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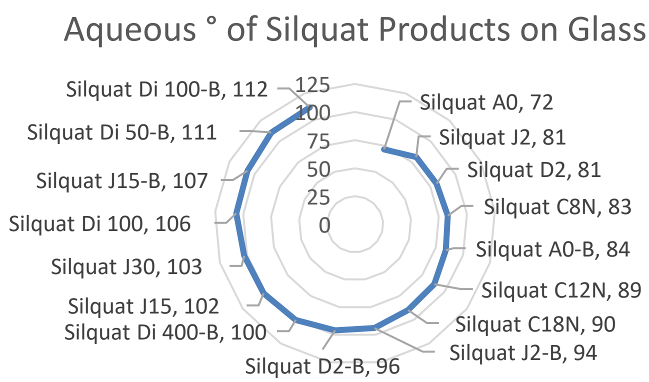
TECHNICAL BULLETIN

Siltech® Water Repellents

DESCRIPTION

Siltech® Silicones are inherently hydrophobic and therefore make excellent water repellents. In this technical bulletin we outline, compare and contrast several different approaches to provide water repellency to surfaces. For more information on any of these, please contact your sales manager or message us directly at sales@siltech.com

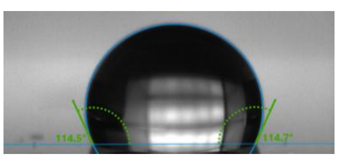
SILQUAT® APPROACH: Silquat cationic polymers are well know to rapidly and efficiently "exhaust" out of a solution onto surfaces. The term exhaustion comes from textile treatments where fabrics are rapidly run through a bath of **Silquat** solution. The charged polymers attach electrostatically onto the fabric thereby "exhausting" the polymer from the solution.



This approach can also be used on hard surfaces. For example, aftermarket car polish and car washes are a large application for this chemistry. Contact angles up to 112° can be obtained with existing products in this way.

The advantages of this approach are simplicity of application and durability. On the other hand, one can lose the silicone feel because the long alkyl groups orient outward and provide a hydrocarbon feel.

SILMER® TMS APPROACH: Silmer TMS polymers have trialkoxy silanes appended to the silicone backbone. These react with surfaces forming Si-O-surface bonds which are driven to form as the alcohol evaporates. This anchoring reaction orients the silicone polymer in a very favored way for repellency. Using this approach, water on glass contact angles maximize at 115° with **Silmer TMS Di-400**. Smaller molecular weights and non-linear versions give a few degrees less.



Advantages of this approach are myriad with other desirable properties such as flexibility, impact resistance, feel, and stain resistance often being improved. We have sometimes seen moderate oil repellency from **Silmer TMS Di**-xxx structures as well. Some disadvantages are the release of a trace amount of methanol and some cure systems need a catalyst to achieve the properties in reasonable time.

CROSS LINKING APPROACH: Traditional organomodified silicones are largely made of dimethyl silicone units (D groups) terminated with trimethyl silicone units (M groups). By including silicon atoms with three and four oxygen bonds (T and Q groups) we can increase cross linking which increases water repellency and durability.

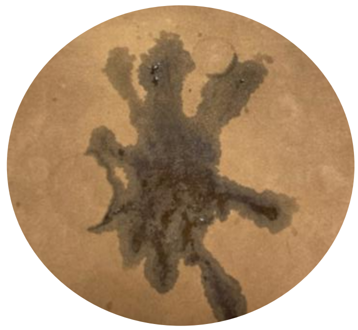
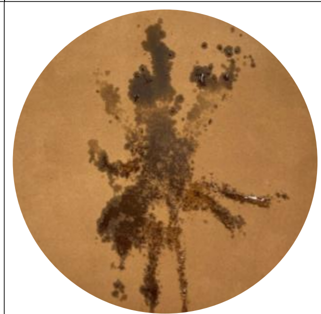
There are several ways to do this. **Siltech Film Formers** such as **Siltech E-2199** are the simplest to use. These aqueous emulsions of reactive silicone oils combined with small amounts of various T containing cross linkers so that they cure when dried to provide a protective film.

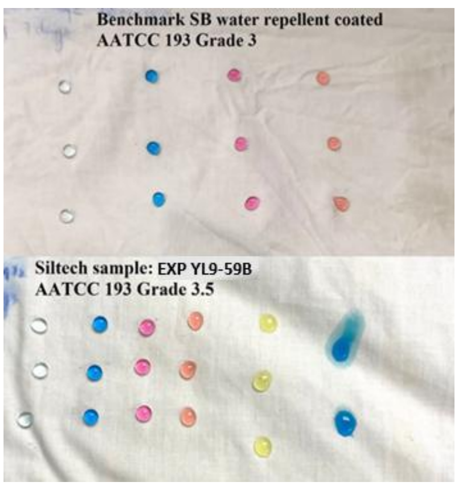
When first applied, the residual emulsifiers keep the contact angle down near 85° but these films get more hydrophobic as the emulsifiers rinse out. As we will see below, analogous emulsifier free systems provide water on glass contact angles up top 115°.

The advantages of Siltech Film Formers are low cost, ease of application, as well as secondary properties such as feel and stain resistance. These systems are commonly used in concrete and roof coatings and other outdoor uses. Disadvantages are the low initial contact angles and some systems need a catalyst to achieve the properties in reasonable time.

Another way to provide cross-linking is with **Silmer MDTQ** resins such as **Silmer QT9-30-CG** and **Silmer T-35**. Often called Q resins or MQ resins in the industry, these contain silicon atoms with four oxygen atoms and provide strong cross linking and the concomitant properties. These are typically delivered in solvent but we have also developed a sol-gel system to deliver these.

Silmer QT9-30-CG was prepared with several standard silicones and evaluated for leather treatment. A commercial PFAS containing DIY product was used as a benchmark. They were applied from IPA and allowed to dry. The PFAS-free silicon system, designated here as YL7-53B, performed comparable in contact angle and stain prevention. Water on glass contact angles were 108° however the water on leather angles were 143°. Shown here is improved performance on suede.

Benchmark water repellent Rating: 70 (ISO 3)	Siltech YL7-53B Rating: 80 (ISO 3)
	



As an alternative to using solvent, various sol-gel systems were prepared with mixtures of **Silmer QT9-30-CG** and several standard silicones and amino silicones. Cotton fabrics were treated and cured in an oven. Water repellency was assessed with AATCC 193 which utilizes dyed solutions of water/ IPA. Results were similar across the sol-gel formulations with contact angles ranging from 110° to 115°.

The sol-gel Q resin formulation labeled here **EXP YL9-59B** bested a commercial benchmark in this difficult test. Left to right the colorless drop is 100% water; the blue is 98% water/2% IPA; pink is 95/5; orange is 90/10; yellow is 80/20; and the dark blue is 70/30. Our formulation still shows repellency at 20% IPA unlike the benchmark.

The advantages of this approach are excellent water repellence and, again, we have sometimes seen oil repellency. The disadvantages are the solvent or the high amount of ethanol in the sol-gel formulations. Also, formulating them can be a complex problem early in the process.

SAFETY

Before handling, read the Material Safety Data Sheet and container label of the individual products for safe use, physical and health hazard information.

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