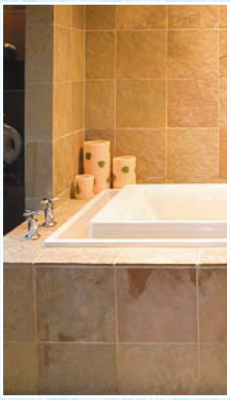
VITROGLAZE
THE CLEAR SOLUTION

A breakthrough in glass protection

Technical Manual

March 2017



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Coating Adhesion Principles

ABSTRACT

Organic-inorganic (hybrid) reagents can be formed from various combinations of metal and silicon alkoxides to create a nanoscale admixture of inorganic-oxides that can covalently bond to silica, metal, ceramic and stone substrates.

The process of bonding (adhesion) at the nanoscale level is made possible by the sol-gel method.

Adhesion generally occurs when the substrate and the coating are held together by interfacial molecular contact in such a way that a unit is formed. Adhesion is a complex phenomenon related to physical effects and chemical reactions at the interface. Adhesive forces are set up as the coating is applied to the substrate and during curing or drying. The magnitude of these forces will depend on the nature of the surface and the binder used in the coating.

VITROglaze bonds onto silane (glass) surfaces both mechanically and chemically. In doing so it modifies the physical and chemical properties of the surface.

THE MECHANICAL THEORY

This mechanism of coating action occurs when the silane surface upon which VITROglaze is spread contains pores, holes, crevices, and voids into which VITROglaze solidifies. In this manner it acts as a mechanical anchor. Adhesion of VITROglaze to old and weathered glass as well as to sand blasted glass is increased (as against new float glass) by this mechanical mechanism. Surface roughness affects the interfacial area between the VITROglaze and the glass substrate. Because the forces required to remove coatings is related to the geometric surface area, whereas the forces holding the coating on to the substrate are in part, related to the actual interfacial contact area, increasing the surface area will increase the difficulty of removing the VITROglaze coating.

The VITROglaze Pre Cleaner, which is an integral part of the application on float glass, will remove surface contamination by microscopically etching the glass surface, leaving no residue upon evaporation. This also goes to preparing the surface for better mechanical adhesion as a result of the increased topographical surface area afforded by the etching process. Generally with other NON nanoscale coatings, as the viscosity and coating stiffness increase and as the coating adhesion to the glass develops, substantial stress is accumulated and retained in the dry film. Under the fixed application parameters of wet and dry film thickness, the film thickness on top of the hills will be less than in the valleys, thus creating variable physical prope The VITROglaze coating is not subjected to these types of forces due to the fact that it is about 600nm thick.rties. The resultant non-uniform film with high levels of internal stress will enter the service environment where it will be further subjected to solvent attack from repair coatings or weathering, often pushing such coatings beyond their capacity for stress. Cracking or delaminating or other evidence of lost coating integrity will be the result.

Windows

Conservatories

Balustrades

Skylights

Bathrooms:
Shower doors
Tiles/grout

Kitchens:
Splash-backs
Granite and marble benchtops

Marine glass

THE CHEMICAL BOND THEORY

The formation of covalent chemical bonds across the interface takes place between VITROglaze and the silane surface. This type of bonding is the strongest and most durable. As is the case, it is requisite that there be mutually reactive and identical chemical functional groups between the coating and the substrate. Therefore contaminated or impure (dirty) surfaces will produce chemical bonds of inferior strength with the coating.Chemically, VITROglaze is generically defined as an organoflurosilane. Industrially organosilane analogues are widely used as primers on glass fibres to promote the adhesion between the resin and the glass in fibreglass-reinforced plastics. Essentially during application, silanol groups are produced which then react with the silanol groups on the glass surface and form extremely strong ether linkages.

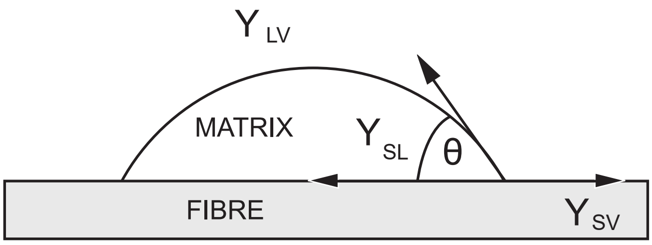
MECHANICS OF ADHESION DEVELOPMENT

When two dissimilar materials are brought into intimate contact, a new interface is formed at the expense of the two free surfaces in air. The nature of the interaction at the interface determines the strength of the bond, which forms between the coating and the substrate. The extent of these interactions is greatly determined by the wet ability of one phase by the other. In the case of coatings that are applied in liquid state, mobility of the coating phase is also of great help. Wetting, therefore, may be viewed as intimate contact between a coating and a substrate. In addition to initial wetting, in order for adhesion to remain between the substrate and the coating, it is important that intimate wetting and bonds remain intact after the coating has solidified. VITROglaze solidifies as a result of the evaporation of the ethyl alcohol solvent and a chemical cross-linking of the solute.

WETT-ABILITY AND SURFACE ENERGETICS

Wetting is a necessary criterion for adhesion. Mechanisms of adhesion are only operational if and only if, effective wetting is present between the coating and the substrate. For this reason VITROglaze applied onto a glass surface must be adequately spread or smeared consistently before the solvent evaporates off. The wetting of that glass surface can be described in thermodynamic terms. The surface tension of the VITROglaze in its liquid state and the surface energetic of both the glass substrate and the solid coating are important parameters that can influence the strength of the interfacial bond and adhesion development. The degree to which VITROglaze wets a glass surface is measured by the contact angle (Ø).

CONTACT ANGLE: The contact angle model is derived from the concept of surface energy. The following is an illustration of what is meant by the term.



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When a liquid droplet (matrix) interacts with a solid surface (fibre), the droplet attains an equilibrium shape. The droplet can be characterized by the angle formed at its edge where the liquid contacts the solid surface. This angle (Ø) is called the contact angle. For example, when water falls on a freshly waxed car, the drops bead up. This occurs because the water molecules are attracted to each other more strongly than they are to the wax's hydrocarbon surface. In this situation, contact angles are observed to be 150° to 160°.As the wax's hydrocarbon surface is exposed to UV light and oxygen, it is oxidized. After a few weeks, water doesn't bead up as much because it has a greater affinity to the surface. The degree to which the water is attracted to the wax is increasing as the wax is oxidized (increasing the molecular polarity) and so the contact angle is decreasing.

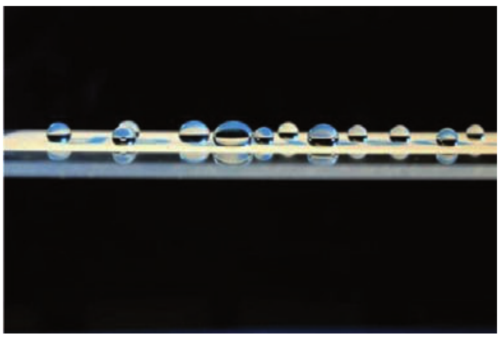
When Ø = 0, this signifies that the liquid is spread freely over the surface and is said to completely wet it. Complete wetting occurs when the molecular attraction between the VITROglaze and the glass molecules is greater than that between the VITROglaze molecules and themselves. The average contact angle measured for water on float glass that has been treated with VITROglaze is 124°.

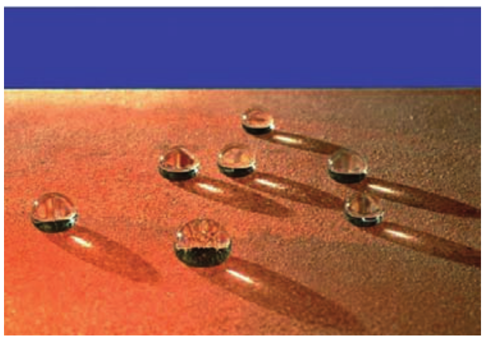
SUMMARY

Mechanical and chemical models can describe the bonding of the VITROglaze molecule to a glass surface. Mechanically, VITROglaze will physically anchor and 'solidify ' into pores of the glass surface via the sol-gel method. A larger surface area will enhance the mechanical adhesion, of which the action of VITROglaze Pre Cleaner will afford. Being a Nano coating it will not delaminate and can only be removed by removing the surface to which it is attached.

Chemically, hydrolysis of the VITROglaze molecules functional group will form a silane intermediate that then chemically reacts with the activated silane surface of the glass, forming an extremely strong covalent bond. This reaction is thermodynamically (entropy and enthalpy) favourable and hence permanent.

Upon curing, VITROglaze molecules cross-link with one another producing a stabilised matrix that modifies the glass surface yielding hydrophobic properties. Contact angle measurements quantify the efficacy of VITROglaze acting as a hydrophobic coating and have been observed at 124° on float glass.





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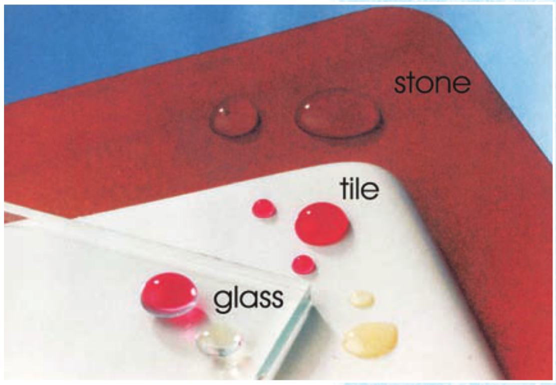
Physical Properties



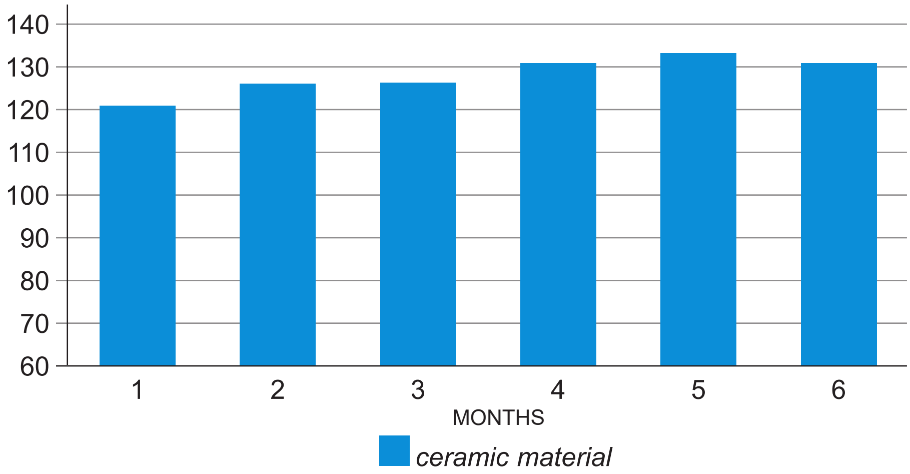
UV-A stability:
No maccroscopical change of appearance upon accelerated 2000h exposition (irradiation at 300 – 425 nm)

Thermal stability:
Excellent performance up to 300°C over extended periods.

Chemical resistance:
No degradation upon interaction with strong acids and alkaline environment.

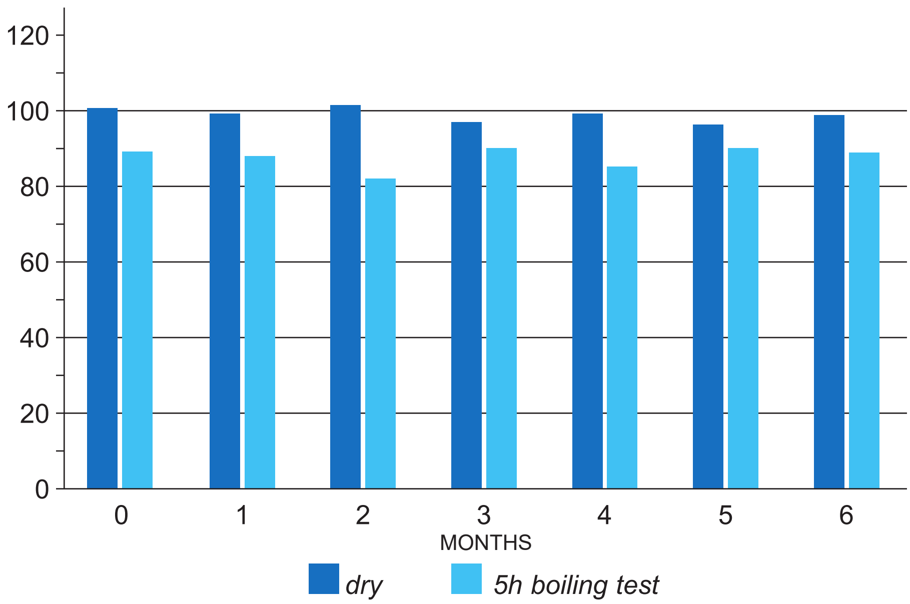
Optical appearance:
Invisible, homogenous, nano-scale film thickness.

Contact angle on ceramic (glass) surface after environmental exposure



Stability testing of Vitroglaze coating on enamel

Contact angle on treatment and after boiling water test



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