Basics of flocking

Figure 1 Detail of a flocked doormat

Foreword

In flocking, fibres cut to the same length are applied vertically to a surface with adhesive using the electric field. After the adhesive has dried and any residual flock has been cleaned, the flocked surface is ready for use.

The origin of 'flocking' lies in the Middle Ages. At that time, paper was coated with resin and sprinkled with fibres to be used as wallpaper.

The first electrostatic 'flocking' was used in the 1950s to make sandpaper. The hard material splinters are shot into the adhesive in an aligned manner by the high voltage.

Flock fibres can be made from a variety of materials. Depending on the material, very different mechanical or physical effects can be created in addition to an attractive look and feel.

Flock can insulate, insulate or conduct electricity. The increase in surface area due to flocking can act as a catalyst or filter. The list of possibilities is endless.

The original purpose of creating a decorative surface has long been extended by a multitude of technical applications - and new applications are added every day....

Content

1. Working steps for flocking

1.1. Pre-treatment

Surfaces to be flocked must be load-bearing, clean and free of grease and release agents so that the adhesive layer and flock layer applied later are optimally bonded to the substrate.

Pre-treatment of the surface to be flocked is only necessary in case of possible adhesion problems between substrate and adhesive. The causes for poor adhesion can be found either in the substrate material itself (e.g. silicone, PE, ...) or through changes in the surface due to soiling, ageing or evaporation of e.g. plasticisers.

Common pre-treatment methods are:

- Wiping with suitable solvent
- Mechanical roughening
- Application of primer
- Scarfing, corona treatment, plasma treatment
- Fluorination

In any case, the necessity of pre-treatment should be clarified in advance in a preliminary test. A test of the surface tension with test inks is also helpful. This value should be above 42 dyn.

1.2. Adhesive application

The adhesive is the link between the substrate and the flock overlay. It not only holds the fibres, but must itself be adapted to the subsequent use. A flock overlay on textiles, for example, requires a very flexible adhesive that must also be wash-resistant.

Information on choosing a suitable adhesive is available from the adhesive manufacturers, as is advice on the right product. Preliminary tests with the selected adhesive are also advisable here.

The adhesive should be applied in as uniform a layer thickness as possible. A guideline is a layer thickness of the dried adhesive of 10 % of the flock fibre length. This ensures that the fibres are optimally anchored in the adhesive and can withstand stress.

The time between application of the adhesive and flocking should be as short as possible so that the adhesive does not dry before the fibres have been incorporated in sufficient density. The so-called 'open time' of the adhesive depends on the product and is specified in the manufacturer's processing instructions.

The application can be either full-surface or partial, by hand or automated. Common application methods for adhesives are e.g.:

- Brush application (or shaped sponges)
- Spraying (with flow cup, pressure container, pump or airless)
- Rolling on with a paint roller
- Squeegee application in a continuous process or with screen printing
- Dipping

Not every application method can be used for every product; the selection often results from the required number of pieces. All methods can be used manually, automated application systems usually require the use of robots in conjunction with a spray application. Here, too, preliminary tests help in case of doubt.

1.3. Flocking

Flocking can be done either electrostatically or electrostatically-pneumatically, depending on the workpiece geometry to be flocked.

Flat or outwardly curved surfaces can be reached very well by the electrostatic field and are therefore flocked purely electrostatically. This can be done either with a hand-held device or with a continuous flocking machine.

The fibre density that can usually be achieved by purely electrostatic flocking is 8-10 %, with a maximum of up to 14 % possible. This means that 90 - 92 % of the flocked area consists of air. This air space can be used in many ways.

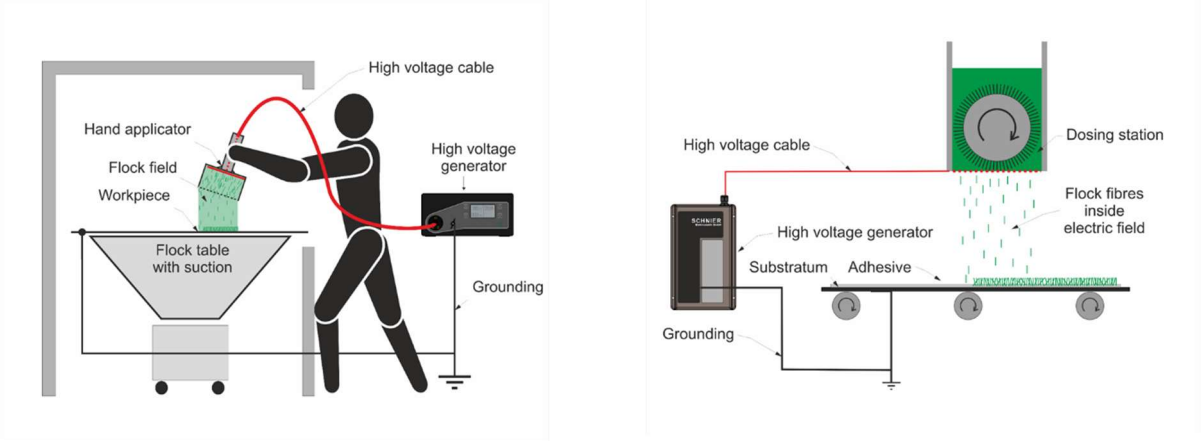


Figure 2 Electrostatic flocking manual and automatic

The electrostatic field can only have a limited effect on parts with recesses. The so-called Faraday cage prevents field formation in recesses, which causes the flock pattern to be less dense than flocking on the outer geometry.

If parts with recesses (such as a glove box) are only flocked electrostatically, then a very dense and well aligned flocking on the outer geometry results. Flocking in the recesses, however, results in only moderate density and negative corners without sufficient radius even remain flock-free.

Supporting the fibre transport by means of air flow helps to minimise these effects. These parts should therefore be flocked electrostatically-pneumatically. Various hand tools, machines or automated systems are available for flocking.

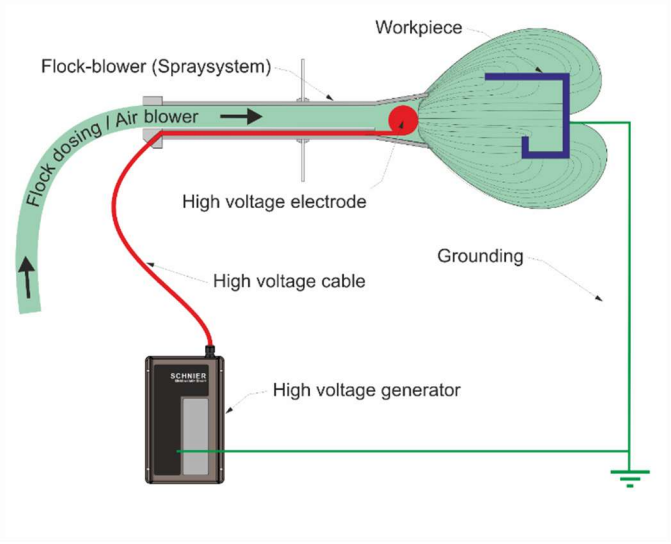


Figure 3 Electrostatic-pneumatic flocking

Electrostatic-pneumatic flocking produces a somewhat lower flock fibre density than with purely electrostatic flocking. The reason for this is the effect of the air flow, which causes the fibres to be applied into the adhesive in a slightly less vertical direction.

The positive effect, however, is a more uniform optical appearance of the later flocked surface. Especially when flocking moulded and interior parts, this process leads to an optimal optical value impression.

1.4. Pre-cleaning

After flocking, the workpiece is pre-cleaned of adhering loose flock. This is done by carefully tapping or blowing off with reduced compressed air in conjunction with a permanently vacuumed workplace.

The purpose of pre-cleaning is to minimise flock carry-over into other, subsequent areas. The collected flock can be reused, provided it has not yet passed through a dryer.

With particularly complicated geometries, it has been shown that the flocking result can be improved again after pre-cleaning and another flocking. The reason is that any unnecessary accumulation of loose, uninstalled flock would prevent the further installation of fibres in areas of the adhesive layer that are still open.

1.5. Drying

In the simplest case, the adhesive is dried in the hall air. For higher quantities or higher resistance requirements, drying can also take place in a cabinet dryer or in a continuous dryer. The drying parameters are supplied by the adhesive manufacturer.

Drying can be carried out by the following methods:

- Hot air with continuous air circulation
- Infrared radiation
- Vacuum drying

Each drying method has advantages and disadvantages that have to be weighed against each other in each individual case.

1.6. Cleaning

After drying, the workpiece is intensively cleaned of adhering excess flock and is then ready for use.

Excess loose flock considerably reduces the impression of quality. Especially with dark flock types, every effort must be made to achieve an optimal cleaning result.

Common cleaning procedures are:

- Blowing off with compressed air
- suction
- Ultrasonic cleaning
- washing

... or a combination of all these methods.

1.7. Quality control

Quality control and quality assurance are an essential part of the flocking process. As different as the flock applications are, the good adhesion of the fibres to the surface, as well as their durability and colour fastness over time are key criteria.

Since the majority of flocking applications are in the automotive sector, the very high quality requirements of car manufacturers and their suppliers have become the standard. These standards are also taken into account by flock and adhesive manufacturers.

Appropriate testing equipment for testing the materials and the finished flock surface can be obtained from specialist companies.

2. Materials

Substrate, adhesive and flock must be matched to each other as a system. The selection should then be checked and evaluated in a practical trial.

2.1. Substrate

Basically, all materials can be flocked that have a certain inherent strength and to which an adhesive can find sufficient adhesion. For problematic materials, a suitable pre-treatment with the pre-treatment methods already presented above will help.

2.2. Flock

Flock is available in different materials, fibre thicknesses, cut lengths and finishes.

Common flock materials are:

- Synthetic fibres made of polyamide, polyester (for automotive parts and profiles)
- Organic fibres made of artificial silk, cotton (for textile applications and household)
- Special fibres made of Kevlar, carbon (for higher temperatures and heavy abrasion)
- Exotic fibres made of glass, stainless steel, graphite, etc... (for purely technical applications))

The fibre strength, i.e. the titre, is given in dtex (decitex) and describes the weight of a single fibre of 10,000 m length in grams. The designation 6.7 dtex thus stands for the weight of 6.7 grams for a fibre 10 km long. The lower this value, the finer the fibre tends to be.

Gängige Titer sind:

- 0.9 dtex for microfibres, very soft to the touch, difficult to process.
- 1.7 dtex as standard fibre, soft, for textile applications and cosmetics
- 3.3 dtex as standard fibre for mouldings, profiles, interior parts of cars, easy to process
- 6.7 dtex robust, easy to process fibre for utility articles, tools
- 22 dtex hard stubby fibre For floor mats, easy to process
- 44 dtex hard fibre for insulation elements or cleaning tools

Common cut lengths of flock fibre lengths range from 0.3 to 4mm, depending on the titer. Short cut lengths below 1 mm are available with almost all titres. Lengths from 2 mm should only be used from titre 22 dtex. Special lengths up to 15mm are possible, but very difficult to process.

A typical fibre designation 'PA 6.6 - 3.3 dtex, 1mm' stands for polyamide flock with a titre of 3.3 and a cut length of 1 mm, i.e. a classic moulding flock.

Flock is usually supplied by the manufacturer in 20 kg cartons; small quantities are available from specialised dealers. It is important to store flock according to the manufacturer's storage recommendations.

Usually, flock consists of non-conductive material. In order to align and accelerate the fibre in the electric field, a defined conductivity is required on the fibre surface. For this purpose, the fibre is chemically prepared by the flock manufacturer.

In order for the flock to jump optimally in the electric field, a minimum conductivity of the flock material must be maintained. The conductivity of the fibre is influenced by the surrounding humidity. Too dry an environment reduces the conductivity, too wet an environment causes flock to clump.

The manufacturers' processing recommendations for Standard-Flock are an ambient temperature of 21 °C and 65 % relative humidity.

Deviations are possible, but this prolongs the flocking time and the flock surface cannot be flocked with the desired density.

The conductivity can be measured with the Texometer DMB-15 by pressing the handle with electrode into the flock. The value of the electrical resistance in Ω is evaluated and converted into a numerical value between 0 - 250 with the designation Skt Mahlo (scale parts Mahlo).

The usual values for a good conductivity are 80-100 Skt Mahlo. If the value is lower, then the flocking room should tend to be set with somewhat higher humidity, or work with technical humidification.

2.3. Adhesive

Adhesive manufacturers offer different adhesive systems to suit different materials.

Basically, a distinction is made between the following main types of adhesives:

- Water-based dispersion adhesives
- Solvent adhesives
- Plastisols (one-substance system without volatile components)
- UV-curing adhesives

The requirements for the adhesive system can be different. Besides the best possible adhesion, other requirements are conceivable:

- Chemical resistance
- Solvent free
- High temperature
- Food fastness
- Toy safe

It is also helpful to dye the flock adhesive with pigments in the same colour as the flocking. This makes the flock image appear even denser and more valuable.

3. Properties and range of use of flocking

The possible applications of flocking are almost limitless. The following is an overview of the most common applications:

3.1. Optics

The fibre surface conveys a higher value than an unflocked surface. The flocking can be either partial or full surface.

By selecting suitable flock types, further optical effects can be incorporated in addition to the colour. Examples of this are:

- Suede effect on pressure-sensitive artificial silk flocks
- Metallic effect on appropriately finished fibres
- Foil embossing after flocking
- Laser inscription for individualisation


Shaped parts or other 3D structures can only be flocked with one flock colour or type per flocking pass. Another flock colour can then be applied, e.g. partially, in a second pass.

Textiles, flat parts or plan blanks can be flocked in one colour or with several colours in one pass. For this purpose, the part to be flocked passes through several stations, each of which then applies a flock colour via appropriately designed screens. This technique is common for flocking T-shirts.

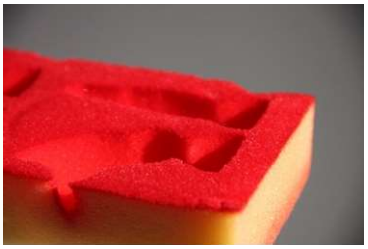

3.2. Haptics

The aligned fibres result in a velvet-like surface that can be adjusted from soft to hard depending on the flock material and fibre length used.Fasern mit kleinem Titer und/oder längerer Schnittlänge fühlen sich weich an. Bei Fasern mit hohem Titer und/oder kurze Schnittlänge ist die Haptik eher rau.

Synthetic fibres are more robust and therefore tend to be harder to the touch than organic fibres, such as artificial silk or cotton.

Flocking is therefore popular for products that are likely to come into contact with the body during subsequent use. Examples are textiles, PVC shoes, orthoses, air mattresses, outdoor articles....





3.3. Avoiding noise

Due to the flocked surface, no noise occurs on contact.

This is why, for example, glove boxes, storage compartments, centre consoles, spectacle compartments, but also coffee cups and crockery are flocked in cars.

Another application is the flocking of microphones and their covers to prevent wind noise.



3.4. Refraction of light and sound waves

The flocking has a damping effect by breaking the sound and light waves many times in the flocking structure.

This effect is used for flocking sound insulation elements, engine covers or the inside of side channel compressor housings.

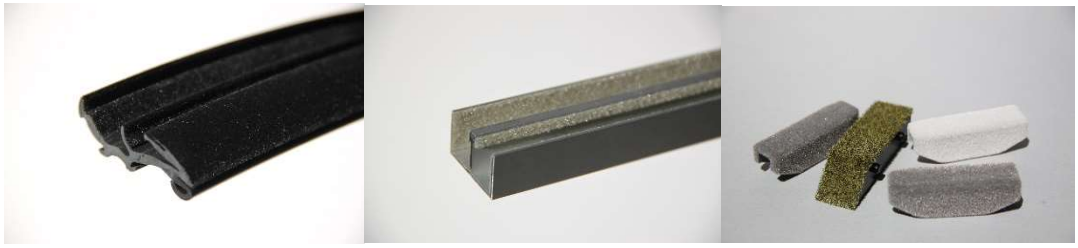
This effect also minimises stray light in optical housings or prevents the reflection of numbers on players' jerseys or other lettering in sports broadcasts.

3.5. Adhesion and sliding effect

Flocking can influence the sliding behaviour of two surfaces in relation to each other. Flocked rubber profiles in cars allow the window pane to slide only on the fibre tips. Freezing of the window pane in winter is impossible.

Glass panes in furniture and trade fair construction can be moved more easily and quietly in flocked aluminium profiles. The user feels a sense of value.

However, if both surfaces are flocked, it is no longer possible to move them. This effect is used for temporary floor coverings, e.g. in trade fair construction.



3.6. Grippy surface

Flocking with flock types with a high titre and short cut length creates a very grippy surface. The function of tool handles of all kinds can thus be optimised.

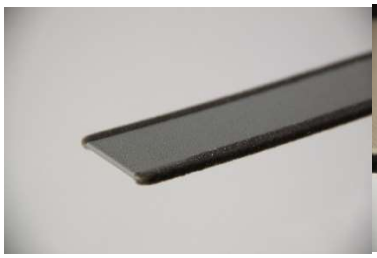
By flocking screwdrivers, for example, a higher torque can be transferred from the hand to the screwdriver. Even with dirty or greasy hands, a secure grip is ensured.

3.7. Compensation of tolerances

The flocking acts as a perfect gap filler. In addition to compensating for gaps, e.g. in interior parts in the car interior, flocking prevents unnecessary rattling.

In the case of belt sliders in the car interior, the flocking creates a double effect. In addition to a damped run in the guide, rattling noises inside the guides are avoided.

The flocking can either be applied directly to the component or as tape to be stuck onto the required areas.



3.8. Isolation against heat and cold

The flocking covers only approx. 10 % of the flocked surface, the still air between the fibres creates an insulating effect. Partial flock dots as spacers between several layers of film create an ultra-insulating material.

Flocking the inside of boat hulls or snow groomer cabins shifts the dew point and reliably prevents condensation.

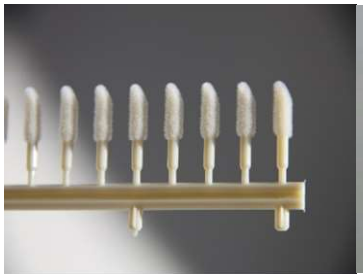
Flocking the linings of heating elements or sauna ovens prevents burns in case of skin contact. Handles on pneumatic tools are flocked to insulate against cold.

3.9. Depot effect between the fibres

The free space between the flock fibres can be used as a depot for many substances. Typical applications are paint rollers, painting tools or applicators for cosmetics.

Flocked cannula ends for applying dental primer also serve as micro-brushes.

Flocked spatulas or rods are also often used for taking saliva samples, the so-called corona swaps.



3.10. Functional surfaces

The following is a small excerpt from other flock applications:

Gentle material transport:

Conveyor belts, devices, grippers, support points are flocked in order not to damage the goods to be conveyed or moved. The contact surface can either be flocked directly or a flock tape can be partially applied.

Cleaning systems:

Suitable flock fibres can be used to create very effective cleaning systems. Typical applications are floor mats for laying out, but also carpets. Rotating brushes are often used in textile machines to clean spinning waste. Partially flocked cleaning cloths or sponges also remove stubborn dirt.



Avoidance of fouling:

Aquaculture nets become unusable over time due to algae and crustacean growth. Flocked nets remain without fouling. The same applies to the flocking of boat hulls.

Bonding agent:

Flock as an intermediate layer between different partners that are difficult to bond permanently.

Examples are architectural elements made of polystyrene moulding with plaster overlay, or orthotic parts made of silicone that are to be bonded to plastic. In both cases, the part to which flock is to be applied is flocked beforehand, and the problem partner then anchors itself mechanically in the flock.

3.11. Active surface

Fibres can be produced with special finishes. This finish can be chemically adapted to the respective application. Another possibility is to finish the fibres after flocking by an additional application step

Conductivity through metallisation:

Flock fibres can be coated with elemental silver. A small admixture of these fibres leads to a very good electrically conductive flock coating to the substrate.

Surface enlargement:

Flocking gives filter elements a larger surface area. The flocking can serve as an active agent depot, or in the wet area as a 'habitat' for microbiology.

4. Usage properties

4.1. Resistatnces

The requirements for the flocked surface are manifold. These requirements are met by a wide selection of suitable materials and processes.

Since the majority of flock applications are in the automotive sector, the very high quality requirements of car manufacturers and their suppliers have become the standard.

An important property, abrasion resistance, is given by the fact that each fibre is deeply anchored in the adhesive. This value is measured by the so-called abrasion test.

Another value is provided by the so-called tear-out test. This determines the tensile force required to detach a defined flock surface from the substrate. This test can be carried out with the tear-out tester.

Further requirements are, depending on the application, light and temperature resistance or chemical resistance.

4.2. Cleaning

Flocked surfaces are easy to clean. In contrast to looped or knitted fabrics, each flock fibre is only anchored in the adhesive at one end. Dirt therefore finds little hold and can simply be brushed or washed out.

4.3. Durability

Flocked surfaces made of robust fibres and a suitable adhesive guarantee a long service life if the flocked surface is loaded evenly. Point loads should be avoided.