

# **WEILBURGER Graphics GmbH**

## **„Data sheet regarding the general processing of UV varnishes“**

Release: April 2010

### **Information and Tips on the topic:**

#### **SENOLITH® FINISHING with UV LACQUERS of WEILBURGER Graphics**

Coating layers serve as protection, and at the same time should produce certain surface effects, i.e. gloss or matt. With UV lacquers both can be achieved in optimal quality, comparable only to foil lamination, yet at significantly less cost. Hardening is done through high energy radiation. Thus a highly cross-linked polymer film is created which is hard, highly glossy, resistant against abrasion and numerous chemical substances.

SENOLITH® UV lacquers can be considered environmentally friendly Hightech-lacquer systems.

#### **Structure and film formation of SENOLITH® UV LACQUERS**

Reactive acrylates, reactive thinners, photo initiators and additives are used to formulate UV lacquers. Via molecular weight distribution of the acrylates plus the reactive thinners the required viscosity is tailored exactly to various application methods.

The curing (chemical: free radical chain polymerisation) is activated by photo initiators. These photo initiators have been selected especially so they can interact with the UV radiation. Thus extremely reactive particles (radicals) are created which are necessary for drying (cross-linking) the UV lacquers.

The additives influence shelf life, flow, adhesion, gluability, slip, gloss, flexibility, foaming and much more.

During curing the chemical structure of the UV lacquer changes and thus also its characteristics. The hardened UV lacquer can be compared with a synthetic covering. The drying procedure requires extra energy, which is supplied by the UV lamp. The UV lacquer remains sticky if the right amount of energy is not provided.

#### **Application of SENOLITH® UV LACQUERS**

**The following application equipment can be used by the graphics industry to apply SENOLITH® UV Lacquers:**

1. Offline coating machines
2. Coating units of offset presses, squeeze roller units or chambered doctor blade systems
3. Flexo coating units
4. Screen printing coating machines
5. Ink duct units of offset presses
6. Damping units of off-set presses
7. Gravure printing units
8. Coating units of web offset presses

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### **Drying of SENOLITH® UV LACQUERS (hardening / cross-linking)**

UV lacquers are lacquer systems hardened by radiation. Drying is achieved by UV radiation transmitted by UV lamps. According to the type of machine, two or three lamps are installed. Generally the lamps can be turned on or off individually. Some drying equipment also allows for variation of the lamp power. The lamp power is stated in Watt/cm.

The essential parts of a UV lamp are the bulb and the reflector. Generally the lamps are cooled down with a water-cooling system. Lamp and reflector have to be handled with great care and need regular maintenance. The lamps need to be replaced as indicated by the manufacturer and a record of the operating hours has to be kept. Neither lamp nor reflector should be touched by hand. For cleaning use IPA and lint free cotton cloth. The lamps should not be replaced at the same time if possible, as it might lead to overcuring of the UV film, which could cause adhesion problems. In any case, the UV lamp should be placed at the end of the extended delivery.

An extended delivery has a positive influence on flow, stack temperature and machine speed. Especially when processing thin printing substrates and foils, temperature is an important factor. Contrary to dispersion coatings, UV hardening is not considered a physical drying process, but a chemical cross-linking. The drying time is < 1 sec., which means the lacquer film has to be hardened by the time the printing sheet has passed the UV lamp and reached the delivery. It is also possible, however, that the UV lacquer, i.e. the total structure doesn't develop its final characteristics of adhesion and scratch resistance until after a couple of days. This depends on the substrate, printing ink, etc.

The stack temperature should be kept as low as possible. Check if less lamp power would be sufficient, or if one lamp could be shut off in general.

Lamp power has to be adjusted if machine speed is increased. Some dryers adjust automatically.

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### Requirement profiles - SENOLITH® UV LACQUERS

Liquid lacquer	Processing	Dry lacquer film
<ul style="list-style-type: none"> <li>– Neutral odour</li> <li>– Stable viscosity</li> <li>– Correct surface tension</li> <li>– Shelf life stability</li> <li>– Suitable processing viscosity</li> </ul>	<ul style="list-style-type: none"> <li>– Neutral odour</li> <li>– Can be pumped</li> <li>– Little foam formation</li> <li>– No misting</li> <li>– Problem-free cleaning</li> <li>– Optimal reactivity</li> <li>– Low consumption</li> <li>– Good wetting of the substrate</li> <li>– No blocking</li> </ul>	<ul style="list-style-type: none"> <li>– Neutral odour</li> <li>– Excellent film adhesion</li> <li>– Clear lacquer films</li> <li>– Chemical consistencies</li> <li>– Flexibility (grooves and creases)</li> <li>– Can be stamped</li> <li>– Can be glued</li> <li>– Slip</li> <li>– Non-yellowing</li> <li>– Recyclable</li> <li>– High gloss</li> <li>– Rub resistance</li> <li>– Blocking resistance</li> <li>– Water resistance</li> </ul>

Based on the strongly varying requirement profiles shown above, a wide spectrum of lacquers is offered. The required parameters should be collected ahead of time, to make selection of the right lacquer easier and unproblematic.

### Requirement profiles - printing ink and substrate

Alkaline-resistant printing inks. The printing inks should be solvent- and alkaline-resistant according to ISO 2836.

If a primer is used, it has to be adapted to the following UV coating.

### Processing SENOLITH® UV LACQUERS

#### 1) Viscosity

Prior to measuring the viscosity in a DIN 4mm cup, the lacquer has to be thoroughly stirred and the temperature taken. The viscosity for each product is stated on the corresponding Technical Data Sheet and was measured at a lacquer temperature of 20°C. The viscosity will change if the temperature varies greatly from 20°C. Therefore it is recommended that the lacquer drums are stored at room temperature or otherwise they should be transferred to the printing machine in time to warm to room temperature. To measure the viscosity, the measuring cup is immersed completely into the lacquer, taken out again and then the time is clocked until the lacquer stream breaks at the spout of the measuring cup.

In case measuring is done during processing, it has to be ensured that no foam gets into the cup, as this distorts the result. UV lacquers are more sensible to temperature variations than dispersion coatings.

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### 2) Starting the coating pump

After taking the measurement just described, the lacquer is pumped into the coating unit. Care should be taken that no waste water or leftovers of other varnishes (i.e. dispersion coatings) are left in the lacquer circulation. Coating rollers and sheet separators or chambered doctor blades have to be adjusted correctly, to prevent lacquer from running out or overflowing. However, if this should happen, the supply of coating must be stopped immediately, the dirty parts must be cleaned and the cause has to be eliminated.

### 3) Roller coverings

Any roller coverings, that have contact with UV lacquers or cleaning agents, have to be suitable. They have to be absolutely UV resistant - this should be checked with the roller supplier prior to processing. EPDM or NBR coverings are recommended. Swelling of the rollers may occur if this is not taken into account.

### 4) Cleaning the coating unit and the anilox roller

For cleaning use **SENOLITH® UV CLEANING AGENT 373008**. Wearing goggles and gloves is obligatory. In comparison to dispersion coatings, UV lacquers only dry under the influence of UV light. This means, that any leftover lacquer stuck on machine parts will not dry but always stays sticky. If chambered doctor blade systems are used, the anilox roller should be cleaned once a week with **SENOLITH® CLEANING AGENT FOR DISPERSION COATINGS 372051** after the shift is finished.

**Cleanliness is rule number one, in order to prevent health risks when processing UV lacquers!!**

### 5) Application via rubber blanket

Use UV resistant rubber blankets only. Conventional rubber blankets tend to swell, which leads to disturbances during lacquer application. The pressure conditions change. If the lacquer is to be applied full surface, a compressible rubber blanket should be used. Calibrated underlay sheets should be used as a base. The backing has to be slightly smaller than the printing material both in width and length, otherwise the coating builds up and dries on the impression cylinder.

### 6) Application via photo polymer plates

For application of UV lacquers special photo polymer panels are on the market – check for UV lacquer resistance. For more important information see also point 7.

**Note: Special mineral oil-free cleaning agents have to be used to protect the surface of these panels!**

We recommend our **SENOLITH® CLEANING AGENT 373008**.

### 7) Print feed adjustment in the coating unit

All necessary printing adjustments in the coating unit have to be kept to a minimum, otherwise crushed edges and build up of ink on the rubber cloth or the coating plate can occur. When using the above mentioned photo polymer plates a kissprint should be done after the plate is clamped down to determine an optimal print adjustment between print cylinder and form cylinder as well as between application roller and form cylinder.

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### 8) Notes on safety

Most of the acrylates responsible and necessary for cross-linking, i.e. hardening are labelled Xi irritant. This indicates that handling of these UV lacquers could cause irritation of the respiratory system, eyes and skin. Furthermore direct skin contact might lead to absorption of these substrates through the skin. There are different R regulations for the various types of irritation.

These are:

R36	irritating to the eyes
R37	irritating to the respiratory system
R38	irritating to the skin

These R regulations can also be listed in combination.

R43 Skin contact may cause sensitization – is an additional warning phrase.

The different acrylates vary in type and number of R regulations - as there are acrylates that are more and less irritant.

These lacquer systems can be processed without danger, if the safety measures and the rules for handling are observed.

Suitable protective clothing is recommended (goggles / rubber gloves). Good ventilation also has to be ensured. In case of skin contact with lacquer, immediately wash with soap and water and change soiled clothing. Never should lacquer splashes on the skin be removed by using organic solvents, as they destroy the natural protective skin layer against acid and the acrylate molecules can be absorbed even more easily through the skin.

Preventive skin protection is also recommended, i.e. after work and thorough washing, protective skin cream should be applied to hands.

If eyes are contaminated, they have to be rinsed for several minutes with running water (eye shower, eye rinsing bottle) and a doctor should be consulted. With irritation of the respiratory system a lot of fresh air is required immediately.

**In principle the rule is: Always consult a doctor when feeling unwell or dizzy.**

### 9) Application trouble

#### a) **Drying problems**

The operating hours of the UV lamps should be checked, referring to the manufacturer information for the UV dryer. A record should be kept regarding replacement of the lamps. The lamp output can be monitored using a voltmeter and ammeter. Another reason for the drying problems could be that the UV lacquer is too old, i.e. outdated.

Through hardening of the dried lacquer film can be checked with a quick acetone test:

Soak a cloth with acetone and wipe across the lacquered surface. It should withstand approx. 10 wiping motions carried out with slight pressure.

A more demanding acetone test in accordance to DIN 68861-1 can be carried out as follows: 0,2 ml acetone is applied on the surface to be tested. After a reaction time of 10 sec. the acetone is dabbed off with a cotton tissue and the surface is checked. The assessment is done using “0” to “5”, “0” meaning “no visible change” and “5” that “the texture of the test area is extremely changed or destroyed”.

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### b) **Flow disturbances**

First of all the UV lacquer must have the right viscosity, corresponding to the application device. The stacks should get acclimatized prior to coating. Flow is positively influenced by an increase of temperature, e.g. external heating of the UV lacquer up to 40°C or additional IR heating along the flow path. Flow disturbances can also be caused by the substrate (surface of substrate, printing ink, printing powder). It is recommended to test various printing substrates. As a further measure **SENOLITH® UV SLIP AND LEVELLING AGENT 372032** can be added. Observe the recommended amount to be added, otherwise foaming problems or orange skin effects might occur.

### c) **Wetting disturbances**

The surface tension of the substrate should be checked. It should not be below 34mN/m. Extreme scratch resisting printing inks, printing powder containing silicone or the wrong selection of primer can all cause wetting problems. If the machine configuration has the equipment, Corona pre-treatment is advisable. Wetting of the substrate can also be improved by adding **SENOLITH® WETTING AGENT 372053** (observe recommended amount). UV wetting agents influence surface smoothness and foaming characteristics of the lacquer. If Corona pre-treatment isn't possible, the following will also help: Run printing sheets through the UV lamps in stacks (ca. 3.000-4.000 sheets) without adding lacquer to activate the surface. Afterwards run the same 3.000-4.000 sheets through applying UV lacquer. When dealing with wetting disturbances, scratch resistance and creasing have to be checked at the same time. Of course wetting disturbances can also be corrected by using a suitable primer.

### d) **Gloss**

Since UV lacquers are products made out of 100% solid contents, the gloss depends on the amount of lacquer applied. One of the most essential pre-requisites for obtaining optimal gloss is a smooth as possible surface, i. e. a sufficient long way of flow between lacquer application unit and UV lamp, suitable lacquer viscosity, right lacquer temperature, machine speed, whereas a slower machine speed is not always an advantage. With very absorbing substrates higher machine speeds can produce better gloss values, because the lacquer has less time to penetrate into the substrate.

### e) **Scratch resistance**

Scratch resistance is tested with the fingernail test. Scratch across the coated surface with finger nail while applying pressure. If the UV lacquer coating comes off easily, embrittlement of the lacquer film might be the cause. In this case the lamp power can be reduced, at the same time hardening of the lacquer has to be taken into account. Another cause for bad scratch resistance might be poor bonding with the substrate. During hardening of UV lacquers the coating film shrinks, i.e. the volume of the liquid lacquer film is larger than that of the hardened film. This shrinkage causes tension, and only a good bonding with the substrate ensures good adhesion, that is scratch resistance. Printing inks containing wax, or general printing inks containing surface-active substances, are therefore not very suitable for subsequent coating with UV lacquer. Using a **SENOLITH® WB PRIMER** is a way to remedy the problem, as it functions as a adhesive mediator between printing ink and UV lacquer.

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### f) **Printing powder**

The use of printing powder influences offline UV coating negatively and should be minimized or completely avoided if possible. This can be achieved for instance, by applying dispersion primer wet-on-wet in offset presses. Should this not be possible, then the powder has to be removed, as it influences gloss and surface negatively. To do that, the print sheets have to be run through the machine again, with the side to be lacquered against the impression cylinder. Only then will the powder be completely destroyed.

### g) **Penetration into the substrate**, especially on paper white

The UV lacquer penetrates into the substrate on various printing substrates, especially on paper white. As a remedy we recommend our **SENOLITH® UV ANTI PENETRATION ADDITIVE 372030**. In general it should be tested, if the printing substrate is suitable for coating with UV lacquer.

### h) **Stack temperature**

The stack temperature should be kept as low as possible. It should be checked if lamp power can be reduced, or if generally on lamp can be shut off. If lamp power is changed, the hardening of the lacquer film must be checked. Ventilating the stack after coating is an advantage. Attention should be paid, that the stacks are not packed for shipping immediately after coating, i.e. through sealing with foil.

### i) **Double sided coating of paper**

For this application special UV lacquers with excellent blocking resistance are available. We recommend **SENOLITH® UV GLOSS LACQUER 360550**.

### j) **Misting**

The viscosity has to be checked. If it differs greatly from the nominal value, it could be the reason for the misting problem. Misting problems with UV products increase the health risk.

### k) **Odour**

Lack of thorough drying can release acrylate or initiator odour.

### l) **Foaming problems**

In roller units foaming is only a problem, if it is visible in the roller nip or in the coating tray. Transfer disturbances can occur. With chambered doctor blades foaming is first visible on the edge of the roller and transfer disturbances happen also. Air occlusion is visible in the hardened lacquer film. In both cases antifoaming agent can be added. The recommended dosage should be observed. In general, slight foaming on the coating surface in the drum itself isn't a problem. Attention should be paid, that the return flow of the coating doesn't hang in the coating drum, because unnecessary air can get into the coating. The speed of the coating pump should be set only so high, that it sufficiently fills and empties the coating unit with lacquer.

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### m) **One-sided coating of paper on double coated material.**

The heat released by UV drying might cause the coating of the reverse side to become thermoplastic and it might combine with the already dried UV lacquer film during stacking under pressure. Suitable lacquers have to be used and the temperature has to be watched constantly. Another cause for the problem could be an overdose of additives, which are floating to the top. We recommend **SENOLITH® UV GLOSS LACQUER 360550**. If problems occur **SENOLITH® SLIP AND ANTIBLOCKING AGENT 372061** should be added in the recommended dosage. It is recommended to ventilate the stacks after coating. Do not pack them for shipping immediately after coating.

### **Note**

Should additives have to be added constantly in order to work reasonably, please contact us. We will adjust the formulation accordingly.

**Under no circumstances work according to the motto: The more, the better !!!**

### **Special applications**

#### **UV MATT LACQUERS**

The problems are similar as with dispersion coatings. The lower the required matt degree, the more mottled the surface (small tree structure). In comparison UV matt lacquers show a much better rub resistance.

For matt lacquer application we recommend using chambered doctor blade systems, as the transmission is considerably more even. A dip volume of approx. 9 ccm proved to be best.

#### **Gluable UV LACQUERS**

Our SENOLITH® product program offers gluable UV lacquers. A reference list for glues that were tested with positive results exists and can be provided on request.

- Requirements for a good gluability:
  1. Surface areas to be glued have to be free of ink.
  2. If primer is used, do not apply primer on areas to be glued
  3. Using a Sellotape resistant primer: the primer has to provide optimal adhesion to the substrate, the printing ink and to the UV lacquer. We recommend **SENOLITH® WB PRIMER SELLOTAPE RESISTANT 350463**.

Gluable UV lacquers are, for example:

**SENOLITH® UV GLOSS LACQUER GLUABLE STAMPABLE 360050, V 45**

**SENOLITH® UV GLOSS LACQUER GLUABLE STAMPABLE 360080, V 80**

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### Stampable UV LACQUERS

The SENOLITH® product program offers stampable UV lacquers. A reference list for suitable stamping foils exists and can be provided on request.

Slip and levelling agents, wetting agents or anti-foaming agents are not allowed to be added when working with stampable UV lacquers, as they influence the stampability negatively. The parameters printing substrate, printing ink, UV lacquer and stamping foil have to be suited to each other. To achieve a good stampability of the foil, it should be coated with a sellotape resistant primer first, e.g. **SENOLITH® WB PRIMER SELLOTAPE RESISTANT 350463**.

Afterwards a stampable UV lacquer, e.g. **SENOLITH® UV GLOSS LACQUER GLUABLE, STAMPABLE 360050**, V 45 or **SENOLITH® UV GLOSS LACQUER GLUABLE, STAMPABLE 360080**, V 80, should be applied.

### Special applications:

In practice, machines with chambered doctor blade systems and double intermediate drying between both of the coating units proved to have the best pre-requisites and offer the most diverse possibilities for surface finishing. Following are some examples:

#### **Dispersion primer – UV lacquer on double coating machines**

##### Application amounts:

Dispersion primer: approx. 13 – 18 ccm

The primer should be dried mainly with hot air, to keep the stack temperature as low as possible.

UV lacquer: approx. 18 – 25 ccm

If too much lacquer is applied, the surface develops an effect similar to orange skin.

Application amounts are dependent on absorption capacity and smoothness of the surface.

Regarding anilox rollers - the manufacturers of the anilox rollers should be consulted to find the optimal configuration.

#### **Check list for processing dispersion primer and UV lacquer - In-line**

- 1) Apply primer on blank material - check drying of primer
- 2) Apply UV lacquer on blank material – check drying of UV lacquer– do acetone test – check scratch resistance
- 3) Apply primer + UV lacquer on blank material – check drying – do acetone test – check scratch resistance (finger nail test)  
Gloss measurement – Depending on the printing substrate the gloss value should be between 75 and 90 gloss points  
Points 1 - 3 should be checked without printing ink
- 4) Apply printing ink + primer – check wetting and drying
- 5) Apply printing ink + primer + UV lacquer – check wetting – check scratch resistance and thorough drying on blank material – acetone test (finger nail test) on blank material
- 6) The UV lacquer must always be dry on the surface, even on printing ink, because there is no after-drying
- 7) Scratch resistance and acetone test always have to show positive on the blank area
- 8) Scratch resistance of the UV lacquer on the printing ink is not given until the printing ink has dried thoroughly



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### Pre-requisites for In-line

Sheet-fed offset press with hybrid equipment:

- At least 5 printing units, PU 1 – 4 hybrid or UV inks, PU 5 for oil-based Litho varnish (conventional roll coverings or combination rolls necessary)
- UV intermediate drying after the last PU, also recommended is variable intermediate drying after the first, i.e. the second PU
- UV final drying, usually 3 lamps
- Coating unit with UV equipment
- Anilox roller with a high dip volume (approx. 13 – 22 ccm/m<sup>2</sup>), Tri-Helical engraving is advantageous

### Pre-requisites for Off-line

- Application equipment (preferably off-set printing press) for Oil-based Litho varnish, directly followed by application equipment for UV lacquer.
- UV final drying
- Can be used with conventional inks, as well as with UV or hybrid inks.

### Matt/gloss effect:

- **SENOLITH® OB MATT VARNISH HYBRID 355422** is applied on the hybrid ink in the last printing unit.
- Directly after our **SENOLITH® UV GLOSS LACQUER 360551** is applied over the coating unit. It should be observed that the applied amount of lacquer is not too thick (recommended anilox rollers 13 – 16 ccm/m<sup>2</sup> dip volume). Tri-Helical engraving is advantageous.
- The spots on the printing sheets, where the UV lacquer is applied over the oil-based Litho varnish appear matt. The spots where it is applied directly on the hybrid ink appear glossy.

### Texture/Gloss effect

- **SENOLITH® OB EFFECT MATT VARNISH 355400** is applied on the hybrid ink in the last printing unit.
- Afterwards our **SENOLITH® UV HYBRID EFFECT LACQUER 360053** is applied in the coating unit. An anilox roller with a large dip volume should be used (recommended is 13 – 22 ccm/m<sup>2</sup>). Tri-Helical engraving is advantageous.
- A texture similar to orange skin develops on the spots of the printing sheet, that have the oil-based Litho varnish underneath. Only the spots with UV lacquer appear glossy again.

### Tips:

- Both effects strongly depend on the application amount of the oil-based Litho varnish, it should be sufficiently high enough
- It is recommended to run a test print only with the hybrid ink and the oil-based Litho varnish to check the amount of varnish used, before the UV lacquer is processed.

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- Furthermore the results strongly depend on the quality of the paper, the machine speed and the quality of the hybrid or UV ink.
- To achieve optimal gloss, the available UV intermediate dryers should be run at full power, to ensure that the hybrid or UV ink is thoroughly dried.
- To avoid high pile temperatures only as much radiation as is necessary should be used during the final UV drying.

### Cationic SENOLITH® UV LACQUERS

Within the various radically curing lacquers the so called “cationic UV curable lacquers” form a special product section. We are dealing here with an acid curing epoxide system, which blocks the acid at first and then releases it through the UV radiation when it passes the UV lamp.

The acid causes polymerisation, thus the liquid lacquer forms a film, a solid polymeric type of lacquer. Epoxide lacquers are widely spread in many industries, i.e. for inner lining of tanks used to transport food, inside covering of tubes, etc. This kind of reactions ( acid catalyst polymerisation) are depending on temperature, i.e. the hardening of the lacquer film is accelerated by warmth.

The fact that the reaction requires acid tells, that basic substrates like calcium carbonate hamper the reaction, as they neutralise the acid, which then is no longer available for film formation. Therefore no basic or alkaline materials should be contained in the paper or cardboard coating. It would cause blocking, loss of gloss, create haze or phantom pictures. This can be prevented by using a suitable **SENOLITH® WB PRIMER**. In any case, trial runs should be carried out, to secure the required result can be achieved on the cardboard that is to be used.

Cationic UV lacquers are used where physiological conformity and at the same time extremely high gloss and the highest resistance are required, e.g. with food packaging and medicine packaging.

Cationic UV lacquers can be formulated in such a way, that they can receive an ISEGA Certificate of Conformity.

When changing from a radical to a cationic lacquer system, rollers and pumping equipment have to be thoroughly cleaned. Omission can result in disturbances with the hardening of cationic lacquer systems. We recommend **SENOLITH® CLEANING AGENT 373008**.

In order to insulate the printing substrate, the use of **SENOLITH® WB PRIMER** is recommended prior to application of cationic lacquer systems. Otherwise the reaction might be inhibited as already mentioned above.

Furthermore the hardening is influenced by the thickness of the layer; the thicker the layer, the better. Contrary to this the lacquer film might brittle, if the coating is too thick.