsion is resistant to the etching acid. Only the areas that have been exposed are etched. Then the photo emulsion is removed from the printing plate, and the plate is cleaned. The etching process produces cup depths of up to approx. 20 µm. The resulting printing image allows the production of finest typefaces and details which are, e.g., required in model making.

In addition to the traditional exposure process and chemical development, laser direct engraving is increasingly used. The printing image is engraved with a high-resolution laser into the printing plate. In this process, preferably steel, aloxide and/or ceramic plates are imaged. All printing plates have in common that they feature a long service life and excellent detail reproduction.

The pad

The pad is the key element in pad printing. The rapid development was initiated with the use of silicone as the basic material for the pad in the 1960s. Actually, the pad material is a mixture of silicone and silicone oil. Its hardness is adjusted by means of the mixture ratio of these two components. For a better distinction between the hardness classes, the pads are colour coded. The material features excellent elasticity and there are no slipping movements at the contact area between the substrate and the pad. The shape of the pad rather causes a rolling movement on the substrate that enables the printing ink to be deposited cleanly and prevents the trapping of air bubbles. At the same time, the material ensures high ink transfer from the printing plate to the substrate. Normally, only an extremely thin ink film is present after the ink transfer. During the printing process, influences of the printing ink and solvents may cause swelling of the pad so that the printing image becomes blurred. The life expectancy of a pad depends on its hardness, resistance to inks and solvents as well as the application conditions. Depending on the specifications of the manufacturers, it is between 20,000 and 500,000 prints. Aggressive inks and solvents reduce the service life accordingly. The service life of a pad is limited anyway. The silicone oil used gradually evaporates out of the pad. This affects the surface tension on the printing area and the hardness of the pad. As a result, the ink transfer and resistance to chemicals decrease, and increased wear of the surface caused by abrasion can be seen. Therefore, it is recommendable to nourish the pads with silicone oil and to ensure pressure-free, clean, dark and not too warm storage.

During the printing process, care must be taken that the dried ink residues are only removed from the pad with an adhesive tape. Strong solvents and rubbing movements on the pad damage the surface and cause increased abrasion. Prior to their first use, new pads must be slightly cleaned with spirit, since otherwise they would not transfer ink. The selection of the pad shape and hardness is determined by the printed motif. A steep pad shape ensures better rolling on the substrate and is, therefore, especially suited for fine lines and signs. For printing on areas, the use of flat pads is recommendable. Care must be taken that the pad is sufficiently large for the printed image to be produced.



The figures shows the different pad shapes

Pad printing inks

As is similarly the case in screen printing, pad printing can also be used to print on nearly every kind of substrate if the right ink system is used. The printing inks are optimized for printing on plastic, metal, wood, textiles and coated substrates. For ink layers with high mechanical and chemical resistance and high printing speeds, UV curing inks are preferred. Furthermore, solvent-based ink systems play the most important part in pad printing. Through the use of additional curing agents, the solvent-based inks also feature excellent resistance to mechanical and chemical stress. Further requirements as regards colour fastness, resistance to perspiration, saliva and cremes are due to pad printing being used for the decoration of control elements, toys and bottle caps. The examples listed above show that the field of application of pad printing is nearly indefinitely expandable.