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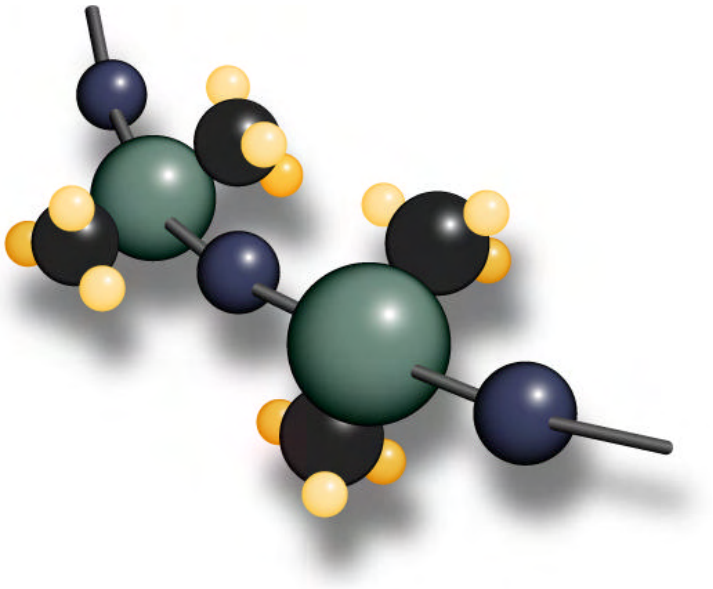

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NuSil SILICONE TECHNOLOGY

Creative Partners in a Material World

Silicone Ice-phobic Coatings

Ice build up has major economic impact on the aircraft industry, resulting in multiple efforts to understand and resolve the problem. When compared to other commercially marketed ice-phobic coatings and non-stick materials such as Teflon®, NuSil's silicone coatings show significantly improved reduction in ice adhesion when applied on aluminum surfaces. In addition, new silicone materials have been developed that cure at room temperature and add fuel resistance.

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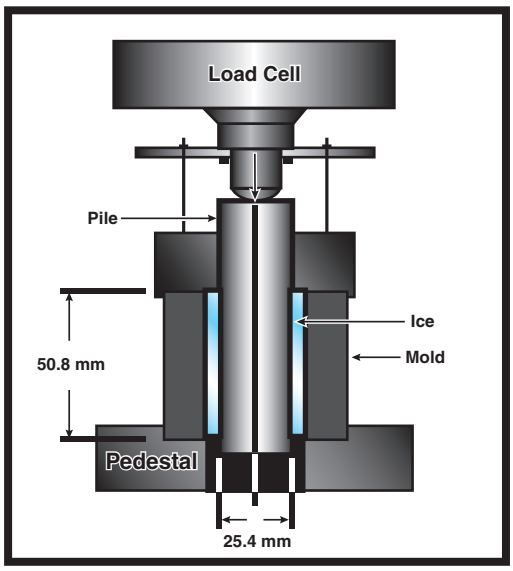
NuSil Technology is the cutting edge manufacturer of silicone products for the aircraft industry requiring precise and predictable materials. NuSil's silicone materials deliver adhesives, potting compounds, encapsulants, and fast-curing silicones.

ISO 9001 certified since 1994, and AS 9100 certified since 2008, NuSil operates state-of-the-art laboratories and processing facilities in North America and provides on-site, in-person application engineering support worldwide.

www.nusil.com

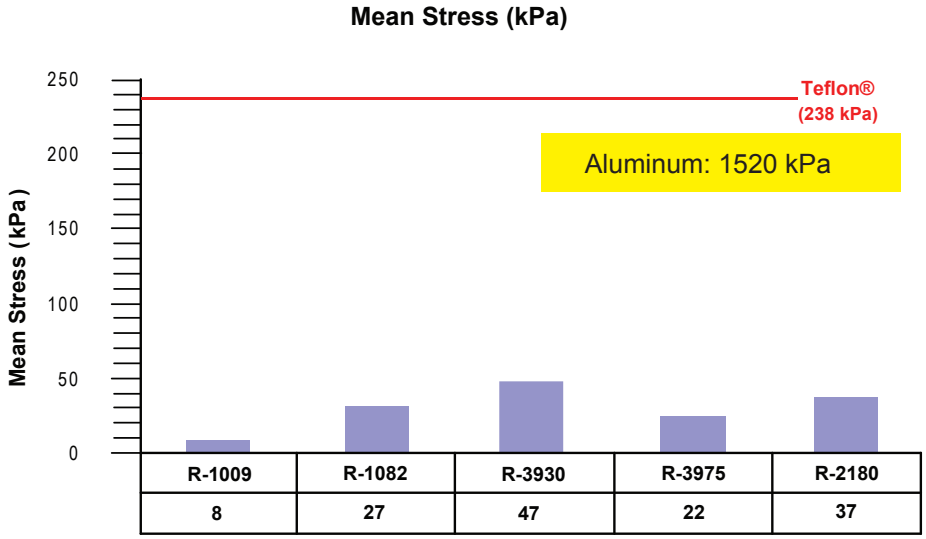
Ice Adhesion Testing

Department of the Army, Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory (CRREL) tested ice adhesion to several new NuSil ice-phobic coatings using the Zero-Degree Cone test. Ice is grown in a gap between two concentric, cylindrical surfaces. The force required to push the inner cylinder out of the ice collar is measured to determine the adhesive strength of the ice to the coating. Samples are frozen at -10 ºC for 48 hours and the nominal shear stress for ice release is calculated from the measured maximum load divided by the surface area of the coated pin/ice interface.



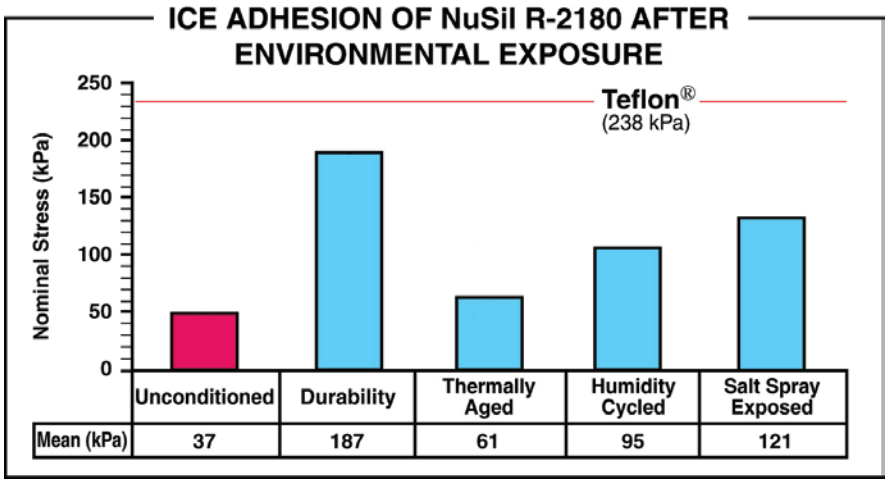
Ice Adhesion Test Results

All of NuSil's materials demonstrate much lower stress compared to the standard Teflon® (238 kPa). Bare Aluminum stress is also referenced at 1520kPa. Coating thickness of the material tested is 0.010 inches.



Environmental Exposure

Evaluation of a coating after exposure to extreme environmental conditions and wear is important to measure when considering material for your application. NuSil's R-2180 shows favorable performance after exposure to wear, heat, humidity, and salt water spray compared to the industry standard Teflon®.



Material Properties

The below table shows the typical material properties in the uncured and cured state of the NuSil products referenced in this study.

Typical Properties	R-1009 RTV Silicone Coating	R-1082 RTV Silicone Coating	R-3930 RTV Fuel Resistant Coating	R-3975 RTV Fuel Resistant Coating	R-2180 Heat Curing Silicone Coating
Uncured:					
Viscosity	6,500 cPs 6,500 mPas	700 cPs 700 mPas	735 cPs 735 mPas	1,625 cPs 1,625 mPas	3,075 cPs 3,075 mPas
Non-Volatile Content	33%	29%	60%	60%	20%
Work Time	>72 hours	N/A	N/A	N/A	>72 hours
Solvent	VM&P Naptha (R-1001)	Xylene (R1-1001)	Tert Butyl Acetate (R2-1001)	Tert Butyl Acetate (R2-1001)	Xylene (R1-1001)
Cured:					
Cure Schedule (days @ ambient)	7	5	3	3	*See Below
Specific Gravity	1.10	1.09	1.36	1.29	N/A
Durometer, Type A	40	25	30	25	40
Tensile Strength	1200 psi 8.3 MPa	1,425 psi 9.8 MPa	750 psi 5.2 MPa	425 psi 2.9 MPa	1,700 psi 11.7 MPa
Tear Strength	95 ppi 16.8 N/mm	125 ppi 22.0 kN/m	40 ppi 7.1 kN/m	Min. 35 ppi 6.2 kN/m	300 ppi 52.9 kN/m
% Elongation	650%	950%	400%	400%	1,050%
Contact Angle	113°	115°	107°	111°	116°
Recommended NuSil Primer**	SP-120 SP-121	SP-120 SP-121	SP-120 SP-121	SP-120 SP-121	SP-270

*30 min @ 25°C (77°F), 45 min @ 75°C (167°F), and 135 min @ 150°C (302°F)
**Some bonding applications may require use of a primer. NuSil Technology recommends the primers listed in the above table.
RTV = Room Temperature Vulcanizing

References

• EM 1110-2-1612, Engineering and Design – Ice Engineering, U.S. Army Corps of Engineers, Department of the Army, October 20, 2002, UPDATE VERSION September 2006.
• Mulherin, ND, RB Haehnel, JF Jones (1998) Toward developing a standard shear test from ice adhesion. Proceedings, 8th International Workshop on Atmospheric Icing Structures, Reykjavik, Iceland, June 8-11, 1998. IWAIS '98.
• Laboratory Ice Adhesion test Results for Commercial Icephobic Coatings for NuSil, June 2009, CRREL.

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