ThreeBond
TECHNICAL NEWS

Ultraviolet-Curing Resin
(Part 2)

1. Introduction

In recent years, due to the modernization of production facilities and the improvement in power-saving and production speed, fast-curing ultraviolet-curing resins have become increasingly indispensable.

About five years ago, Three Bond placed ultraviolet-curing resins on the market as the Three Bond 3000 series. Since then, Three Bond has successively developed new products in response to various needs, and the demand for them is growing rapidly. In particular, the recent expansion of the scope of the applicability of ultraviolet-curing resins is remarkable.

A summary of the demand for ultraviolet-curing resins was given in the Technical News published in November 1984, "Ultraviolet-Curing Resin <No. 1>." This issue describes the properties required of ultraviolet-curing resins at present and in the future, as well as their applications, with my speculations.

Contents

2. Scope of applicability of ultraviolet-curing resins

It is the prime characteristic of ultraviolet-curing resins that they change from a liquid to a solid plastic in a short time. By taking advantage of this characteristic of ultraviolet-curing resins and by changing the form of the resins after curing, the applicability of ultraviolet-curing resins has been expanded for the purpose of replacing currently used plastics with such resins.

Fig. 1 shows the applications of ultraviolet-curing resins and materials that can be replaced with ultraviolet-curing resins in various fields on the basis of their functions.

Table 1 shows the resins that can be replaced with ultraviolet-curing resins and a comparison of their properties.

Table 2 shows the applications of various types of functional ultraviolet-curing resins that are currently on the market or under development by Three Bond.

Table 3 shows the characteristics of representative ultraviolet-curing resins that are currently on the market.
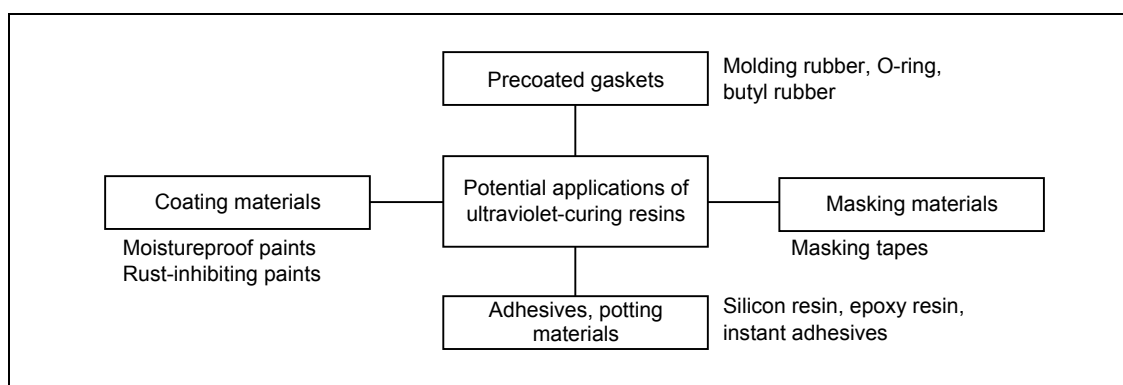

Fig. 1. Scope of applicability of ultraviolet-curing resins, and materials that can be replaced with ultraviolet-curing resins

Table 1.　Comparison of properties between ultraviolet-curing resins and conventional resins that can be replaced with ultraviolet-curing resins

Required properties	Ultraviolet-curing resins	Two-part silicon-rubber RTV	Butyl rubber	One-part / two-part epoxy resin	Instant adhesive
Curing speed	◎	✕	-	✕	◎
Surface curing properties	○	◎	-	◎	◎
Thick-film curing properties	○	◎	-	◎	✕
Rubber elasticity/elongation	○	◎	○	✕	✕
Adhesive properties	◎	✕	○	◎	◎
Resistance to moisture	○	◎	◎	◎	✕
Resistance to heat	○	◎	✕	◎	✕
Low-temperature properties	○	◎	○	✕	✕

◎ Excellent　　○ Moderate　　✕ Poor

Table 2. Properties and applications of functional ultraviolet-curing resins

Properties	Use purposes or particular uses	Names of products or prototypes
Thick film curing properties	Potting materials, potting of electrical components	TB3018 TB3016
Rubber elasticity	Vibration-proofing materials, sound-proofing materials, Precoat G	S716-99 R674-4
Water-solubility	Temporary adhesion, temporary adhesion of rock crystal and lenses	W-33
Resistance to abrasion	Hard coat, resin surface coat	TB3070
Underwater curing properties	Rust-inhibiting protection	UVR100
Low refractive index	Optical-fiber clad, adhesion	AVR110 AVR100
High refractive index	Optical-fiber core, adhesion	AVR200
Surface adhesive properties	Resistance to shock, anaerobic primer curing	TB3062/TB3095
Fitting adhesive properties	Motor shaft, anaerobic curing	TB3060 TB3066
Machinability	Grinding of stepping motors	TB3057
Heat-curing properties	Potting materials, coil casting	TB3013C
Thixotropy	Sagging prevention, temporary fixing of chips	TB3069 TB3035
Resistance to chemicals	Resistance to LLC	M-65
Casting use	For 2P optical disks	UVX-SS120
Resistance to moisture	Coating, adhesion	TB3003 TB3030
Resistance to galvanic corrosion	Potting, coating	R422-2
Adhesive properties	Adhesion of plastic films	S716-70 R723

Table 3. Representative products of ultraviolet-curing resins

TB number	Appearance	Viscosity cps	Shore hardness	Elongation %	Features and applications
3067B	Pale yellow transparent liquid	120	90 (D)	2	Anaerobic, fast-curing, motor fitting
3062/ 3095 (Primer)	Pale yellow transparent liquid Solvent-containing pale yellow transparent liquid	10,000 5	70 (D)	180	Anaerobic, primer curing, surface adhesion, ferrite adhesion, glass/plastic adhesion
3070	Solvent-containing colorless and transparent liquid	5	7 H Pencil hardness	-	Hard coating of plastics, optical disks
3016	Pale blue liquid	20,000	25 (A)	1,800	Rubbery, thick-film potting, resistant to heat cycles
3030	Opaque white thixotropic liquid	16,000 *	95 (A)	50	Resistant to moisture, fast-curing, thick-film, adhesion
3069	Whitish thixotropic liquid	50,000 *	90 (D)	5	Anaerobic, thixotropic, chip parts, electronic parts adhesion
3013	Pale brown transparent liquid	6,000	90 (A)	120	Elasticity, high adhesion, plastic adhesion
3054	Brown liquid	35,000	90 (D)	5	Resistant to moisture, sealing of liquid-crystal material inlet
3057	Whitish thixotropic liquid	40,000 *	90 (D)	2	Heat-curing, machinable, stepping-motor abrasives
3003	Colorless and transparent liquid	1,500	95 (A)	40	Transparent, resistant to moisture, coating, sealing materials
3041N	Colorless and transparent liquid	1,200	80 (D)	15	Transparent, low-illuminance curing, painted-plate/adornment coating
3062B	Green transparent liquid	4,000	70 (D)	70	Anaerobic, glass/metal adhesion, liquid-crystal pin lead adhesion
3013C	Blue-green liquid	5,500	90 (A)	100	Heat-curing, potting materials
3021B	Pale yellow transparent liquid	20	30 (D)	30	Low-viscosity, soldering-heat resistance, high adhesion to plastics

* Thixotropic

3.   Ultraviolet-curing resins as adhesives

When an ultraviolet-curing resin is used as an adhesive, one adherend must transmit ultraviolet light. Materials that transmit visible light and those that transmit ultraviolet light may or may not be identical. Transparent materials include glass, acrylic resins, polycarbonate resins, and polyester films (PET). Of these, polycarbonate resins are transparent yet do not transmit ultraviolet light. As you know, they contain a large amount of ultraviolet-absorbing agents as a stabilizer, due to the fact that polycarbonate resins are by nature inferior in terms of weather resistance. As a result, ultraviolet light is naturally absorbed into the agents, thereby significantly retarding the curing of ultraviolet-curing resins. Such a phenomenon also occurs in acrylic resins used in automobiles or the like. The quantity of ultraviolet light that passes through transparent resins normally depends on the amount of contained ultraviolet-absorbing agents.

On the other hand, some opaque resins transmit a relatively large quantity of ultraviolet light. Examples thereof include polypropylene resins, polyethylene resins, nylon, and polyacetal resins. Resins that transmit very little ultraviolet light include polyimide resins.

The usability of ultraviolet-curing resins as adhesives is partly dependent upon the fact that the amount of ultraviolet light that passes through the adherend (365 nm) is 10% or more.

In fact, many studies on the use of ultraviolet-curing resins as adhesives discuss the adhesion between plastics and metals, or between plastics and inorganic materials. In such studies, such as those in which glass and an acrylic resin are bonded together using an ultraviolet-curing resin, the difference in the coefficient of linear expansion of glass and the acrylic resin presents a major problem.

When a glass plate and an acrylic-resin plate with a length of 300 mm are bonded together under the condition that the coefficient of linear expansion of the glass and the acrylic resin is 10^{-6}/°C and 10^{-4}/°C, respectively, assuming that the environmental temperature deviates from the normal temperature by ±40°C, the variation in the elongation of the glass and the acrylic resin is as follows:

Acrylic resin $300 \times 40 \times 10^{-4}$ mm=1.2 mm
Glass $300 \times 40 \times 10^{-6}$ mm=0.012 mm

Difference   1.2-0.012=Ca. 1.2 mm

The distance from the center to the edge of the plates is 150 mm, and differs between the glass and the acrylic-resin plates by 0.6 mm when the environmental temperature changes by 40°C from the normal temperature, resulting in a corresponding deviation or distortion.

When an adhesive is applied at a thickness of 0.1 mm, the adhesive causes a cohesive failure regardless of the high adhesion, or the glass breaks unless the adhesive itself elongates by 600% or more.

Even in the case of an adhesive with a degree of elongation of 600% or more, if it has a high Young's modulus when it is elongated, the adhesive is constantly applied to its interface as a stress, and is likely to eventually peel off.

In consideration of the above, ultraviolet-curing resins with various properties were prototyped and examined experimentally, and we found that an ultraviolet-curing resin with a degree of elongation of 1,000% or more and a Young's modulus of 0.3 kg/cm^2 or less practically achieves good results, and the resin was commercialized as an ultraviolet-curing resin for the adhesion of large-surface heterogeneous materials.

As mentioned above, when an ultraviolet-curing resin is used as an adhesive, it is very important to consider the ultraviolet transmittance and coefficient of thermal expansion of adherends, and thickness of the adhesive.

4.   Ultraviolet-curing resins for optical communication

We received an inquiry from a certain manufacturer regarding the ultraviolet-curing resin with a refractive index of 1.4627. A refractive index of 1.4627 is equal to that of silica glass. At that time, our R&D laboratory had only ultraviolet-curing resins with a refractive index of 1.48 at the lowest.

Optical communication is a technology for causing light to travel through the core of optical fibers, which prevent the light from going out by exploiting the difference in the optical refractive index. We believed that the development of ultraviolet-curing resins with various refractive indexes would contribute to the development of optical-communication technology. Based on the inquiry, we decided to work toward the development of ultraviolet-curing resins with a lower refractive index, higher transparency, and

higher adhesiveness.

Optical fibers cannot be connected together by connectors or soldering using copper wires or the like. The connection of optical fibers is enabled through the application of the functions of adhesives to ultraviolet-curing resins having high and low refractive indexes, respectively.

In the investigation of the properties of the various ultraviolet-curing resins, we found that the refractive index of the majority of ultraviolet-curing resins falls in the range of 1.49 to 1.52. There are very few ultraviolet-curing resins that have a refractive index above or below that range. We attempted to incorporate various molecules with a high or low density into oligomers in order to increase the possibility of synthesizing ultraviolet-curing resins with a larger range of refractive indexes. As a result, we succeeded in synthesizing highly transparent ultraviolet-curing resins with refractive indexes of 1.44 to 1.55.

We formed an optical fiber composed of an ultraviolet-curing resin with a high refractive index of 1.55 as the core, and an ultraviolet-curing resin with a low refractive index of 1.44 as the cladding, using a silicon-resin mold. Light traveled through the core without leakage. This technique was applied to the UV forming of optical waveguides,

and enabled the connection of optical fibers with other components to allow the convergence, divergence, and trapping of light with ease and cost-efficiency.

Recently, demand for an ultraviolet-curing resin with a refractive index of 1.41 has grown for use as a polymer-cladding connector adhesive also serving as a clad material. At present, we are searching for a method for decreasing the refractive index from 1.44. We believe that we can develop the desired ultraviolet-curing resin with a refractive index of as low as 1.41 in the near future.

If further development of the forming technique enables the formation of a plastic lens successively changing the refractive index on a round of a circle, the manufacture of flat plastic lenses may be one of the applied technologies of ultraviolet-curing resins. Continuous efforts to quest for the refractive index of ultraviolet-curing resins will widely expand the possibilities of optical communications.

For your reference, the following section provides an abstract of the lecture titled <Study on Optical Waveguides for Plastic Optical Fibers> delivered by Mr. Yoshizawa and Mr. Kaino at Ibaraki Electrical Communication Laboratory of NTT Corp. at a meeting of the Society of Fiber Science and Technology, Japan.

========================= <Reference> =========================

Study on Optical Waveguides for Plastic Optical Fibers

Tetsuo Yoshizawa, Toshikuni Kaino

Ibaraki Electrical Communication Laboratory, NTT Corp.

1. Introduction

Plastic optical fibers have been attracting attention in various fields as a short-distance light-transmitting medium due to the reduction in their dissipation and increase in their reliability. However, no connector or turnout, which is indispensable for interconnecting two or more terminals, that is generally excellent in cost, productivity, and performance has yet been developed. Thus, we have developed a method, which is described below, for readily manufacturing an optical branch/coupled circuit having fibers that are compatible with the material properties of plastic fibers, low in cost, and suitable for mass production, which are the advantages of the plastic fibers.

2. Design plan for optical waveguides

We conducted our study on the basis of the design plan to achieve the following objectives:

1) Developing a fundamental technology for freely forming arbitrary circuits such as a 1-to-n (branch, coupling) or n-to-n (star coupler) circuits
2) Using acrylic resin as a forming material due to its good conformity to fibers
3) Using a fiber insert mold without requiring postprocessing
4) Completing forming in a short time without special techniques or apparatuses for mold construction and forming
5) Allowing both factory assembly and on-site fabrication
6) Enabling low-cost production

The following section describes the development of the bifurcated circuit and the results thereof.

3. Circuit design

As forming materials, we selected two types of ultraviolet-curing acrylic resins with different refractive indexes: resin A (n_1=1.52) and resin B (n_2=1.48) (manufactured by Three Bond Co., Ltd.). When resin A was used as the core material and resin B as the cladding material, angle θ, which is

the angle of the total reflection of light, is calculated at $\theta = 13°$ by the following formula (1):

$$\theta = \cos^{-1}\left(\frac{n_1}{n_2}\right) \qquad (1)$$

Then, we extremely simplified the light transfer in the waveguide, and designed the branch circuit as shown in Fig. 1. If the crossing angle ϕ is equal to or less than θ, light will be guided to the branch point by the total reflection without leakage. We set ϕ=17° to ease the construction of a master mold.
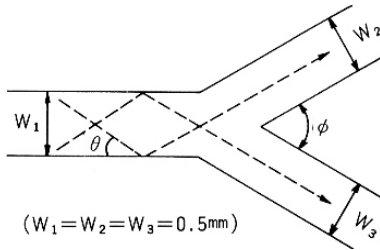

Fig. 1   Size and shape of the branch point

If the width of the waveguide is equalized with the outer diameter of the fiber (here, the width was 500 μm, which is equal to the outer diameter of the fiber) and the cross section is rectangular to ease forming a fiber insert, light may be lost when it enters the fiber. However, plastic fibers have a core diameter of nearly 480 μm and an outer diameter of 500 μm, thus they cause loss as low as approximately 1.4 dB, as shown in Fig. 2, which is far smaller than that caused by glass fibers (e.g., outer diameter of 125 μm and core diameter of 50 μm).
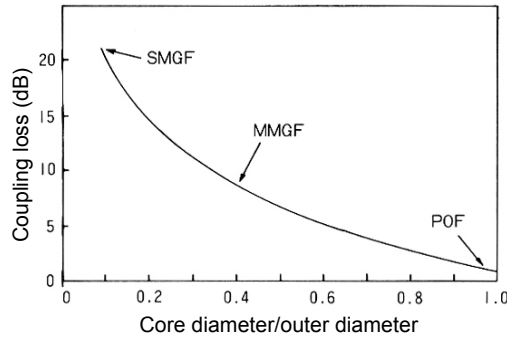

Fig. 2. Coupling loss of fiber and rectangular waveguide

4. Construction of a forming mold

To decrease the loss of guided light in an optical waveguide, the core must have excellent transparency, and the interface between the core and the cladding must be as smooth as possible. The forming mold must have the pattern shown in Fig. 1 in rectangular groove form, and the wall of the groove must be smooth. We ensured that the silicon rubber had an excellent transfer property of approximately 0.1 μm, which had been used by the author in the forming of a deformed diffraction grating[1]; thus, we used silicon rubber for the forming mold.

The construction of a rubber mold requires the construction of a convex master mold having a reverse convexo-concave pattern. We considered it difficult to machine the surface (corresponding to the aforementioned wall) of the convex pattern of the size and shape shown in Fig. 1 to make it smooth; thus, we constructed the master mold by etching a photoresist of the dry-film type. Using a mask of the size and shape shown in Fig. 1 and ultraviolet exposure, we constructed a master mold having a rectangular section of approximately 500 μm square.

Using the master mold, which had been thoroughly dried and exposed to light, we obtained a silicon-rubber mold by vacuum injection method. It was confirmed that the master mold was adhering to the base film with sufficient tightly to construct multiple silicon-rubber molds. Photograph 1 shows the obtained rubber mold. The size and shape of the groove on the rubber mold were almost equal to those of the master mold.
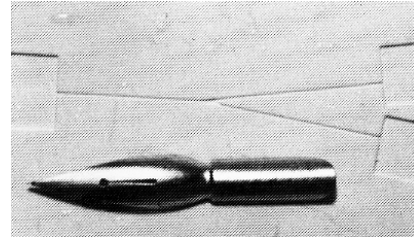
Photograph 1. Forming rubber mold

5. Waveguide forming

As shown in Fig. 3, fibers were squeezed into the groove in the rubber mold. Even if the outer diameter of the fibers is somewhat larger than the groove due to manufacturing deviations, the forming mold made of rubber permits their easy insertion at predetermined positions, and prevents the inserted fibers from sliding due to their friction against the rubber. Thereafter, a predetermined amount of resin A with a higher refractive index was poured into the groove, and cured by ultraviolet irradiation. All over the surface, resin B with a lower refractive index was poured, cured, and then released from the rubber mold. Resin B was poured and cured once again, and the forming was then completed. The total forming time was approximately 10 minutes. Photographs 2 and 3 show the obtained bifurcated molding and the cross section of the waveguide, respectively.
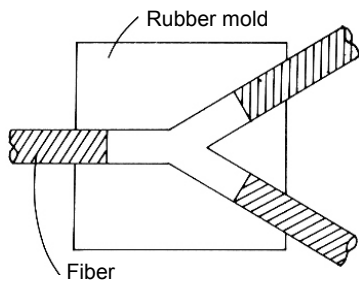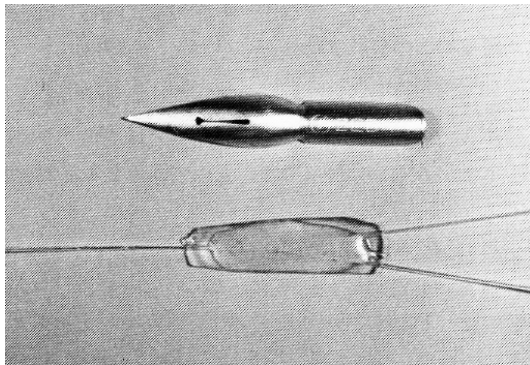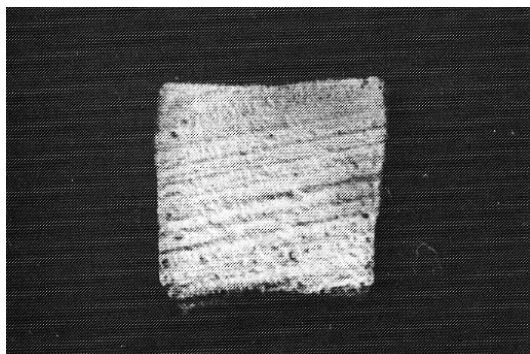
Fig. 3   Fiber setting

Photograph 2   Bifurcated molding

Photograph 3   Cross section of waveguide

6. Properties of the waveguide

The quantity of light is halved in a bifurcated waveguide to cause basic loss of approximately 3 dB in the waveguide. The quantity of light is further decreased by the following factors:

1) Branch losses (-10.log (1/n), n: number of branches)
2) Coupling losses due to the difference in the sectional area of the waveguide and the fiber
3) Losses due to the branch structure
4) Transmittance losses (scattering and absorption due to molecular movement/structures, scattering by foreign particles)
5) Losses due to structural irregularities at the interface between the core and cladding
6) Losses based on inconsistencies in the refractive-index parameters of the fiber and waveguide

The formed waveguide was evaluated by measuring the losses of He-Ne laser (λ=632 nm) caused in the waveguides having the same full length as shown in Fig. 4. The results are shown in Table 1.

According to the results of the measurement of the linear waveguides, the sum of the transmission loss of the waveguide and the coupling loss of the waveguide and fiber was 1.3 dB, suggesting that most of the losses caused in the present waveguide were due to the coupling losses. On the other hand, the quantity of light decrease was by 5.6 dB due to the bifurcation, which was 1.3 dB higher than the estimated value of 4.3 dB. This increase is considered to primarily be due to the large crossing angle ϕ at the branch point and the insufficient sharpness at the crossing point, suggesting the necessity of improving the accuracy of the master mold construction.

Table 2 lists the values of the cross talk, which are significant when the formed circuit is used as a coupler, suggesting that the waveguide can be practically used.
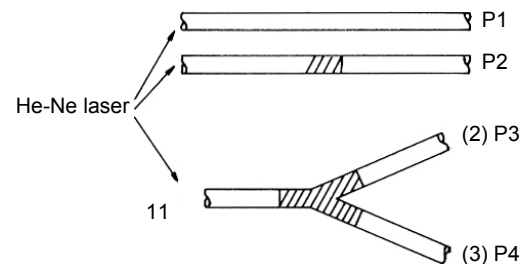

Fig. 4   Measurement method

Table 1 Properties of the waveguide

Difference in light quantity	dB
P1-P2	1.31
P2-P3	5.54
P2-P4	5.65

Table 2 Cross talk

Incident port	Cross talk (dB)
(2)	((1)-(3)) 26.28
(3)	((1)-(2)) 26.59

7. Conclusion

We developed a new method for constructing a waveguide compatible with the properties of plastic fibers using a silicon-rubber mold and an ultraviolet-curing acrylic resin. The obtained waveguide had excellent forming properties and waveguide properties, and the forming method satisfied all of the conditions specified in the design plan. In the future, we will attempt to apply this method in the construction of multiple branches and couplers, and will study their reliability.

Reference: (1) T. Yoshizawa: Plastic Molding of Irregular Shaped Gratings, 28th Proc. of JCMR (1985)

●End of reference●

5. Underwater curing of ultraviolet-curing resins

The radical polymerization of acrylic ultraviolet-curing resins is generally inhibited by atmospheric oxygen, and a stickiness remains on the surface exposed to air.

When a very rapid curing speed is required, curing is conducted in an atmosphere that has been made inactive by replacing air with nitrogen gas. Formerly, curing in the presence of air was a major advantage; recently, however, ultraviolet-curing resins that adequately cure in air are becoming mainstream as technological advances promote the study of the chemical structure of acrylic resins and the catalysts for them. This is also significantly contributed to by the development of ultraviolet-curing epoxy resins and the replacement of radical polymerization with ionic polymerization, which is not affected by air.

We have also spent time studying curing in air, and feel a strong need to continue doing so. However, some places on earth have little air, such as underwater. Water transmits ultraviolet light and the atmosphere contains less oxygen, making underwater conditions more suitable for curing ultraviolet-curing resins than atmospheric conditions. Unlike in air, energies for curing such as heat cannot be readily provided in water. Therefore, we consider underwater conditions to be ideal for the use of the ultraviolet-curing resins, which cure in a short time.

We collected information on the application of ultraviolet-curing resins underwater, and found that their major application is as a rust preventive for marine architecture.

At present, the rust prevention of marine architecture that is decades old is carried out through the application of a two-part epoxy resin underwater by skilled divers using a brush or trowel. Conventionally, the desired performance could not be achieved, as the epoxy resin dissolved in water before curing or the specific gravity of the resin was too low. Recently, revolutionary epoxy resins for underwater conditions have been developed and are increasingly being used.

However, this method is not necessarily adequate. This is partly due to the pot life of the resins, mixing errors, and insufficient mixing of the two fluids by the operator, but is primarily due to the fact that only a small area can be treated in an hour even by a skilled diver.

Ultraviolet-curing resins may be applied underwater in the same manner as epoxy resin, but we would like to add a new twist.

This example includes the preimpregnation of ultraviolet-curing resins; in this process, a fabric such as a glass cloth or a nonwoven fabric is impregnated in an ultraviolet-curing resin, the impregnated fabric is sandwiched between a transparent plastic film that is permeable to ultraviolet light and a released paper that is releasable in water, and the resulting resin is formed into a suitable size.

The pre-preg ultraviolet-curing resin of a size suitable for underwater architecture is simply adhered to the surface of the architecture with its plastic film surface facing upward, thereby preventing water from entering between the pre-preg and architecture. The adhered pre-preg was irradiated with a water-retentive ultraviolet lamp to cure it in a short period of time.

This method has many advantages over conventional methods, such as improving workability and performance.

Examples of other applications include the instantaneous stopping of water leakage or gas leakage. It is also suitable for the conditions of low-temperature storage in which water constantly exists on the surface.

The pre-preg ultraviolet-curing resin adheres even in the presence of water, and cures in several seconds. In addition, if it is cured, it forms a tough coating of reinforced plastic. We believe that, in the near future, pre-preg with these functions will find various applications and contribute to society.

6. Curing thickness of ultraviolet-curing resins

There are many commonly held views regarding ultraviolet-curing resins. Examples include the view that the maximum curing thickness of ultraviolet-curing resins is 2 to 3 mm. Under such circumstances, studies on thick-film curing are rarely undertaken, and those who participated in the

current study tend to consider it impossible to cure resin with a thickness of 10 mm. The author considers such inaccurate stereotypes to be a leading cause of the delays in research and development. Commonly accepted theories on ultraviolet-curing resins are often established based on the technical limitations of the ultraviolet-curing resin manufacturers. However, such technical limitations tend to be regarded as being based on scientific principles. This is due to the fact that ultraviolet-curing resin manufacturers have extensive expertise with ultraviolet-curing resins; thus, we should not set limitations on research based on current technical limitations.

A resin with a curing thickness of 15 mm was once accidentally synthesized. However, we could not determine how the ultraviolet-curing resin cured thickly. A resin having the same molecular structure cured in thick-film form. We concluded that the special molecular structure had caused the thick-film curing, and conducted further study to achieve curing with a thickness of 20 to 30 mm.

The ultraviolet-curing resins cured in a thick film will find various applications. The primary examples thereof include potting materials, which are conventionally made of epoxy resins. Although some of them are made of ultraviolet-curing resins, they are cured by a combination of heat and ultraviolet light, using two fluids, which decreases their workability and significantly prevents labor savings.

Ultraviolet-curing resins cannot be used as potting materials simply because they cure in thick-film form. Another problem to be overcome is shrinkage in curing. In general, ultraviolet-curing resins shrink by 3% to 8% when they change in form from liquid to solid. The degree of shrinkage is normally determined by the reactive groups involved.

The present technology cannot make the degree of shrinkage 0 or enable expansion on a practical level. At present, the technology has been improved to a practical level by increasing the amount of fillers, or by softening the cured substances in order to reduce distortion caused by shrinkage during curing through internal plastic deformation of the distortion, which is the same procedure used for epoxy resins.

If we were to place the ultraviolet-curing resin on the market as Three Bond 3016, studies related to the product would be conducted as never before.

7. Conclusion

At present, the development of ultraviolet-curing resins involves the difficult challenge of curing the parts that are not irradiated with ultraviolet light.

In the development of ultraviolet-curing resins, the combination of ultraviolet curing with other curing methods must be taken into consideration to satisfy user requests. Fortunately, Three Bond has the underpinning of curing technology established in a wide range of studies on anaerobic adhesives, RTV silicon, acrylic structural adhesives, instant adhesives, epoxy adhesives, and others; therefore, we consider ourselves to be in a very advantageous position for the development of ultraviolet-curing resins.

Moreover, we are deeply indebted to the generous support of users in the development of ultraviolet-curing resins.

A need results in the development of a new product, a technical advance creates various needs, and another need involves significant technical limitations. With an understanding of those technical limitations, we want to work to eliminate them.

Tsutomu Saito
UV Laboratory
Industrial Application Group
R&D Laboratory
Three Bond Co., Ltd.

Tough deposits can be quickly removed!

Three Bond 6609
Water-scale Cleaner

Three Bond 6609 is a foam-type water-scale cleaner. Tough deposits accumulated due to rainwater or the like are easily removed simply by applying the foam and then wiping it off. Three Bond 6609 is also effective in removing stains from a windshield or leather. Containing no abrasive, Three Bond 6609 can be used with no worries about scratches.

Features
❶ Deposits are suspended by the application of foam, and removed simply by wiping the foam off.
❷ Three Bond 6609 is not a compound (abrasive)-type agent, but a water-soluble cleaner.
❸ Three Bond 6609 will not affect rubber, baked finishes, or metal plating.

Directions for use
❶ Thoroughly shake the container prior to use.
❷ To remove deposit, directly spray the cleaner onto the body, and then wipe it off using a waste cloth or the like.
❸ To clean leather or glass, spray the cleaner once onto a waste cloth, and then wipe off the stain.

Major applications
❶ Removal of deposits from automobile bodies and dirt from the underside of the hood
❷ Removal of stains from leather
❸ Cleaning of a windshield

Precautions for use
❶ If the car body is hot from sitting in the sun, pour water on the body to cool it before spraying on the cleaner.
❷ The cleaner may affect the metallic coating and the interior parts of the car. As a trial, spray a portion on an inconspicuous location in advance.
❸ Do not spray the cleaner on the plastic sections of interior parts.
❹ Be sure to remove the sprayed liquid by wiping or washing off.

● Content: 300 ml

ThreeBond
TECHNICAL NEWS

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