

WACKER

CREATING TOMORROW'S SOLUTIONS

SILRES®

INDUSTRIAL COATINGS | SILICON-BASED RAW MATERIALS

**SILRES® RESINS AND INTERMEDIATES –
FOR COATINGS THAT DARE**



Chemical Structure of the Silicone Resin Network

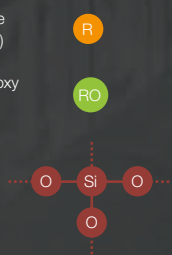
Organic residue
(methyl, phenyl)



Hydroxy or alkoxy
groups



Inorganic
backbone



Why Choose SILRES® Silicone Binders and Intermediates?

Coatings basically consist of five main types of raw materials: binders, pigments, fillers, additives and solvents. Each of these plays a specific role in ensuring that the coating performs as expected in the intended application. Incorporating elemental silicon into the binder

backbone provides additional benefits for solving tough performance challenges. The silicone resin network not only makes all the difference, but is responsible for the outstanding properties for which the coatings are known.

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WANT TO TUNE THE PERFORMANCE OF YOUR COATINGS? TEAM UP WITH THE BEST!

By enhancing coatings performance, WACKER opens up new possibilities for you.

WACKER has been a global technology leader in silicone products for many years. An ambitious partner for the paints and coatings industry, we develop and produce SILRES® brand liquid resins, powder coatings resins and intermediates which are designed to selectively optimize coating systems so that they meet the highest requirements.

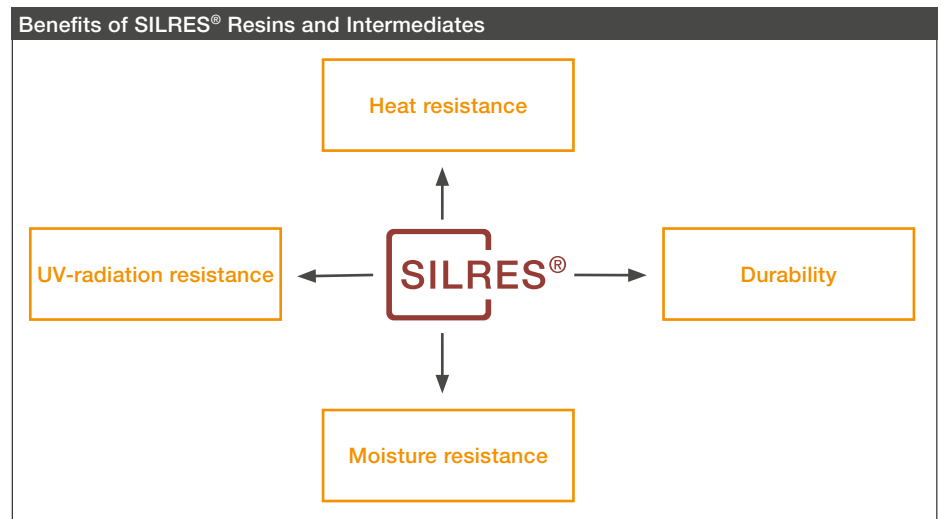
Broaden the Property Spectrum of Your Coating!

SILRES® resins and intermediates can broaden the property spectrum of your coatings, open up new fields and take existing applications to a whole new level of performance. Whether serving as sole silicone binder or being used for chemical or cold-blend modification of organic binders, such as polyesters, alkyds and epoxies, SILRES® products can impart specific film properties. This ability comes from their excellent resistance to high temperatures, UV radiation and moisture.

Profit from Global Presence and Local Customer Support

SILRES® products for industrial coatings are available in the same high standard anywhere in the world. We have also set up technical centers across the globe to

offer you comprehensive support with applications and selection of SILRES® products for industrial coatings.



COATINGS THAT RESIST UP TO 650 °C.
TAKE THE HEAT WITH **SILRES® BINDERS.**



Heat-resistant coatings must provide continuous service at temperatures between 200 °C and 650 °C, with little discoloration and loss of adhesion. This imposes extreme demands on the binder and the formulation. SILRES® silicone resins have proven particularly effective in long-term applications because of their very high inorganic content.

SILRES®: A Broad Portfolio

Chemically, there are three types of silicone resin to choose from:

- Pure phenyl polysiloxane
- Pure methyl polysiloxane
- Mixed phenyl/methyl polysiloxane

For Excellent Heat Resistance

Phenyl groups are the most thermally stable organic substituents. In highly pigmented paint systems, they provide heat resistance up to 650 °C. Phenyl silicone resins are particularly compatible with organic resins.

And More Interesting Properties

Methyl groups are the second most stable organic substituents. In coatings with a low pigment content, they confer heat resistance up to 200 °C. A high content of methyl groups in heat-resistant coatings increases their hardness, water repellency and non-stick properties. Methyl resins are ideal for formulating aluminum-pigmented paints that will resist temperatures up to 650 °C.

Suitable For Many Coating Systems

WACKER has innovative and established SILRES® binder alternatives for:

- Solvent-borne systems and systems with little or no solvent content
- Water-borne systems
- Powder-coating systems
- Room-temperature-curable systems

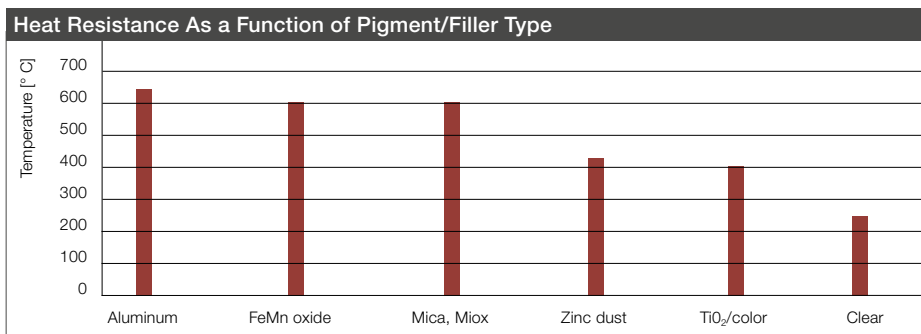
Ideal for Many Applications

In conclusion, SILRES® silicone resins are the right binders for any structural element that might get hot when installed between other system parts of:

- Vehicles (e.g. exhaust systems, mufflers, engine parts, brakes)
- Industrial plant components (e.g. flues, stacks, furnaces, heat exchangers)
- Household appliances (wood-burning ovens, stoves and stovepipes, BBQs, pots and pans)

Benefits of SILRES® Binders in Heat-Resistant Coatings

- Heat resistance up to 650 °C, combined with perfect adhesion
- Durability under extreme temperature variations
- Long-lasting corrosion protection
- UV and weathering resistance
- Low-VOC formulations possible



The chart illustrates how the maximum heat resistance of a coating varies with the type of pigment/filler.

Adjust the Profile to Your Demands!

In addition to the binder's heat resistance, versatile pigmentation is crucial for formulating heat-resistant paints. The right mix of SILRES® silicone resins, heat-resistant pigments and fillers will meet most demands.

COATINGS THAT OUTLAST THE REST? CUSTOMIZE YOUR POLYMERS WITH SILRES® INTERMEDIATES.



Hostile environments, such as intense UV radiation, temperature fluctuations and acid rain, mar the appearance of coatings. SILRES® intermediate-modified coatings are many times more durable than most coatings that contain pure organic binders and are more weather resistant. They are less sensitive to environmental factors, retain their value and have a much longer lifetime.

A Proven Portfolio

WACKER meets your precise needs with a wide range of both liquid methoxy-functional and solid hydroxy-functional intermediates that can be reacted with:

- Polyesters, for weather-resistant coil-coatings or heat-resistant non-stick coatings
- Medium-oil alkyds, for corrosion-resistant protective coatings
- Acrylics, for improved surface hardness

Compatible With Many Organic Resins

SILRES® intermediates can be reacted in almost any proportions with a wide variety of organic resins. Typical examples are alkyd, polyester, epoxy and acrylic resins.

No Undesired Side Effects

Modification of organic resins and coatings with SILRES® intermediates leaves the following product properties unchanged:

- Hardness
- Baking rate
- Mechanical resistance
- Pigment compatibility
- Adhesion

Improved Heat Resistance

The more SILRES® intermediate added, the more heat resistant the coating becomes. Coatings containing 50% or more intermediate will resist continuous exposure to temperatures above 250 °C – for up to several hundred hours.

Benefits of SILRES® Intermediates

- Increased heat resistance of decorative coatings on pots and pans
- Higher weathering resistance of coil coatings
- Reduced maintenance costs for wood coatings
- Improved corrosion resistance and lifetime of marine and protective coatings

HIGHLY WEATHER-RESISTANT EPOXY TOPCOATS? TRY SILRES® HP!



Two-component epoxy coatings find extensive application in marine & protective coatings (e.g. as corrosion protection and maintenance coatings for oil, gas and chemical appliances, for infrastructure facilities, for transport vehicles and devices and power-generation parts). Standard epoxy coatings are given an additional weather-resistant polyurethane topcoat to minimize outdoor damage caused by the UV component of sunlight.

With SILRES® HP, WACKER offers an alternative that imparts unique weathering resistance to epoxy coatings.

Benefits of SILRES® HP in Epoxy Polysiloxane Coatings

- Excellent long-term gloss retention and weathering resistance
- Outstanding solvent resistance (easy-to-clean)
- Very high hardness
- Low VOC values (high solids, 100 – 250 g/l, depending on desired viscosity)
- No content of harmful isocyanates or urethane groups



HOW DO YOU APPLY SILRES[®] MODIFIED COATINGS EASILY?

Applying SILRES[®] based coatings is easy. Just follow these suggestions:

Substrate Preparation

If the coating must adhere readily at high temperatures or exhibit more critical leveling behavior, the substrate needs to be prepared:

- Carefully remove oils, greases and contaminants
- Roughen the surface mechanically, e.g. by sandblasting
- Avoid pretreatment, such as phosphating and chromating

Effect of Film Thickness

For maximum adhesion and resistance to temperature changes, the SILRES[®] silicone resins must have the right film thickness. Film thicknesses between 10 and 30 µm (for powder coatings: 30 – 70 µm) after baking ensure that the coatings have the maximum lifetime. Note: thicker films may experience adhesion loss.

Physical Drying

Due to evaporation of solvent (in liquid paints), paint begins to dry as soon as it is applied. The rate of drying depends on the solvent type, spray-booth temperature and air speed in the baking oven. It is vital that the dryer air have a low particle count and be free of oil. Most SILRES[®] silicone resins ensure tack-free drying at room temperature.

Curing by Baking

The hydroxyl and alkoxy groups that are still present condense during baking as the coating develops its optimum resistance to heat, corrosion and chemicals. For a fast and complete process, coatings that contain methyl groups should be heated at 200 °C for one hour, while methyl phenyl resins should be baked at 250 °C for half an hour. Higher temperatures may be used, but may increase the tendency to blister. In general, it is recommended that painted objects be air-dried at room temperature and then dried at progressively higher temperatures.

Room-Temperature Curing

WACKER has developed specialty silicone curing systems for those applications which do not permit baking and curing at 200 °C. Paints formulated with these binders cure at room temperature, enjoy a long shelf life and have high resistance to heat. Some of these systems need a suitable catalyst and sufficient air humidity to cure properly.

Low-VOC Alternatives

The presence of solvent requires additional process controls so that adverse effects on humans and the environment may be avoided. More and more regulations are placing restrictions on exposure to VOCs and hazardous air-polluting substances (HAPS). WACKER has therefore developed low-solvent, water-borne silicone and powder coating resins that replace conventional binders with the same proven level of quality.

Product Information and Technical Support

WACKER assists you in using SILRES[®] resins and intermediates by providing:

- Technical and material safety data sheets for products
- Formulation examples
- Product samples
- Customer service in the form of sales, marketing and technical support

Just ask and find out for yourself.



PRODUCT OVERVIEW – LIQUID RESINS AND EMULSIONS

Liquid Resins							
SILRES® type	SILRES® REN 50	SILRES® REN 60	SILRES® REN 70-M	SILRES® REN 80	SILRES® KX	SILRES® HK 46	SILRES® MSE 100
Characteristics							
Physical form	Solvent solution	Solvent solution	Solvent solution	Solvent solution	Solvent solution	Solvent solution	Liquid polysiloxane
Main functionality	Butoxy	Butoxy	Silanol	Butoxy	Ethoxy/silanol	Ethoxy/silanol	Methoxy
Silicon dioxide content, based on resin [wt. %]	54	54	52	54	88	87	70
Degree of crosslinking [%] ¹	66	66	74	66	71	71	75
Substituent type	Phenyl, methyl	Phenyl, methyl	Phenyl, methyl	Phenyl, methyl	Methyl	Methyl	Methyl
Phenyl/methyl ratio	0.82	0.82	1.1	0.82	0	0	0
Hardness	Medium hard	Medium hard	Hard	Medium hard	Hard	Hard	Very hard
Molecular weight [M _w]	> 100,000	20,000 – 60,000	2,000 – 5,000	20,000 – 60,000	8,000 – 15,000	80,000 – 120,000	2,000 – 5,000
Typical properties							
Solid content [wt. %]	50	60	70	82	50	50	100 (actives)
Solvent	Xylene/n-butanol (9:1)	Xylene	Methoxypropyl acetate (PMA)	Xylene	Xylene	Xylene/n-butanol (4:1)	–
Density [g/ml]	1.02	1.05	1.18	1.12	1.05	1.01	1.14
Viscosity [mm ² /s]	135 – 185	45 – 75	300 – 600	~2,000 mPa s	6 – 12	40 – 60	20 – 35
Flash point (DIN 51755) [°C]	25	25	53 (ISO 13736)	25	24	26 (DIN 53213)	69 (ISO 3679)

¹ SiO₂/Silica 100% - Silicone fluids (R₂SiO)_x 50% crosslinking

Note: these figures are intended as a guide and should not be used in preparing specifications.



Emulsions

SILRES® type	SILRES® MP 50 E	SILRES® MPF 52 E
Characteristics		
Physical form	Emulsion	Emulsion
Functionality		Methoxy
Substituent type	Phenyl, methyl	Phenyl, methyl
Phenyl/methyl ratio	~ 1	~ 1
Molecular weight [M _w]	20,000–60,000	
Typical properties		
Solid content [wt. %]	50	~ 55
Solvent	Xylene/water	Water
Density [g/ml]	1.08	1.07
Viscosity [mm ² /s]	100–200	60–300
Flash point (ISO 3679) [°C]	45	60

Organofunctional Polysiloxanes

SILRES® type	SILRES® HP 2000
Characteristics	
Physical form	Solvent solution
Functionality	Methoxy/(2-aminoethyl) aminopropyl
Substituent type	Phenyl, methyl
Amine value [mmol/g]	2.6–2.9
Amine hydrogen equivalent weight AHEW [g/mol]	230–256
Epoxy equivalent weight [g/mol]	n.a.
Typical properties	
Solid content [wt. %]	89–91
Solvent	Xylene
Density [g/ml]	1.12
Viscosity [mm ² /s]	100–400
Flash point [°C]	38 (DIN 53213)

Note: these figures are intended as a guide and should not be used in preparing specifications.

PRODUCT OVERVIEW – INTERMEDIATES

Intermediates				
SILRES® type	SILRES® SY 300	SILRES® IC 836	SILRES® REN 168	SILRES® SY 409
Characteristics				
Physical form	Solid, flakes	Solid, flakes	Solid, flakes	Liquid polysiloxane
Functionality	Hydroxy	Hydroxy	Hydroxy	Hydroxy
Functional group content [wt. %]	3.0–5.5	3–4.5	3.5–7.0	1.5–4.5
Substituent type	Phenyl, propyl	Phenyl	Phenyl, methyl	Phenyl, methyl
Phenyl/methyl ratio	n.a.	n.a.	1	1
Molecular weight [M _w]	1,500–1,800	1,500–2,000	1,800–2,200	4,000
Typical properties				
Solid content [wt. %]	> 98	> 98	> 98	~75
Viscosity [mm ² /s]	n.a.	n.a.	n.a.	40–150
Flash point (DIN 51755)	n.a.	n.a.	n.a.	26 °C
Refractive index [25 °C]		1.560–1.570	1.520–1.540	1.505–1.515
Volatiles [5 g/1h/150 °C; wt. %]	< 2	< 2	< 2	n.a.
Melting point/melting range [°C]	45–60	65–85	55–80	n.a.

Intermediates				
SILRES® type	SILRES® IC 232	SILRES® SY 231	SILRES® IC 368	SILRES® IC 678
Characteristics				
Physical form	Liquid polysiloxane	Liquid polysiloxane	Liquid polysiloxane	Liquid polysiloxane
Functionality	Methoxy	Methoxy	Methoxy	Methoxy
Functional group content [wt. %]	~ 15	~ 13	~ 15	~ 15
Substituent type	Phenyl, methyl	Phenyl, methyl	Phenyl, methyl	Phenyl
Phenyl/methyl ratio	1	1	1	n.a.
Molecular weight [M _w]	~ 1,200	~ 1,800	~ 1,900	~ 900
Typical properties				
Solid content [wt. %]	84	89	84	84
Density [g/ml]	1.14	1.14	1.15	1.18
Viscosity [mm ² /s]	70	130	320	450
Flash point (DIN 51755)	~ 75 °C	~ 75 °C	~ 75 °C	~ 75 °C
Refractive index [25 °C]	1.500–1.505	1.500–1.505	1.500–1.505	1.500–1.505
Volatiles [5 g/1h/150 °C; wt. %]	< 2	< 2	< 2	< 2

Note: these figures are intended as a guide and should not be used in preparing specifications.

PRODUCT OVERVIEW – RESINS FOR POWDER COATINGS

Resins for Powder Coatings		
SILRES® type	SILRES® 603	SILRES® 604
Characteristics		
Physical form	Solid, flakes	Solid, flakes
Functionality	Hydroxy	Hydroxy
Functional group content [wt. %]	4.5–6.5	3.5–7.0
Substituent type	Phenyl	Phenyl, methyl
Phenyl/methyl ratio	n.a.	1
Molecular weight [M _w]	~ 1,200–2,600	~ 2,400–3,100
Typical properties		
Solid content [wt. %]	> 99	> 99
Solvent	–	–
Melting point/melting range [°C]	65–85	55–80

Note: these figures are intended as a guide and should not be used in preparing specifications.



EXPERTISE AND SERVICE NETWORK ON FIVE CONTINENTS



● Sales offices, production sites and technical competence centers around the world

WACKER is one of the world's leading and most research-intensive chemical companies, with total sales of €4.93bn. Products range from silicones, binders and polymer additives for diverse industrial sectors to bioengineered pharmaceutical actives and hyperpure silicon for semiconductor and solar applications. As a technology leader focusing on sustainability, WACKER promotes products and ideas that offer a high value-added potential to ensure that current and

future generations enjoy a better quality of life, based on energy efficiency and protection of the climate and environment. Spanning the globe with 4 business divisions, we offer our customers highly-specialized products and comprehensive service via 24 production sites, 23 technical competence centers, 14 WACKER ACADEMY training centers and 51 sales offices in Europe, North and South America, and Asia – including a presence in China.



With a workforce of some 14,700, we see ourselves as a reliable innovation partner that develops trailblazing solutions for, and in collaboration with, our customers. We also help them boost their own success. Our technical competence centers employ local specialists, who assist customers worldwide in the development of products tailored to regional demands, supporting them during every stage of their complex production processes, if required.

WACKER e-solutions are online services provided via our customer portal and as integrated process solutions. Our customers and business partners thus benefit from comprehensive information and reliable service to enable projects and orders to be handled fast, reliably and highly efficiently. Visit us anywhere, anytime around the world at: www.wacker.com

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