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(54) Titre : PROCÉDE DE REVETEMENT DE LAQUES A PLUSIEURS COUCHES
 (54) Title: MULTILAYER LAQUER COATING PROCESS

(57) **Abrégé/Abstract:**

Multilayer lacquer coating process by application of surfacer and/or further coating composition layers and subsequent application of a topcoat lacquer layer of a base lacquer/clear lacquer structure or of a pigmented single-layer topcoat lacquer onto a substrate, wherein at least one of the layers of the multilayer structure is prepared from a coating composition at least partially curable by means of high-energy radiation, in which process, once the coating composition at least partially curable by means of high-energy radiation has been applied, irradiation is performed first with IR radiation and then with high-energy radiation.

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5 subsequent application of a topcoat lacquer layer of a base
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radiation.

Multilayer lacquer coating process

This invention relates to a process for providing multilayer lacquer coatings on substrates using radiation curable coating compositions. The process may advantageously be used for automotive and industrial lacquer coating, preferably in automotive repair lacquer coating.

10 It has been known for a relatively long time to use UV technology in coating and curing, particularly in the wood coating industry. It is, however, also known in other areas of application, such as for example in automotive lacquer coating, to use coating compositions which are curable by means of high-energy radiation. These applications also enjoy the advantages of radiation curable coating compositions, such as for example the very short curing times, low solvent emissions from the coating compositions and the very good hardness of the coatings obtained therefrom.

In addition to suitable radiation curable binders and photoinitiators, various types of radiation sources have also become known.

25 DE-A-196 35 447, for example, accordingly describes a process for the production of a multilayer repair lacquer coating, wherein a coating composition solely containing binders free-radically polymerisable by UV radiation is applied as the clear lacquer or pigmented topcoat lacquer.

Once applied, the coating composition is exposed to UV light with UV flash lamps.

EP-A-0 540 884 describes a process for the production of a multilayer coating for automotive original lacquer coating by application of a clear lacquer layer onto a dried or cured base lacquer layer, wherein the clear lacquer coating composition contains binders curable by free-radical polymerisation and the clear lacquer layer is cured by means of UV radiation. Application of the clear lacquer proceeds with illumination with light of a wavelength of greater than 550 nm or with exclusion of light.

Coating compositions curable by means of high-energy radiation have also been described which contain binders which may be cured by means of high-energy radiation and additionally by means of a further crosslinking mechanism.

DE-A-28 09 715, for example, discloses binders curable by means of high-energy radiation which are based on an NCO- and acryloyl-functional urethane compound, which is produced from a (meth)acrylic acid hydroxyalkyl ester and a polyisocyanate, and on a polyfunctional hydroxyl compound.

EP-A-0 000 407 describes coating compositions curable by means of high-energy radiation based on an OH-functional polyester resin esterified with acrylic acid, a vinyl compound and a polyisocyanate. In a first curing step, irradiation is performed with UV light and, in a second curing step, final curing proceeds at temperatures of 130 to 200°C.

U.S. Patent No. 6,332,291 proposes coating compositions curable by means of high-energy radiation, which contain as binder compounds A) having free-radically polymerisable double bonds and further functional groups reactive for the purposes of an addition and/or condensation reaction together with compounds B) having free-radically polymerisable double bonds and further functional groups reactive for the purposes of an addition and/or condensation reaction, wherein the latter should be reactive towards the additional reactive groups of the compounds A). The resultant coatings may be completely cured after UV irradiation by exposure to relatively high temperatures of for example 30 to 120°C.

However, the coatings obtained with the above-stated processes for multilayer automotive lacquer coating using binders curable by means of high-energy radiation are still in need of further improvement in certain respects. The coatings still exhibit weaknesses with regard to resistance to weathering and chemicals and exhibit unsatisfactory sandability. Moreover, the curing process for the coating compositions curable by means of high-energy radiation brings about a shrinkage in volume of the applied coating, which gives rise to stresses and cracking in the film. This may result in detachment from the substrate. The problem of cracking and deficient interlayer adhesion has not hitherto satisfactorily been solved.

The object of the invention was accordingly to provide a multilayer automotive lacquer coating process, in particular for multilayer automotive repair lacquer coating, using at least partially radiation curable coating compositions, by means of which process coatings are obtained which exhibit no cracking and exhibit good adhesion to the substrate. The resultant coatings should exhibit very good resistance to chemicals and weathering together with good sandability. The coatings should also exhibit adequate flexibility even at an elevated crosslink density. The coatings should moreover exhibit a perfect optical appearance.

This object is achieved by the multilayer lacquer coating process provided by the invention which comprises the application of one or more surfacer layers and/or further layers, which may, for example, comprise conventional interlayers, onto an optionally precoated substrate, and subsequent application of a topcoat lacquer layer of a base lacquer/clear lacquer structure or of a pigmented single-layer topcoat lacquer, wherein at least one of the layers of the multilayer structure is prepared from a coating composition at least partially curable by means of high-energy radiation, which process is characterised in that, once the coating composition(s) at least partially curable by means of high-energy radiation has/have been applied, irradiation is performed first with infrared radiation (IR radiation) and then with high-energy radiation, preferably ultraviolet radiation (UV radiation), wherein irradiation with IR radiation may at least in part overlap with the subsequent irradiation with high-energy radiation.

The high-energy radiation used may in particular comprise UV radiation, but may also be electron beam radiation.

5 Once the coating composition(s) at least partially curable by means of high-energy radiation have been applied, a flashing-off phase is preferably provided. This may, for example, comprise flashing-off for 5 to 15 minutes, preferably for 5 to 10 minutes, at room temperature. Only
10 thereafter is irradiation with IR radiation performed.

The coating compositions at least partially curable by means of high-energy radiation used in the process according to the invention may be aqueous, diluted with
15 solvents or contain neither solvents nor water. The coating compositions may comprise those which are completely or only partially curable by means of high-energy radiation, preferably by means of UV radiation. Coating compositions curable by means of high-energy radiation in particular
20 comprise cationically and/or free-radically curing coating compositions known to the person skilled in the art. Free-radically curing coating compositions are preferred. The action of high-energy radiation on these coating compositions gives rise to free-radicals in the coating
25 composition which initiate crosslinking by free-radical polymerisation of olefinic double bonds.

The preferably usable free-radically curing coating compositions contain conventional prepolymers, such as
30 polymers or oligomers, the molecules of which comprise free-radically polymerisable olefinic double bonds, in

particular in the form of (meth)acryloyl groups. The prepolymers may be present in combination with conventional reactive diluents, i.e. reactive, liquid monomers.

- 5 Examples of prepolymers or oligomers are (meth)acrylic-functional (meth)acrylic copolymers, epoxy resin (meth)acrylates, polyester (meth)acrylates, polyether (meth)acrylates, polyurethane (meth)acrylates, unsaturated polyesters, unsaturated polyurethanes or silicone
- 10 (meth)acrylates having number average molecular weights (Mn) preferably in the range from 200 to 10000, particularly preferably from 500 to 3000, and with an average of 2 to 20, preferably 3 to 10 free-radically polymerisable, olefinic double bonds per molecule.
- 15 (Meth)acrylic should here be taken to mean acrylic and/or methacrylic.

If reactive diluents are used, they are used, for example, in quantities of 1 to 50 wt.%, preferably of 5 to 30 wt.%,

20 relative to the total weight of prepolymers and reactive diluents. These reactive diluents comprise defined, low molecular weight compounds which may be mono-, di- or polyunsaturated. Examples of such reactive diluents are:

(meth)acrylic acid and the esters thereof, maleic acid and

25 the semi-esters thereof, vinyl acetate, vinyl ethers, substituted vinylureas, ethylene and propylene glycol di(meth)acrylate, 1,3- and 1,4-butanediol di(meth)acrylate, vinyl (meth)acrylate, allyl (meth)acrylate, glycerol tri-, di- and mono(meth)acrylate, trimethylolpropane tri-, di-

30 and mono(meth)acrylate, styrene, vinyltoluene, divinylbenzene, pentaerythritol tri- and

tetra(meth)acrylate, di- and tripropylene glycol di(meth)acrylate, hexanediol di(meth)acrylate. Reactive diluents may be used individually or as a mixture. Diacrylates, such as for example dipropylene glycol diacrylate, tripropylene glycol diacrylate and/or hexanediol diacrylate, are preferably used as the reactive diluents.

The free-radically curing coating compositions contain photoinitiators, for example in quantities of 0.1 to 5 wt.%, preferably of 0.5 to 3 wt.%, relative to the total of free-radically polymerisable prepolymers, reactive diluents and photoinitiators. Conventional photoinitiators are suitable, such as for example benzoin and the derivatives thereof, acetophenone and the derivatives thereof, anthraquinone, 1-benzoylcyclohexanol, organophosphorus compounds, such as for example acyl phosphine oxides. The photoinitiators may be used individually or in combination. Further synergistic components, for example tertiary amines, may also be used.

The coating compositions at least partially curable by means of high-energy radiation usable in the process according to the invention preferably contain, apart from the binder system curable by means of high-energy radiation, one or more further binders. The further binders which may additionally be present preferably comprise conventional binder systems curable by means of addition and/or condensation reactions. They may, however, also comprise conventional physically drying binder systems or combinations of both stated binder systems. It is also

possible for the binder systems which are *per se* curable by means of high-energy radiation to have groups capable of crosslinking by addition and/or condensation reactions in addition to the free-radically polymerisable double bonds.

5

The addition and/or condensation reactions for the present purposes comprise lacquer chemistry crosslinking reactions known to the person skilled in the art, such as for example ring-opening addition of an epoxy group onto a carboxyl
10 group with formation of an ester and a hydroxyl group, the addition of a hydroxyl group onto an isocyanate group with formation of a urethane group, the reaction of a hydroxyl group with a blocked isocyanate group with formation of a urethane group and elimination of the blocking agent, the
15 reaction of a hydroxyl group with an N-methylol group with elimination of water, the reaction of a hydroxyl group with an N-methylol ether group with elimination of the etherification alcohol, the transesterification reaction of a hydroxyl group with an ester group with elimination of
20 the esterification alcohol, the transurethanisation reaction of a hydroxyl group with a carbamate group with elimination of alcohol, the reaction of a carbamate group with an N-methylol ether group with elimination of the etherification alcohol.

25

The binder system preferably contains functional groups which permit crosslinking at low temperatures, for example at 20 to 80°C. These particularly preferably comprise hydroxyl and isocyanate groups. The functional groups, in
30 particular the hydroxyl groups and isocyanate groups, may

in each case be present either in the binder curable by means of high-energy radiation and/or in a separate binder.

Polyurethane (meth)acrylates, polyester (meth)acrylates
5 and/or (meth)acryloyl-functional poly(meth)acrylates may preferably be used in the clear lacquer, base lacquer or single-layer topcoat lacquer, while epoxy (meth)acrylates are preferably used in the surfacer or further layers, such as interlayers. Particularly good results are obtained if
10 the above-stated (meth)acryloyl-functional binders are combined with binders based on a crosslinking mechanism between hydroxyl and isocyanate groups. The hydroxyl and/or isocyanate groups may here also be present in the (meth)acryloyl-functional binder(s). It should merely be
15 noted that those components comprising hydroxyl groups and those components comprising isocyanate groups must be stored separately and may be mixed together only shortly before application. Particularly preferably and advantageously used binder systems are those which contain
20 (meth)acryloyl- and OH-functional components and polyisocyanates, wherein the (meth)acryloyl and OH groups may be present in a single and/or different binder components, and also binder systems containing A) compounds comprising one or more free-radically polymerisable double
25 bonds, which additionally contain at least one further functional group reactive for the purposes of an addition and/or condensation reaction and B) compounds comprising one or more free-radically polymerisable double bonds, which additionally contain at least one further functional
30 group reactive for the purposes of an addition and/or condensation reaction, wherein the additional reactive

functional group is complementary to or reactive towards the additional reactive functional groups of component A). In the latter case, one or more monomeric, oligomeric and/or polymeric compounds having at least one functional group reactive for the purposes of an addition and/or condensation reaction towards the functional groups from component A) or component B) present in addition to the free-radically polymerisable double bonds may optionally also be present.

10

The coating compositions which are at least partially curable by means of high-energy radiation and are usable in the process according to the invention may contain additional components conventional in lacquer formulation. They may, for example, contain conventional lacquer additives. The additives comprise those conventional additives usable in the lacquer sector. Examples of such additives are levelling agents, anticratering agents, antifoaming agents, catalysts, coupling agents, rheological additives, thickeners, light stabilisers and emulsifiers. The additives are used in conventional quantities familiar to the person skilled in the art.

The coating compositions usable in the process according to the invention may contain proportions of organic solvents and/or water. The solvents comprise conventional industrial lacquer solvents. These may originate from the production of the binders or are added separately. Examples of such solvents are mono- or polyhydric alcohols, for example propanol, butanol, hexanol; glycol ethers or esters, for example diethylene glycol dialkyl ethers, dipropylene

glycol dialkyl ethers, in each case with C1 to C6 alkyl, ethoxypropanol, ethylene glycol monobutyl ether; glycols, for example ethylene glycol, propylene glycol and the oligomers thereof, esters, such as for example butyl acetate and amyl acetate, N-methylpyrrolidone and ketones, for example methyl ethyl ketone, acetone, cyclohexanone; aromatic or aliphatic hydrocarbons, for example toluene, xylene or linear or branched aliphatic C6 to C12 hydrocarbons.

10

The coating compositions usable in the process according to the invention may contain pigments and/or extenders. These comprise the conventional extenders usable in the lacquer industry and organic or inorganic coloured and/or effect pigments and anticorrosion pigments. Examples of inorganic or organic coloured pigments are titanium dioxide, micronised titanium dioxide, iron oxide pigments, carbon black, azo pigments, phthalocyanine pigments, quinacridone and pyrrolopyrrole pigments. Examples of effect pigments are: metal pigments, for example made from aluminium, copper or other metals; interference pigments, such as for example metal oxide coated metal pigments, for example aluminium coated with titanium dioxide or with mixed oxide, coated mica, such as for example mica coated with titanium dioxide and graphite effect pigments. Examples of extenders are silicon dioxide, aluminium silicate, barium sulfate and talcum. In addition to the conventional additives, the coating compositions may advantageously contain specially coated extenders for increasing scratch resistance.

Extenders which may be considered for this purpose are, for example, micronised aluminium oxide or micronised silicon

oxides. These extenders are coated with compounds which contain UV-curable groups, for example with acrylic-functional silanes and consequently also participate in the radiation curing of the coating composition. Such
5 transparent extenders which are particularly suitable for clear lacquers are available as commercial products, for example under the name AKTISIL®.

The overall composition of the usable coating compositions,
10 for example the nature of the pigment, is determined by which layer of the multilayer structure is to be produced with the particular coating composition, *i.e.* whether, for example, it comprises a clear lacquer, a base lacquer or a surfacer or another conventional interlayer.

15

The coating composition may be applied onto various substrates in the process according to the invention. Preferred substrates are metal or plastics substrates. Application in the multilayer structure proceeds by
20 conventional methods, preferably by spraying. The substrates may be precoated, for example provided with a conventional priming coat.

Once the coating composition(s) at least partially curable
25 by means of high-energy radiation has/have been applied, irradiation with IR radiation is performed. IR light sources known to the person skilled in the art and conventional for lacquer drying may be used. The IR light source is positioned in front of the substrate surface to
30 be irradiated, for example at a distance of 20 to 70 cm. The duration of irradiation with IR radiation may be, for

example 1 to 20 minutes. Depending upon the duration of irradiation and the power of the radiation source, substrate surface temperatures of for example 40 to 200°C may be achieved. The settings are favourably arranged such that temperatures of for example 40 to 100°C at the substrate surface are achieved. Particularly good results are achieved if irradiation with IR radiation is not performed directly after application, but instead a flashing-off phase intervenes. Flashing-off may last, for example, for 5 to 15 minutes, preferably 5 to 10 minutes, at room temperature.

When the desired substrate surface temperature is achieved by means of IR irradiation or the planned duration of irradiation has elapsed, irradiation may be performed with high-energy radiation, preferably with UV radiation.

Curing of the coating at least partially curable by means of high-energy radiation, preferably UV radiation, may preferably proceed with UV radiation sources emitting in the wavelength range from 180 to 420 nm, in particular from 200 to 400 nm.

Examples of usable UV radiation sources are, for example, high-, medium- and low-pressure mercury lamps. Lamp length may vary. Lamps of between 5 and 200 cm in length are usual. Lamp and reflector geometry may be tailored relative to each other in the conventional manner depending upon the particular application and the required radiation energy. Lamp power may, for example, vary between 20 and 250 W/cm (Watts per cm of lamp length). Lamps of a power of between

80 and 120 W/cm are preferably used. The mercury lamps may optionally also be doped by the introduction of metal halides. Examples of doped light sources are iron- or gallium-mercury lamps.

5

Further examples of UV radiation sources are gas discharge tubes, such as for example low pressure xenon lamps, UV lasers, UV point light sources, such as UV-emitting diodes, and black light tubes. In addition to these continuously
10 operating UV radiation sources, however, discontinuous UV radiation sources may also be used. These preferably comprise so-called high-energy flash installations (abbreviated to UV flash lamps). UV flash lamps may contain a plurality of flash tubes, for example quartz tubes filled
15 with inert gas, such as xenon. The UV flash lamps exhibit, for example, an illuminance of at least 10 megalux, preferably of 10 to 80 megalux, per flash discharge. The energy per flash discharge may, for example, amount to 1 to 10 kJoules.

20

The UV radiation sources are generally incorporated into a UV installation, which normally consists of the UV radiation sources, the reflector system, the power supply, electrical controls, screening, cooling system and ozone
25 extractor. Other arrangements are, of course, also possible and certain of the stated components may also be omitted.

When UV flash lamps are used as the UV radiation source, the duration of irradiation with UV radiation may, for
30 example, be in the range from 1 millisecond to 400 seconds, preferably from 4 to 160 seconds, depending upon the

selected number of flash discharges. The flashes may, for example, be triggered approximately every 4 seconds. Curing may proceed, for example, by 1 to 40 successive flash discharges.

5

When continuous UV radiation sources are used, the duration of irradiation may, for example, be in the range from a few seconds to approx. 5 minutes, preferably below 5 minutes.

10 The distance between the UV radiation sources and the substrate to be irradiated may be, for example, 5 to 60 cm. Screening of the UV radiation sources to prevent escape of radiation may be achieved, for example, by using a suitably lined protective housing around a transportable lamp unit
15 or by means of other safety measures known to the person skilled in the art.

The multilayer lacquer coating process according to the invention, which is characterised in that, once the coating
20 composition(s) at least partially curable by means of high-energy radiation have been applied, irradiation is performed first with IR radiation and then with high-energy radiation, may be performed in various embodiments.

25 It is, for example, possible to perform the UV irradiation phase once the IR irradiation phase is complete or UV irradiation may begin while IR irradiation is still under way. In the latter case, the IR and UV irradiation phases may partially or completely overlap, *i.e.* the IR
30 irradiation phase may be ended before or simultaneously with the completion of the UV irradiation phase.

It is also possible to perform a further IR irradiation phase once the UV irradiation phase has ended. The subsequent IR irradiation phase may amount, for example, to 5 0.5 to 30 minutes. Otherwise, the statements already made above with regard to IR irradiation apply. In the case of an IR irradiation phase following the UV irradiation phase, irradiation may be performed in succession in the order IR, UV, IR irradiation, or the IR irradiation phase may extend 10 over the entire irradiation time, *i.e.* IR irradiation is performed before, during and after the UV irradiation phase.

The IR irradiation phase and subsequent UV irradiation 15 phase may, if required, also be repeated several times in succession.

In either of the stated embodiments, the duration of irradiation per irradiation period and the overall duration 20 of irradiation may be varied.

It is furthermore also possible to apply the associated IR and UV irradiation periods in conjunction with the performance of two or more spray passes, two or more 25 operations or in conjunction with the radiation curing of two or more successive layers of the multilayer structure.

For example, once the at least partially radiation curable coating composition has been applied in one spray pass, 30 intermediate hardening may be performed first with IR irradiation and subsequent UV irradiation, whereafter the

coating composition is applied in one or more further spray passes and then first IR irradiation and subsequently UV irradiation are performed in turn. This mode of operation is particularly advantageous for applying surfacer layer films which are desired in relatively high thicknesses, for example of up to 400 μm .

It is also possible in the multilayer structure first to apply an at least partially radiation curable base lacquer and to subject it first to IR and then UV irradiation. An at least partially radiation curable clear lacquer may then be applied and in turn subjected first to IR and then UV irradiation. In both cases, further IR irradiation may optionally be performed after the UV irradiation. Radiation curing of the individual layers of the multilayer structure and of the layers applied by means of two or more spray passes may here be performed in each case with differing radiation intensity and differing duration of irradiation for each layer individually or jointly for two or more layers.

The lacquer-coated substrate surfaces may, for example, be irradiated according to the invention by positioning IR light sources and UV light sources next to each other and to switch them appropriately or optionally to position the light sources alternately in front of the substrate surface to be irradiated. It is also possible to use a so-called combined light source which contains the IR and UV radiation source in a single device. In the latter case, IR and UV lamps may, for example, be arranged alternately next to each other in the device.

One or more layers at least partially curable by means of high-energy radiation of a conventional multilayer structure in automotive lacquer coating may be cured using the process according to the invention. Said layers may, for example, comprise a multilayer structure comprising primer, surfacer, base lacquer and clear lacquer or comprising primer, surfacer and single-layer topcoat lacquer. One or more layers of the multilayer structure may here be prepared from at least partially radiation curable coating compositions.

Crack-free coatings having very good adhesion to the substrate and very good interlayer adhesion are obtained by the process according to the invention. The applied coatings exhibit adequate sag resistance and, once cured, perfect optical appearance. Resistance to chemicals and to weathering is very good. The resultant coatings simultaneously combine an elevated crosslink density with adequate flexibility. Surfacer coatings produced using the process according to the invention are very readily sandable.

The following Examples are intended to illustrate the invention in greater detail.

Example 1

A clear lacquer curable by means of UV radiation was first produced. To this end, the following components were mixed together and homogenised for several minutes using a high-speed stirrer:

55 g of a conventional commercial OH- and acryloyl-functional binder (Jägalux 5154)

5 10 g of a conventional commercial polyisocyanate (Desmodur N 75)

3.8 g of a conventional aryl phosphine oxide based photoinitiator (Lucirin TPO)

10

0.5 g of a conventional commercial levelling agent (Byketol OK)

2.5 g of butyl acetate.

15

Production of a multilayer structure

A surfacer layer (binder based on 2-component polyurethane, solvent-based) was applied to a resultant dry film thickness of approx. 80 μm onto a cathodically
20 electrocoated metal sheet and, after a brief flashing-off period at room temperature, cured for 30 minutes at 60°C.

An aqueous base lacquer (produced according to DE-A-196 43 802, production example 4) was applied to a resultant dry
25 film thickness of 13 to 15 μm onto the surfacer layer. After flashing-off for 20 minutes at room temperature, the clear lacquer curable by means of UV radiation described above was applied to a resultant dry film thickness of 40-50 μm .

30

After flashing-off for 5 minutes at room temperature, IR irradiation of the applied clear lacquer was performed. Irradiation time was 5 minutes. UV irradiation was then performed with a UV flash lamp (power 3500 Ws). Irradiation was performed with 30 flashes, which were triggered at approx. 4 s intervals, at a distance of approx. 20 cm from the object.

Example 2

10 A similar method was used as in Example 1, except that the UV irradiation was followed by a further IR irradiation (5 minutes' irradiation).

Comparative Example 1

15 A similar method was used as in Example 1, except that, once the clear lacquer had been applied and after a flashing-off phase of 30 minutes at room temperature, UV irradiation was performed directly with a UV flash lamp (power 3500 Ws). UV irradiation was performed with 30
20 flashes, which were triggered at approx. 4 s intervals, at a distance of approx. 20 cm from the object.

25

30

Comparison of resultant lacquer properties

	Example 1	Example 2	Comparative Example 1
Humid heat test (1) (2)	1/1	1/1	1/3
Adhesion (3)	0-1	1	1-2
Adhesion (3) after humid heat test (1)	2	2-3	3
Optical properties	OK	OK	slight microtexture

- (1) Humid heat test to DIN 50017
- 5 (2) Evaluation of blistering to DIN 53209
- (3) Crosshatching according to DIN 53151

Patent Claims

1. Process for multilayer lacquer coating by application of one or more surfacer layers and/or further coating composition layers onto an optionally precoated substrate and subsequent application of a topcoat lacquer layer of a base lacquer layer/clear lacquer layer structure or of a pigmented single-layer topcoat lacquer, wherein at least one of the layers of the multilayer structure is prepared from a coating composition at least partially curable by means of high-energy radiation, characterised in that, the coating composition at least partially curable by means of high-energy radiation is applied and subsequently irradiated, wherein irradiation is performed first with IR radiation and then with high-energy radiation, wherein irradiation with IR radiation overlaps with the subsequent irradiation with high-energy radiation.
2. Process according to claim 1, characterised in that, once the coating composition at least partially curable by means of high-energy radiation is applied, a flashing-off phase is performed at room temperature, whereupon irradiation with IR radiation proceeds.
3. Process according to claim 1 or 2, characterised in that the one or more surfacer layers, the pigmented topcoat lacquer layer, the base lacquer layer and/or the clear lacquer layer is applied as the coating composition at least partially curable by means of high-energy radiation.

4. Process according to any one of claims 1 to 3, characterised in that the coating compositions curable by means of high-energy radiation additionally contain binder systems curable by means of addition and/or condensation reactions.
5
5. Process according to claim 4, characterised in that the additionally present binder systems comprise those based on OH-functional and NCO-functional binder components.
10
6. Process according to any one of claims 1 to 3, characterised in that the coating composition curable by high-energy radiation contains (meth)acryloyl-functional binders which additionally comprises reactive functional groups.
15
7. Process according to claim 6, characterised in that the additional functional groups comprise OH and/or NCO groups.
20
8. Process according to any one of claims 1 to 7, characterised in that a further IR irradiation is performed after the irradiation with high-energy radiation.
25
9. Process according to any one of claims 1 to 8, characterised in that the process is performed for repair lacquer coating.
- 30 10. Process according to any one of claims 1 to 8, characterised in that the process is performed for repair lacquer coating of vehicles.