ThreeBond
TECHNICAL NEWS

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Trends in Automobile Body Stain-Proof Coatings

Introduction

Conventionally, we had been mainly been involved in development and release of automotive aftermarket maintenance products, such as an anti-rust chassis coating as mandated at vehicle inspection in Japan cleaner for brake maintenance, anti-rust lubricants for repair, inspection and maintenance as well as other maintenance products. However, chassis coating is no longer mandatory maintenance, and the automotive aftermarket has undergone fundamental changes over the last decade. Currently, the driving force behind the industry is products such as body coatings and water repellents for window glasses. At ThreeBond, we have been working hard at developing a variety interior, exterior and engine area products designed for cosmetic appeal and comfort by harnessing our long history of resins, coatings and related technologies. Here, we will introduce the types, features and performance of our body coatings, from their release in 2005 until their rise as trending products in the automotive aftermarket.

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1. Effects of Body Coating

Body coatings bring a variety of effects, such as gloss retention and improvement, water repellency for coated surfaces, dirt repellency and improved efficacy of vehicle cleaning maintenance. Regular cleaning and maintenance can ensure long-term protection of the vehicle body.

2. Types of Body Coatings

2-1 Bases

Currently, a wide variety of body coatings are available, from the easy-to-apply general purpose monthly products available at car parts dealers, to professional goods designed for long-term durability that are pushed at dealerships. The bases of these coatings vary as well, including wax, resin (polymer) and glass.

Wax Type

Though not currently enjoying widespread popularity, a typical wax is solid, mainly composed of natural carnauba, and boasts deep luster and gloss. However, waxes are difficult to apply and finish as they are applied with a sponge, and all solids must be wiped away after drying.

Liquid waxes contain components such as carnauba resin, silicone oils or paraffin wax emulsions that are applied to still-wet cars after cleaning, and some can simply be coated on at the same time as a vehicle is wiped down. Liquid wax is easy to install, glossy and water repellent, making it excellent for general users so it is made available through a variety of products at major retailers. However, it has low durability therefore effect last only one months or two months.

Resin Type

New vehicle opptional services at dealers begin with resins. These resins called paint sealant and are composed of paint sealants composed of fluorocarbon resin and silicone oil, using petroleum solvents as a medium. There are called polymer type also. Resins handled at dealers contain PTFE (polytetrafluoroethylene), which is firmly sponge buffed onto coated surfaces with an electric polisher. PTFE and resins are also used to fill scratches by forming a layer of oil that provides gloss and water-repellency. This also includes general market sponge coating applications of acrylic and silicone resins.

Glass Type

Glass type is roughly divided into reactive and nonreactive types. Reactive types contain moisture-curing oligomers which are hydrolyzed by humidity in air to bind to coated surfaces and form a solid glass-based film (Fig. 1). Dealers promoted manly reactive body coating. Non-reactive types include simple water-soluble water-repellent coatings containing silicone resin emulsions. These are called glass-fiber types, and have very little durability because they are simply painted on coated surfaces. Water soluble coatings indicated as glass-based at major dealers are almost all classified as these types. However, there are considerable differences between reactive and inert (glass fiber) glass types, but the reactive type demonstrates better durability in its reaction with the vehicle body.

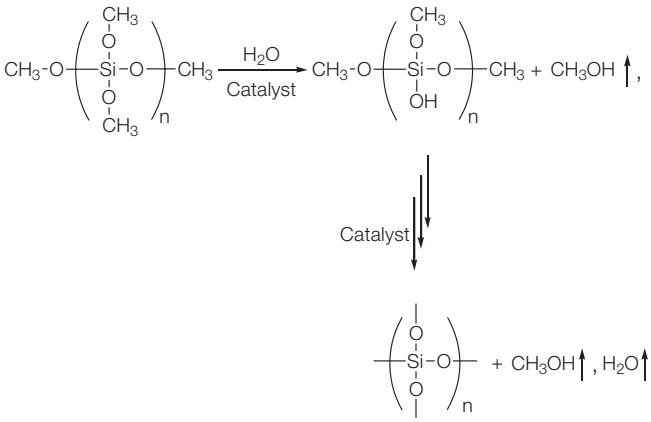


Fig. 1 Silane Oligomer Reaction

2-2 Water Affinity

Hydrophilic Types

Hydrophilic types do not repel water, but self-clean by forming a water film across the entire body to wash away adhering dirt. However there are some issues. In case of little rain, there is not enough water to form the water film, reducing this self-cleaning effect and dirt is difficult to remove once it adheres. These coatings do not give much of a visual impression, so it became popular in the past but then had been become to be avoided by general users.

Low Water-Repellent Types

The so called Ultra Glass Coating was the first active-type coating introduced at ThreeBond. Using polysilazane as the main ingredient makes it a low water-repellent type that reduces the likelihood of water spots and dirt adherence to form an incredibly strong glass-based film. The water contact angle of low water-repellent types is usually 70 to 80 degrees and these coatings are difficult to visually confirm, so there has been a gradual shift toward water-repellent types.

Water-Repellent Types

Water droplets form into little balls and are repelled in water-repellent types. They have gained popularity due to a water contact angle of over 90 degrees and visual presence that is easy to confirm once applied. However, in some of the conventional wax and resin water-repellent types as well as glass types sold at dealerships, some water droplets remain on the body. The magnifying effect when they dry then creates difficult-to-remove water spots.

Water-Repellent and Hydrophobic Types

To solve the issues mentioned above, we developed a water repellent and water slipable body coating. Improving the coating film strength and adding water slip effect enabled a water contact angle of above 90 degrees and an even lower angle of falling water. Water droplets roll right off, making water spot formation unlikely. Furthermore, if a water spot is caught early, it can be easily rinsed away, reducing the issues in repellent types. Our reactive polysilazane-based Ultra Glass Coating NEO was released in 2009, and has since been adopted by many automobile dealers.

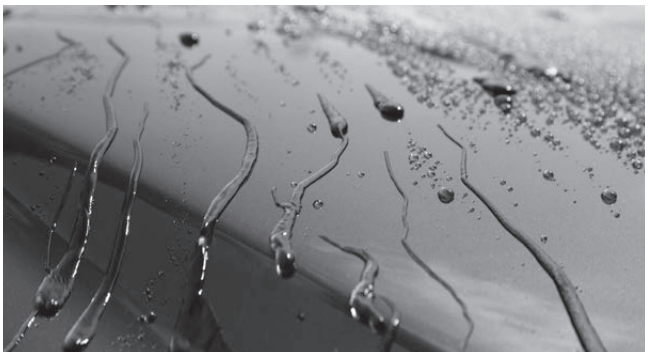


Fig. 2 Water-Repellent and Hydrophobic Coating

Super Water-Repellent Types

Our super water-repellent type is the ultimate coating—water droplets slide right off, and it boasts a contact angle of at least 150 degrees. However, the fine, uneven structure formed on the surface is gradually broken down due to chafing which weakens its water repellency. As a result this transparent and durable super water-repellent type has not yet been put into practical use as a body coating. Currently, it is used to coat sideview mirrors as they are affected less by external factors. Even there, however, chafing and touching causes irregularities in the coating to be broken down, impairing the functionality of super water-repellent coating.

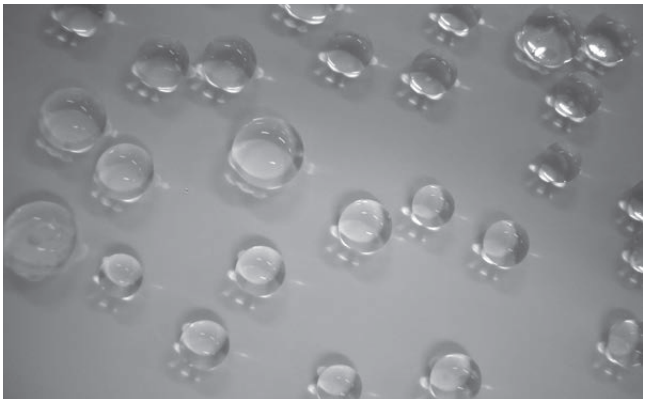


Fig. 3 Super Water-Repellent Coating

3. Polysilazane

Polysilazane coatings oxidize to form a strong glass film (silica: SiO_2). This polymerized compound contains alternating silicon (Si) and nitrogen (N) which is hydrolyzed by in the air then bond with hydroxyl groups on coated surfaces through covalent bonds. These coatings cure quicker and have better adhesion than standard glass types.

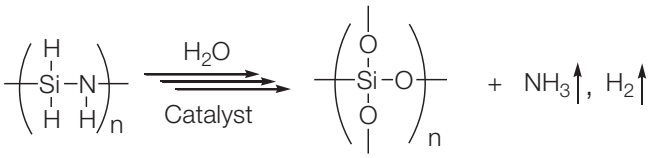


Fig. 4 Polysilazane (Inorganic Polysilazane) Reaction

Low Water-Repellent Type: Ultra Glass Coating

Due to water spots occurring in conventionally popular water-repellent types, acid rain water droplets with nitrogen and sulfur oxides (NOX, SOX) from the atmosphere remain on the surface of the body. When the water evaporates due to exposure to the sun, strongly acidic droplets are created which corrode into the coating over time.

We improved this issue in 2005, releasing our low water-repellent Ultra Glass Coating, which forms a coating film with a water contact angle of 75 to 80 degrees to reduce the aforementioned magnifying effect caused by water droplets. While we were able to reduce water spot formation compared to conventional types, the coating was still difficult to visually confirm and dirt repellency decreased during light rainfall.

Water-Repellent and Hydrophobic Type: Ultra Glass Coating NEO

To deal with these issues, we began developing a body coating with a hard, hydrophobic film that repels water to reduce the development of water spots. In 2009, ThreeBond released our Ultra Glass Coating NEO products (ThreeBond 6649 Coating / ThreeBond 6649B Finishing Agent) which uses polysilazane as its main ingredient to create a durable and strong glass film. Ultra Glass Coating NEO is a water-repellent body coating agent which water rolls right off - no off of, even when falling at small angles. We also improved dirt repellency, and we are pleased that this coating has become a mainstay in the automotive aftermarket.

Water-Repellent Hydrophobic Single-Liquid High Durability Type: Ultra Glass Coating NE'X)

At the end of 2015, we released Ultra Glass Coating NE'X, a single-liquid version of Ultra Glass Coating NEO with improved durability. Ultra Glass Coating NE'X is the latest pinnacle of evolution in our body coating series. The hard film of a polysilazane base combined with our proprietary technology to create a special water repellent that bonds to three-dimensional structures to form a next-generation hard glass-based film with long-term durability.

This pinnacle of body coatings has improved durability for long-term maintenance of water repellency and gloss. Furthermore, conversion to a single liquid shortens work time to improve operations.

4. Ultra Glass Coating NEO (ThreeBond 6649/ThreeBond 6649B)

ThreeBond 6649 is the main agent in the series, with polysilazane as the main ingredient for dirt repellency (Table 1). ThreeBond 6649B is a finishing agent for removing excess main agent and providing a uniform coating (Table 2). By using the main agent, ThreeBond 6649, and the finishing agent, ThreeBond 6649B form a hard, glass-based film of SiO_2 (Table 3).

Table 1 ThreeBond 6649 (Main Agent) Properties

Features	Unit	Measured Value	Testing Method	Remark(s)
Appearance	—	Colorless, transparent	3TS-2100-001	—
Specific Gravity	—	0.80	3TS-2500-002	20°C
Non-Volatile Content	%	5.5	3TS-2510-005	100°C × 5h

Table 2 ThreeBond 6649B (Finishing Agent) Properties

Features	Unit	Measured Value	Testing Method	Remark(s)
Appearance	—	White	3TS-2100-001	—
Specific gravity	—	0.95	3TS-2500-002	20°C
Non-Volatile Content	%	3.4	3TS-2510-005	100°C × 5h

Table 3 Ultra Glass Coating NEO Coating Layer Characteristics

Features	Unit	Measured Value	Testing Method	Remark(s)
Contact Angle (Water)	°	101	3TS-2A00-002	On a silicon wafer base
Pencil Scratch Hardness Test	—	9H equivalent	3TS-2B00-009	SUS plate application
Adhesion Test (Cross-Cut Test)	—	100/100	3TS-2140-001	SUS plate application

Table 4 Ultra Glass Coating NEO Accelerated Weather Resistance Test (Gloss)

ASTM G154 Accelerated Weather Resistance Test	Initial Value	200 hrs. = Approx. 1 yr.	400 hrs. = Approx. 2 yr.	600 hrs. = Approx. 3 yr.	800 hrs. = Approx. 4 yr.	1000 hrs. = Approx. 5 yr.
Gloss (°)	100	99	101	102	100	101

ASTM G154: As defined by ASTM International industrial standards.
A coated plate is repeatedly exposed to ultraviolet rays, then misted with water and dried to reproduce a natural environment.
Gloss is measured every hour.

Features

1. Hard glass-based coating maintains long-term gloss (Table 4, 5).
2. Hydrophobic so that droplets more easily roll off the body, making water spots less likely to form than with conventional water-repellent types.
3. This hydrophobic coating reduces the coefficient of friction so water slides off more readily, making it harder for dirt to adhere. As a result dirt can be removed through simple rinsing and water droplets are easier to wipe away after rinsing for excellent maintainability (Table 6).

Ultra Glass Coating NEO maintains protection, even after 1,000 hours of the accelerated weather resistance test. Furthermore there is less color difference after xenon arc lamp accelerated weather resistance testing compared to an un-coated piece for maintained protection (Table 5).

This hydrophobic trait also reduces the friction coefficient on the body surface for improved resistance to scratches (Table 6).

We compared the degree of dirt adhesion using a white bumper where it easily adheres (Fig. 5). Ultra Glass Coating NEO prevented dirt from adhering far better than both the non-treated surface and low water-repellent Ultra Glass Coating.

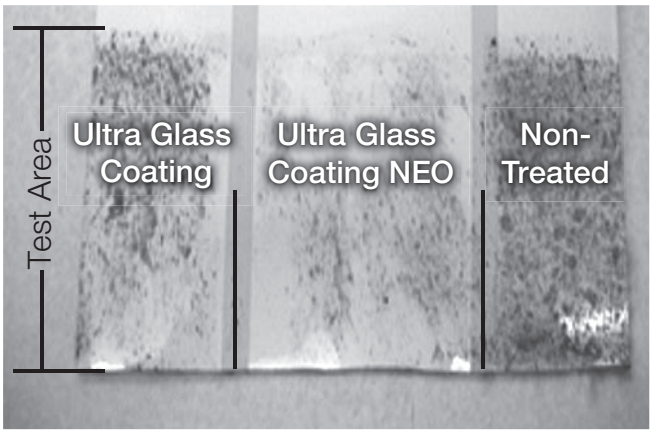
Table 5 Comparative Color Measurement (Xenon Arc Lamp, Accelerated Weather Resistance Test)

Result	Non-Treated	Ultra Glass Coating NEO
After 33 days	0.46	0.17
After 78 days	0.50	0.17

Testing method: Coated plate left in a Ci4000 (ATLAS) tester for 33 and 78 days, then measured for difference in color (light source: D65, field of view: 10°, gauge: 5 mm).

Table 6 Coefficient of Friction Test

Coefficient of Friction Test		Static Coefficient of Friction	Dynamic Coefficient of Friction
Non-Treated		0.32	0.30
Ultra Glass Coating NEO		0.18	0.14
	Reduction (%)	43.8	53.3



Testing Method: White bumper was repeatedly dipped into water containing a dirty substance, then staining degree was visually confirmed.

Fig. 5 Ultra Glass Coating NEO Dirt-Repellency

Fig. 6 Ultra Glass Coating NEO Products

5. Ultra Glass Coating NE'X (ThreeBond 6659)

ThreeBond 6659 is a single-liquid Ultra Glass Coating with polysilazane as the main ingredient for stain-proof property (Table 7, 8). Ultra Glass Coating NE'X is part of the same series as NEO, but boasts improved concentration of its glass base for even better durability. Additionally, water repellency bonds at high density for long-term maintenance of stain-proofing. While it is difficult to soil, it is also easy to remove adhered dirt for excellent maintainability. Finally, making it a single liquid shortens work time and improves productivity.

Features

1. The main ingredient, polysilazane, reacts with moisture in the air to form a hard glass-based film with an SiO_2-based framework.
2. Ultra Glass Coating NE'X hard glass-based film boasts excellent weather resistance.
3. Maintains long-term stain-proofing and gloss.
4. Single-liquid type for excellent workability.

The coating system of Ultra Glass Coating NE'X is part of the same series as NEO, but boasts improved concentration of its glass base for even better protection. After 2,000 hours of the ASTM G 154 accelerated weather test, NE'X maintained high gloss and excellent water repellency with a low contact angle (Fig. 4).

Table 7 ThreeBond 6659 Properties

Features	Unit	Measured Value	Testing Method	Remark(s)
Appearance	—	Colorless	3TS-2100-020	—
Specific Gravity	—	0.74	3TS-2500-002	20°C
Non-Volatile Content	%	6.2	3TS-2510-005	100°C × 5h

Table 8 Ultra Glass Coating NE'X Coating Layer Characteristics

Features	Unit	Measured Value	Testing Method	Remark(s)
Contact Angle	°	101	3TS-2A00-002	On a silicon wafer base
Pencil Scratch Hardness Test	—	9H	3TS-2B00-008	SUS plate application
Cross-Cut Peel Test	—	100/100	3TS-2140-001	SUS plate application

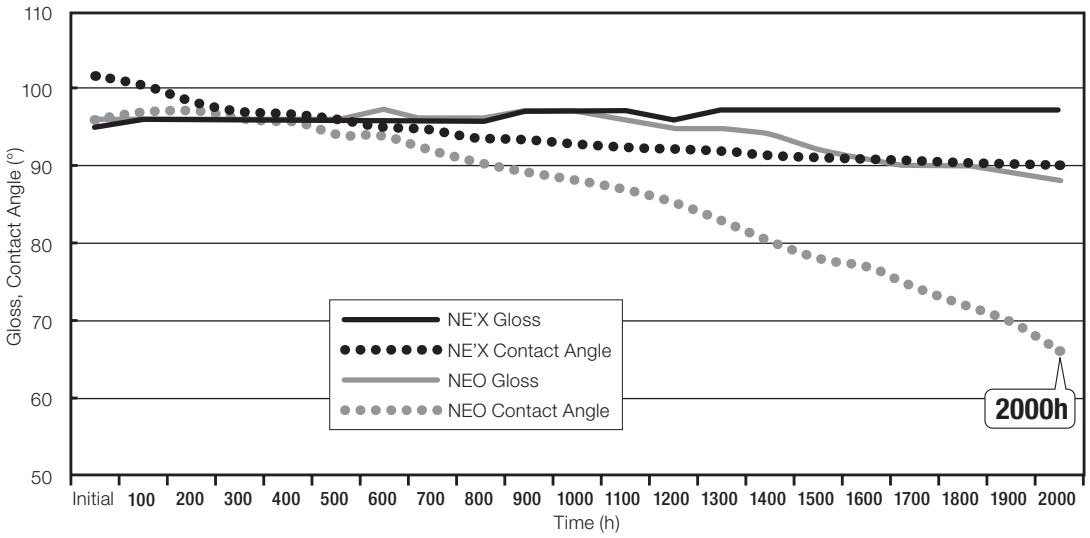
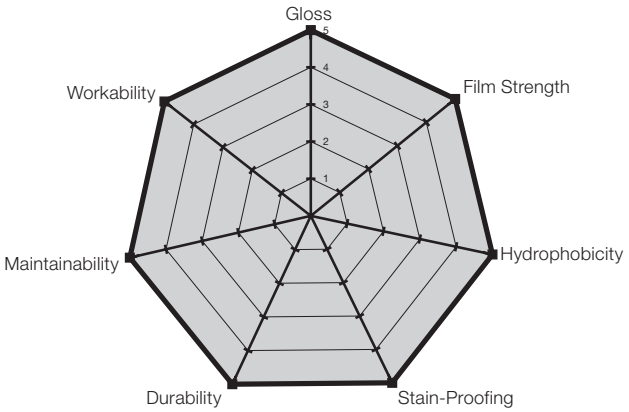


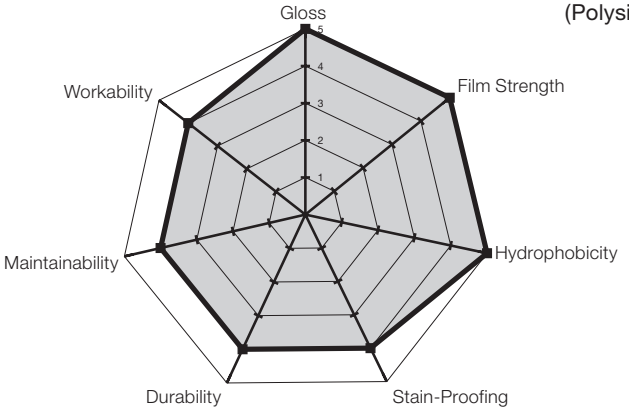
Fig. 7 Ultra Glass Coating NE'X and NEO Comparative Weather Resistance

6. Ultra Glass Coating Series Characteristics Comparison

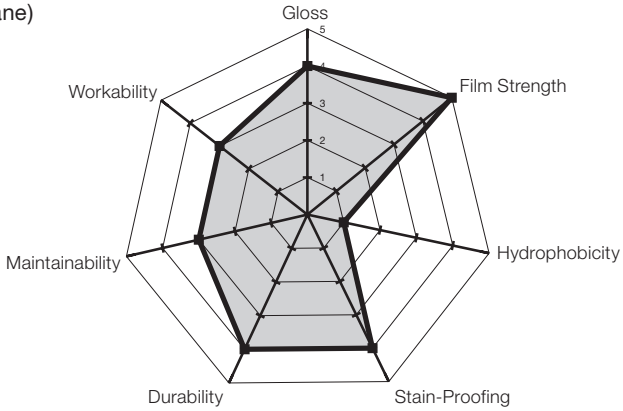
Table 9 Ultra Glass Coating Series Characteristics Comparison



Ultra Glass Coating NE'X
Glass Base: Water-Repellent Hydrophobic
(Polysilazane)



Ultra Glass Coating NEO
Glass Base: Water-Repellent Hydrophobic
(Polysilazane)



Ultra Glass Coating
Glass Base: Low Water Repellent
(Polysilazane)

Fig. 8 Ultra Glass Coating NE'X Products

Closing

The Ultra Glass Coating Series' products introduced here are designed to make your journey on the roadways as pleasant as possible. In Japan, recent years have seen a continuing decline in automobile sales as the younger generation seeks other forms of transportation , values change, society ages and the overall population declines. In response to this, dealerships are promoting the sale of new vehicles by offering incidental service sets . In this competitive sales environment, we are developing chemical products to meet market demand, leading to product development for incidental services and period inspection at garages. As a part of our development, we will continue to work on the release of even more advanced body coatings.

<References>

1) ThreeBond Technical News 70: Vehicle Coating Agents, January 1, 2008

2) Ultra Glass Coating NEO, Catalog, AK2008005

3) Automotive Aftermarket: Exploring Market Vitalization from Body Coating Trends, April 2012

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