

# SILRES<sup>®</sup> MK FLAKES



## Silicone Resins

SILRES<sup>®</sup> MK FLAKES is a condensation curing methyl silicone resin with good solubility in various organic solvents. The product can be used as a binder or as an impregnation agent for porous materials. Besides SILRES<sup>®</sup> MK FLAKES is the ideal product for making tack-free prepregs with excellent storage stability.

Compared to other WACKER silicone resins SILRES<sup>®</sup> MK FLAKES gells relatively fast at elevated temperature. It is therefore particularly suitable for fully automated production lines.

Fully cured SILRES<sup>®</sup> MK FLAKES has the lowest carbon content of all WACKER silicone resins and thus yields a very high ash content when pyrolyzed.

Composites made of SILRES<sup>®</sup> MK FLAKES show long-term stability against weathering, moisture and UV light; they can therefore be exposed continuously to constantly changing climatic conditions, UV radiation and temperatures significantly higher than 300 °C (572 °F). SILRES<sup>®</sup> MK FLAKES further provides water repellency and excellent electrical insulation properties to the respective composite materials.

## Properties

### Uncured:

- Silicone resin with methyl groups only
- Solid
- Delivery form: flakes (when needed as powder, please ask for our product SILRES<sup>®</sup> MK POWDER)
- Good solubility in organic solvents
- Fast heat curing when catalyzed

### Cured:

- Lowest carbon content of all WACKER silicone resins
- Very high binding strength
- Excellent heat stability
- Marginal smoke emission on pyrolysis

## Specific features

- Crosslinking Property: Condensation-curing
- Regulation: Solvent-free
- Resistance: Heat resistant
- Resistance: Provides excellent water repellency
- Resistance: UV & weathering-resistant
- Specific Features: Condensation-curing
- Specific Features: Electrically insulating
- Specific Features: Filler and pigment compatibility
- Specific Features: Heat resistant
- Specific Features: Hydrophobic
- Specific Features: Solvent-free
- Specific Features: UV & weathering-resistant
- Vulcanizate: Electrically insulating

## Technical data

### General Characteristics

Property	Condition	Value	Method
Ash content (after pyrolysis at 1000 °C)	-	approx. 82 wt. %	-
Bulk density	-	690 kg/m <sup>3</sup>	-
Carbon content (cured resin)	-	approx. 18 wt. %	-
Colour	-	colourless	-
Melting point	-	35 - 55 °C	-
Supply form	-	flakes	-

These figures are only intended as a guide and should not be used in preparing specifications.

All the information provided is in accordance with the present state of our knowledge. Nonetheless, we disclaim any warranty or liability whatsoever and reserve the right, at any time, to effect technical alterations. The information provided, as well as the product's fitness for an intended application, should be checked by the buyer in preliminary trials. Contractual terms and conditions always take precedence. This disclaimer of warranty and liability also applies particularly in foreign countries with respect to third parties' rights.

## Applications

- Heating Elements
- Mica and Glass Cloth Laminates
- Resistors & Capacitors

## Application details

- Impregnation agent for porous materials
- Binder for composites made of inorganic mineral fillers
- Binder for laminates made of fibrous fillers, cloths, woven or non-woven reinforcing materials
- Typical fields of industrial applications: household appliances, mechanical engineering, automotive, electrical industry.

# Processing

## Handling and Curing

SILRES<sup>®</sup> MK FLAKES typically is processed in solution. The silicone resin powder is readily soluble in toluene, xylene and THF. For solutions with a solids content below 50 wt.% acetone, ethyl acetate and methyl isobutyl ketone (MIBK) can be used. With ethanol (technical quality, water content < 2 wt.%), propanol or butanol the preparation of low concentrated solutions is possible, while SILRES<sup>®</sup> MK FLAKES is barely soluble in methanol and aliphatic hydrocarbons.

The curing of SILRES<sup>®</sup> MK FLAKES is accelerated by a number of catalysts. The curing speed depends on the type of curing agent, the catalyst amount and the curing temperature. Please note: curing acceleration is most efficient with liquid catalysts or when the resin is processed in solvent. Adjacent table lists some typical catalysts and the resulting gelling times at 150°C as a function of the catalyst quantity (solution of 50 wt.% SILRES<sup>®</sup> MK FLAKES in toluene; catalyst quantities given in % by weight, based on solid silicone resin).

Gelling time at 150 °C, minutes			
Added catalyst quantity:	0.5 wt. %	1.0 wt. %	2.5 wt. %
WACKER <sup>®</sup> Catalyst F, 100%	5	5	4
WACKER <sup>®</sup> Catalyst K83	135	45	7
GENIOSIL <sup>®</sup> GF 91	6	5	4
Triethanolamine	6	5	7
Tetrabutylammonium acetate*	3	3	3
Butyltitanate	120	30	9

\* applied as a 10 wt.% solution in ethanol

**IMPORTANT:** the pot life of catalyzed resin solutions usually is limited, even at room temperature. We therefore recommend to add the catalyst immediately before use and to process the catalyzed mixture within the next few hours. To increase the life time of concentrated, catalyzed SILRES<sup>®</sup> MK FLAKES solutions it is beneficial to add some 5 wt. % of alcohol, such as ethanol or butanol.

As curing speed may considerably vary within certain limits, these figures are intended as a guideline only. We recommend running preliminary tests to optimize conditions for the particular application.

## Typical Applications

### 1. Glass Fibre Laminates

Please note: manufacturing prepregs and laminates is a complex process that needs a thorough control of various process parameters, such as temperature, catalyst quantity, nature of catalyst, solvent type, machine specific conditions, etc. Therefore, the following indications are intended as a guide only, and we recommend running preliminary tests to optimize the conditions of the particular process.

Since fully cured SILRES<sup>®</sup> MK FLAKES provides water repellency, excellent electrical insulation properties, outstanding heat resistance and long term stability against weathering, moisture and UV light, this silicone resin is often used as a binder for laminates made of fibrous fillers, cloths, woven or non-woven reinforcing materials. The following process illustrates a typical production sequence for the manufacture of glass cloth laminates.

SILRES<sup>®</sup> MK FLAKES is dissolved in toluene, or any other suitable organic solvent, to form a resin solution with a solids content of about 10-20 % by weight. The curing catalyst is added right prior processing; for the purpose of storage-stable prepregs WACKER<sup>®</sup> Catalyst F, 100%, WACKER<sup>®</sup> Catalyst K83, zinc acetylacetonate or related metal salts of acetylacetonate and of long-chained carboxylic acids proved most useful as catalysts.

The glass cloth is then impregnated by the catalyzed silicone resin solution either by spraying, or by running the fabric through an impregnation bath. The solvent subsequently is evaporated in a drying oven at moderate temperature (130 to 150 °C). Please note: the drying temperature must not be too high in order to avoid premature curing of the B-stage resin and of the prepreg web, respectively. Also a very long drying cycle can impair the storage stability of the prepregs made.

Depending on the target shape of the laminate product the prepreg web either is rolled-up in layers on a stainless steel mandrel, or it is cut up into smaller pieces which in turn are sandwiched to a layered stack. By applying heat (e.g. 200 °C) and high pressure (for the layered stack assembly: >10 bar) the B-stage resin converts into the C-stage to form a durable and flexurally very rigid composite with very high heat resistance.

Please note: inserting a PTFE coated glass fabric between the pressing plates and the layered prepreg stack can help to prevent the composite from sticking to the plates. Besides it has proven useful to first cool the composite down to 80 °C (or lower) before the laminating press is opened, as this minimizes the delamination risk during the decompression phase.

## 2. Mica Laminates

Please note: manufacturing prepregs and laminates is a complex process that needs a thorough control of various process parameters, such as temperature, catalyst quantity, nature of catalyst, solvent type, machine specific conditions, etc. Therefore, the following indications are intended as a guide only, and we recommend running preliminary tests to optimize the conditions for the particular process.

The process of making mica laminates is similar to the production of glass fibre laminates. Important: the quality of the final product strongly depends on the type of mica, its particle size distribution and the uniformity of the mica paper used.

Similar to the process described for glass fibre laminates, the binder-free mica paper is first impregnated by a catalyzed solution of SILRES® MK FLAKES in toluene or any other suitable organic solvent (solids content of about 10-20 % by weight). After a short residence time the solvent is evaporated in a drying oven at moderate temperature (130 to 150 °C) to yield a physically dry, prepreg web that can be rolled-up in layers for storage.

For producing mica laminates, the prepreg web is cut up into smaller pieces, sandwiched to a layered stack of desired thickness and pressed for approximately 1 hour at 200 °C under high pressure (>10 bar).

Please note: inserting a PTFE coated glass fabric between the pressing plates and the layered prepreg stack can help to prevent the composite from sticking to the plates. Besides it has proven useful to first cool the composite down to 80 °C (or lower) before the laminating press is opened, as this minimizes the delamination risk during the decompression phase. Pressureless post-curing at 250 °C can further improve the laminate's properties in terms of hardness and cohesive strength.

## 3. Binder for Resistor/Capacitor Coatings

As SILRES® MK FLAKES can be highly filled with mineral fillers, it often is used as binder in coatings for resistors and capacitors. The respective silicone resin based blends are highly fire-retardant, and they safely protect the electrical parts from moisture or any other environmental impact. Besides the thermal management is improved, which extends the lifecycle of the particular electrical element - even when continuously run at high temperature levels.

For the production of resistor and capacitor coatings SILRES® MK FLAKES is dissolved in toluene, xylene or any other suitable organic solvent, to form a resin solution with a solids content of about 25 to 35 % by weight. Then the finely ground fillers and pigments, which in total account for up to 75 % of the final coating formulation, are added and thoroughly mixed in a kneader. Finally, a curing catalyst (e.g. WACKER® Catalyst F 100%, WACKER® Catalyst K 83 or GENIOSIL® GF 91) is admixed in a quantity of some 1.5 to 3 wt.%, based on the amount of solid silicone resin used. If necessary, more solvent can be added to adjust the consistency of the coating slurry to the particular needs.

For coating the respective electrical part is dipped into the slurry; alternatively, resistors can be coated by rolling them over the surface of the slurry. The solvent subsequently is evaporated at moderate temperature, e.g. in a drying oven. Finally the green body is cured at high temperature (150 °C, 90 min.) to give a hard, durable coating of 0.5 to 1 mm thickness. Note: to increase the coating thickness multiple dip-coating is possible.

## Packaging and storage

### Storage

Store in a dry and cool place.

The 'Best use before end' date of each batch is shown on the product label.

Storage beyond the date specified on the label does not necessarily mean that the product is no longer usable. In this case however, the properties required for the intended use must be checked for quality assurance reasons.

## Safety notes

While heat curing SILRES® MK FLAKES can release a total of approx. 5 wt.% alcohol. To avoid accumulation of this chemical byproduct ventilation of the work place is recommended.

Comprehensive instructions are given in the corresponding Material Safety Data Sheets. They are available on request from WACKER subsidiaries or may be printed via WACKER web site <http://www.wacker.com>.

## QR Code SILRES® MK FLAKES



### For technical, quality or product safety questions, please contact:

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