Scotchbond™ Multi-Purpose Plus Dental Adhesive System
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Abbreviations are used in many of the illustrations in this report. These abbreviations are defined in the table below:

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<th>Abbreviation</th>
<th>Product</th>
<th>Manufacturer</th>
</tr>
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<tbody>
<tr>
<td>AB2</td>
<td>All-Bond® 2 Universal Adhesive System</td>
<td>Bisco Dental Products</td>
</tr>
<tr>
<td>APH</td>
<td>Advanced Particle Hybrid</td>
<td>L.D. Caulk</td>
</tr>
<tr>
<td>AMAL</td>
<td>Amalgambond® Plus Dentin Bonding Agent</td>
<td>Parkell</td>
</tr>
<tr>
<td>AMAL HPA</td>
<td>Amalgambond® with High Performance Additive</td>
<td>Parkell</td>
</tr>
<tr>
<td>ART</td>
<td>A.R.T. Bond® Advanced Retention Technology</td>
<td>Coltène</td>
</tr>
<tr>
<td>ÆLITE</td>
<td>Ælitebond™ Single Primer Adhesive</td>
<td>Bisco Dental Products</td>
</tr>
<tr>
<td>BISFIL</td>
<td>Bisfill Light Cure Composite</td>
<td>Bisco Dental Products</td>
</tr>
<tr>
<td>C&amp;B META</td>
<td>C&amp;B Metabond™ Adhesive Luting Cement</td>
<td>Parkell</td>
</tr>
<tr>
<td>CHARISMA</td>
<td>Charisma® Microglass® Composite</td>
<td>Kulzer</td>
</tr>
<tr>
<td>CL</td>
<td>Clearfil® Photo Bond</td>
<td>Kuraray</td>
</tr>
<tr>
<td>CLB</td>
<td>Clearfil® Liner Bond</td>
<td>Kuraray</td>
</tr>
<tr>
<td>CNB</td>
<td>Clearfil® New Bond</td>
<td>Kuraray</td>
</tr>
<tr>
<td>DH</td>
<td>Denthesive® Dentin Bond System</td>
<td>Kulzer</td>
</tr>
<tr>
<td>DH2</td>
<td>Denthesive® 2 Dentin Bond System</td>
<td>Kulzer</td>
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<tr>
<td>FUJI II LC</td>
<td>Fuji II Light-Cured Glass Ionomer Cement</td>
<td>GC Corporation</td>
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<tr>
<td>G2000</td>
<td>Gluma® 2000 Two Step Bonding System</td>
<td>Bayer Dental</td>
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<td>MIRAGE</td>
<td>Mirage Bond™ Dentin-Enamel Bonding System</td>
<td>Chameleon Dental</td>
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<tr>
<td>IMPERVA</td>
<td>Imperva Bond™ Light-Cure Dentin Bonding System</td>
<td>Shofu</td>
</tr>
<tr>
<td>OPTI</td>
<td>Optibond™ Multi-Use Bonding Agent</td>
<td>Kerr</td>
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<td>PAN 21</td>
<td>Panavia® 21 Dental Adhesive</td>
<td>Kuraray</td>
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<tr>
<td>PFM</td>
<td>porcelain fused to metal</td>
<td></td>
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<tr>
<td>PRO</td>
<td>ProBOND™ All-Purpose Bonding Agent</td>
<td>Dentsply Intl.</td>
</tr>
<tr>
<td>PUB2</td>
<td>Prisma Universal Bond®2</td>
<td>Dentsply Intl.</td>
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<tr>
<td>PUB3</td>
<td>Prisma Universal Bond®3</td>
<td>Dentsply Intl.</td>
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<td>SB2</td>
<td>Scotchbond™ 2™ Dental Adhesive</td>
<td>3M Dental Products</td>
</tr>
<tr>
<td>SBDC</td>
<td>Scotchbond™ Dual-Cure Dental Adhesive</td>
<td>3M Dental Products</td>
</tr>
<tr>
<td>SBMP</td>
<td>Scotchbond™ Multi-Purpose Dental Adhesive</td>
<td>3M Dental Products</td>
</tr>
<tr>
<td>SBMP PLUS</td>
<td>Scotchbond™ Multi-Purpose Plus Dental Adhesive</td>
<td>3M Dental Products</td>
</tr>
<tr>
<td>SYNTAC</td>
<td>Syntac™ Enamel/Dentin Bonding System</td>
<td>Vivadent</td>
</tr>
<tr>
<td>TEN</td>
<td>Tenure™ Solution Dentin Bonding System</td>
<td>Den-Mat Corp.</td>
</tr>
<tr>
<td>Z100</td>
<td>3M Restorative Z100</td>
<td>3M Dental Products</td>
</tr>
<tr>
<td>ZPC</td>
<td>Fleck’s® zinc phosphate cement</td>
<td>Mizzy</td>
</tr>
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</table>
Introduction

Dental adhesive systems differ in their clinical indications. Certain systems have been designed primarily for the application of light-cured composite. This design philosophy may have as its basis the fact that, in most offices, the largest single use for dental adhesives is direct placement of light-cured composites. Other systems have been designed primarily for use in indirect restorations. Perhaps a more current trend, however, is to provide an adhesive that is essentially "all-purpose" in application. The illustration on the right presents several dental adhesive systems and graphically approximates their intended applications.

Since its introduction in 1992, the Scotchbond multi-purpose adhesive system has become one of the leading light-cure dental adhesive systems. Being a light-cure system, however, it has not been an appropriate choice for bonding amalgam to tooth structure or for bonding indirect restorations such as inlays, onlays, and crowns.

The Scotchbond multi-purpose plus adhesive system was developed to bond these self-cure and dual-cure applications and to bond amalgam. Direct placement of light-cure composite uses the same components and procedures as the Scotchbond multi-purpose adhesive system. Adding the activator and catalyst allows the Scotchbond multi-purpose plus adhesive system to be used for a wide array of bonding situations including bonding amalgam, self-cure composite, and indirect bonding procedures involving metal, porcelain, or composite restorations.
As you will see, all of these indications can be divided into one of three basic procedures:

1: A light-cure procedure for direct placement of light-cure composite.
3: A procedure for bonding indirect restorations.

Direct light-cure composite placement:
This procedure uses the same components and the same instructions as the Scotchbond multi-purpose adhesive system. Enamel and dentin are etched using Scotchbond etchant, a single coat of a Scotchbond multi-purpose primer is applied and dried, and Scotchbond multi-purpose adhesive is applied and light-cured for 10 seconds. For porcelain repair situations, Scotchbond ceramic primer is substituted for Scotchbond multi-purpose primer.

Bonding amalgam and self-cure composite:
The addition of the Scotchbond multi-purpose plus activator and catalyst allows the system to be used for bonding amalgam and self-cure composite. After etching enamel and dentin, single coats of the activator and the primer are applied and dried. The catalyst is then mixed with the adhesive to yield a dual-cure resin. This resin is applied, and the restorative is placed.

Indirect bonding procedures:
The procedure for bonding indirect restorations is very similar to that used for bonding amalgam. Again, tooth structure is etched followed by application of the activator and primer solutions. However, instead of mixing catalyst and adhesive, only the catalyst is used. Using only the catalyst alleviates the concern that the adhesive will set before placement of the indirect restoration. The catalyst will polymerize in conjunction with the dual-cure luting material.

A recent survey conducted by 3M Dental illustrates that most applications for dental adhesives can be accomplished using a light-cure system. Survey results are illustrated in Figure 1. With the advent of the Scotchbond multi-purpose plus adhesive system, we are able to offer a dental adhesive with one of the fastest techniques for light-cure bonding applications as well as techniques for the applications requiring bonding in the absence of light. This profile outlines the procedures, chemistry, and performance of the Scotchbond multi-purpose plus adhesive system.
Direct Composite Placement

1. Apply Scotchbond Etchant to enamel and dentin—wait 15 seconds then rinse.
   Dry gently for 2 seconds or blot dry. Leave moist.

2. Apply Primer to enamel and dentin.
   Dry gently for 5 seconds.

3. Apply Adhesive to enamel and dentin.
   Light cure for 10 seconds.

Place light-cure composite.

Bonding Amalgam and Self-Cure Composite

1. Apply Scotchbond Etchant to enamel and dentin—wait 15 seconds then rinse.
   Dry gently for 2 seconds or blot dry. Leave moist. Apply matrix band.

2. Apply Activator to enamel and dentin.
   Dry gently for 5 seconds.

3. Triturate amalgam or mix self-cure composite.
   Mix Adhesive and Catalyst 1:1 and apply to enamel and dentin.

Place amalgam or self-cure composite.

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Indirect Bonding Procedures

**Applied to Preparation**

Apply Scotchbond Etchant to enamel and dentin—wait 15 seconds then rinse. Dry gently for 2 seconds or blot dry. Leave moist.

Apply Activator to enamel and dentin. Dry gently for 5 seconds.

Apply Primer to enamel and dentin. Dry gently for 5 seconds.

Apply Catalyst to enamel and dentin.

NOTES:
This technique can be used to bond inlays, onlays, crowns, and adhesive bridges fabricated of porcelain, metal or composite.

To facilitate bonding, the bonding surfaces should be treated. Porcelain surfaces are typically HF etched by the dental lab and should be treated with a silane before placement. Metal surfaces benefit from sandblasting and a silane treatment. Composite surfaces can be roughened with a diamond.

Core buildup materials should be cleaned prior to bonding, and then are treated at the same time as adjacent enamel and dentin.

Composite luting materials can be accelerated by dual-cure adhesive systems. This effect should be investigated in the office prior to placing indirect restorations.

**Applied to Restoration**

Apply Catalyst to the bonding surface of the restoration.

Mix and apply a self-cure or dual-cure luting material to the bonding surface of the restoration.

Seat the restoration. If a dual-cure cement was used, light-cure the margins. Set time is dictated by the choice of luting material.

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Chemistry

Scotchbond etchant:
Scotchbond etchant etches the enamel and removes the dentinal smear layer in preparation for bonding. Either Scotchbond 10% maleic acid etchant or 35% phosphoric acid etchant can be used. Use of an etchant is critical on both enamel and dentinal surfaces. The maleic acid etchant has a pH of approximately 1.2 while the phosphoric acid etchant has a pH of approximately 0.6.

Both acids are thickened, although the phosphoric gel is thickened to a higher viscosity. The maleic acid etchant is provided in vials while the phosphoric acid gel is available in either vials or syringes for direct application to the tooth. Both acids have been found equivalent in a variety of bonding situations. However, the phosphoric acid gel has been found to yield a more frosty clinical appearance of enamel.

Scotchbond multi-purpose plus activator:
Scotchbond multi-purpose plus activator is used for self-cure applications such as bonding amalgam, bonding self-cure composites, and for all indirect procedures except bonding porcelain veneers. (Bonding porcelain veneers is accomplished using light-cure components only.) Activator 1.5 is an ethanol based solution of a sulfinic acid salt and a photoinitiator component. This solution is not needed for direct placement of light-cure composite. This solution, however, has been found essential in the absence of a light-cure activation. It is theorized that the sulfinic acid salt of the activator reacts with the polyalkenoic acid of the primer to yield free radicals that aid in the polymerization of the resins. As with other solutions in the Scotchbond multi-purpose plus adhesive system, only one coat is applied and dried for approximately 5 seconds. No waiting time is required before drying.

Scotchbond multi-purpose primer:
Scotchbond multi-purpose primer is an aqueous solution of HEMA and a polyalkenoic acid copolymer first introduced in 3M™ Vitrebond™ glass ionomer liner/base. Incorporation of the polyalkenoic acid into the formulation has been shown to aid in resisting the detrimental effect of moisture in a high relative humidity environment (Fundingsland et al. 1992). This effect is discussed later in a section devoted to moisture resistance. Scotchbond multi-purpose primer is supplied in both the Scotchbond multi-purpose and Scotchbond multi-purpose plus dental adhesive kits.

This solution is required for all applications involving dentin. The primer allows the subsequent resin layer to flow or "wet" the etched surface. While application to etched enamel is not required for light-cure applications, application of the primer is required for self-cure applications since it comprises a component of the self-cure chemistry. The pH of the primer is approximately 3.3.
Scotchbond multi-purpose adhesive:
Scotchbond multi-purpose adhesive is a BIS-GMA and HEMA resin combined with a novel initiation system. A blend of amines allows for a fast, 10-second light cure as well as compatibility with the peroxide component of the catalyst resin. Thus the adhesive can be used in either a light-cure mode or, when combined with the catalyst, in self-cure or dual-cure modes. Because the new adhesive incorporates an additional amine, previous Scotchbond multi-purpose adhesive is not suitable for use in self-cure applications. To make identification easier, the bottle color has been changed from black to gray. Adhesives provided in gray bottles with either the Scotchbond multi-purpose or Scotchbond multi-purpose plus adhesive systems are identical.

Scotchbond multi-purpose adhesive is used for all light-cure applications. When mixed with the catalyst, a dual-cure system is obtained which is indicated for bonding amalgam and self-cure composite.

The effect that different initiator systems can have on the curing of resin systems is illustrated in Figure 2 (Aasen, 3M). These data were obtained using a photodifferential scanning calorimeter (Photo DSC). By observing the heat output of resins during photo-polymerization one can compare the efficacy of various curing systems. Note that the Scotchbond multi-purpose resin cures faster than the Scotchbond 2 resin and two competitive resins.

Scotchbond multi-purpose plus catalyst:
Scotchbond multi-purpose plus catalyst is comprised of the same BIS-GMA and HEMA resin system used in the Scotchbond multi-purpose adhesive, but incorporates the peroxide component of a self-cure resin system. When mixed with the adhesive the resulting solution will set in approximately 4-5 minutes at room temperature or approximately 2-3 minutes at 36 °C (96 °F).

As discussed earlier, the catalyst and adhesive are mixed for applications involving bonded amalgam or self-cure composites. The catalyst is used alone, however, for indirect applications (other than veneers, which are bonded using light-cure techniques). Use of the catalyst without the adhesive for indirect applications alleviates concern that the resin will set in the preparation before the restoration has been placed. When the restoration is placed, the polymerization taking place with the luting composite also cures the adhesive. Hence, set time is dictated by the choice of luting material.

Scotchbond ceramic primer:
Scotchbond ceramic primer is a prehydrolyzed, single-phase silane specifically designed to enhance the bond to ceramics. Test results have also suggested some benefit of application to metals, as well.

Scotchbond ceramic primer is recommended for use in the repair of fractured porcelain and in the preparation of crowns, inlays, onlays, and veneers for bonding. (Note: Scotchbond ceramic primer was previously known as Scotchprime™ ceramic primer.)
Acid Etching Enamel and Dentin

Figures 3-4 and 6-7 illustrate scanning electron micrographs of human enamel and dentin etched with 10% maleic and 35% phosphoric acid (Fundingsland 1993). Both acids yield excellent bond strengths. The maleic etchant, however, yields less calcium removal and a somewhat shallower etched surface (Glasspoole et al. 1994).

On dentinal surfaces, both acids yield surfaces with similar appearances when etched for the recommended 15 seconds. When discussing etching dentin, the depth of etch is often considered important. Excessive etch depth could possibly result in inadequate resin penetration and a weak bond. Ikami et al. (1993) evaluated a wide variety of acidic solutions and determined that the depth of dentinal decalcification was a function of both the choice of acid and the length of time of the etch. Most combinations show decalcification of less than 5 microns. Etching with 38% phosphoric acid yielded a 5-micron decalcified layer for times of 30 seconds or less, but yielded a 20-micron depth for a 60-second etch. This reinforces the recommendation that etch time be limited to 15 seconds with Scotchbond phosphoric acid etching gel. Another topic discussed by Ikami was whether or not the collagen remaining after the etch had been denatured. Only 60-second etches with 38% phosphoric acid and 50% citric acid yields traces of denatured collagen. All other combinations of etch time and acid fail to denature the collagen.

When the smear layer is removed by etching, dentin permeability increases. Figure 5 was plotted using data from Prati (1994). Note that 10% maleic acid actually yields...
higher permeability than does 37% phosphoric acid. These values reinforce the concept that once dentin has been etched it needs to be sealed to protect the pulp from contamination.

Dentin has an excellent capacity to buffer acids, protecting the pulp from the direct effect of an acid. Wang and Hume (1988) evaluated the ability of a variety of acidic and basic materials to affect a solution isolated from the test material by a dentin slab, and found that dentin was an excellent buffer to acidic materials. This ability has also been documented by Ishikawa et al. (1989) and Chan et al. (1986).

Finally, both maleic and phosphoric acids have been shown to yield surfaces amenable to the formation of a hybrid layer. Van Meerbeek et al. (1993) provided data that suggested complete resin penetration of the decalcified layer when using the Scotchbond multi-purpose adhesive system with either 10% maleic acid or 40% phosphoric acid.
Direct Light-Cure Procedures

The direct composite placement technique of the Scotchbond multi-purpose adhesive system begins with a 15-second etch of enamel and dentin. The etchant is rinsed and then dried using a brief, gentle air stream. It is recommended that tooth structure be left slightly moist at this step.

Next, the Scotchbond multi-purpose primer is applied. This entails a single coat of the primer followed by drying with a gentle air stream.

Lastly, the Scotchbond multi-purpose adhesive is applied and light cured for 10 seconds. Avoid excessive air thinning of the adhesive.

Ceramic repair cases are treated in much the same way, substituting the Scotchbond ceramic primer for the Scotchbond multi-purpose primer. Scotchbond ceramic primer is a silane material designed to enhance the bond to ceramic. Benefits of the ceramic primer for bonding to metals are discussed in a later section.

Throughout this report you will see references to in vitro bond test results. These tests are conducted by bonding a cylinder of test material to polished enamel or dentin. The materials bonded can be light-cure or self-cure composite, amalgam, or prefabricated cylinders of porcelain, metal or composite. After bonding, the samples are stored for 24 hours at 37 °C. In some cases, the samples are also thermal cycled.

Bond Strength Summary

Bond strengths obtained for the direct application of 3M Restorative Z100 composite to a variety of substrates are presented in Table 1 (Ario/Fundingsland, 3M). These values were obtained using 35% phosphoric acid as etchant.

Many tests were performed to compare the performance of the Scotchbond multi-purpose adhesive system when used with 10% maleic and 35% phosphoric acid. Test results are summarized in Figure 8 (Ario/Fundingsland, 3M). No significant differences were noted between 10% maleic acid and 35% phosphoric acid etched surfaces.

### Table 1: Bond Strength of Light-Cure Composite to Various Substrates

<table>
<thead>
<tr>
<th>Substrate:</th>
<th>Bond Strength</th>
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<tr>
<td></td>
<td>MPa</td>
</tr>
<tr>
<td>Enamel</td>
<td>30</td>
</tr>
<tr>
<td>Dentin</td>
<td>31</td>
</tr>
<tr>
<td>Porcelain</td>
<td>24</td>
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<tr>
<td>Composite Repair</td>
<td>27</td>
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<td>Set Amalgam</td>
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<tr>
<td>Non-Precious Metal</td>
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Table 2: Effect of Etching Time and Priming Time.

<table>
<thead>
<tr>
<th>EFFECT</th>
<th>P VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Etch time on dentin adhesion.</td>
<td>.934</td>
</tr>
<tr>
<td>Etch time on enamel adhesion.</td>
<td>.320</td>
</tr>
<tr>
<td>Prime time on dentin adhesion.</td>
<td>.844</td>
</tr>
<tr>
<td>Prime time on enamel adhesion.</td>
<td>.655</td>
</tr>
</tbody>
</table>

CONCLUSION: No significant effects.

**Bond to Enamel**

The bond to enamel measures approximately 25-30 MPa. Application of the primer is not mandatory for high bond strength. It is not necessary, however, to keep the primer off of the etched enamel. Again, if no dentin is exposed, one can omit the priming step and still obtain equivalent bond strengths.

**Bond to Dentin**

The bond to dentin measures approximately 30 MPa. The bond to dentin has proven to be resistant to atmospheric moisture, as well as moisture contamination and pulpal fluid flow. Moisture effects are addressed later in a separate section. Additional tests were conducted to ensure that the Scotchbond multi-purpose adhesive system would be "technique insensitive." In the operatory, controlling the application times of the various solutions can be as difficult to control as moisture contamination. For this reason the effect of etching times (5 to 30 seconds), and the effect of waiting time before drying the primer (immediate to 30 seconds) was measured. As shown in Table 2, neither was found significant with respect to bonding enamel and dentin (Ario, 3M).

When bonding composite to dentin it is essential to use the etchant, primer, and adhesive components of the system. The etchant removes the smear layer. The primer prepares the surface for the adhesive and the light-cure adhesive seals the dentinal surface and provides an interface for bonding composites.

**Bond to Sclerotic Dentin**

The bond to highly sclerosed (mineralized) dentin is one area where dentinal bonding systems such as the Scotchbond 2™ adhesive system have displayed low *in vitro* bond strengths. As illustrated in Figure 9, the Scotchbond multi-purpose adhesive system offers an improvement over the Scotchbond 2 adhesive system. Because of the difficulty in obtaining suitable teeth for tests such as this, no other comparisons are available. *(Data courtesy of E.S. Duke, D.D.S., M.S.D., University of Texas, San Antonio; testing performed using 10% maleic acid)*
Moisture Contamination
Moisture contamination can occur from several sources. The relative humidity in the operatory can be high. If no rubber dam is being used, oral relative humidity can reach 84% (Plasmans et al. 1994). Moisture can also be introduced from the air/water syringe or by saliva contamination. Finally, pulpal pressure can work to create a damp field. The Scotchbond multi-purpose adhesive system has been evaluated under all of these conditions.

Humidity
During the development of the Scotchbond multi-purpose adhesive system it was noted that the bond strengths of current dental adhesive systems including the Scotchbond 2 adhesive system tended to decrease when evaluated in the summer months, increasing only as fall and winter approached. Retrospective analysis of test data strongly suggested a relationship to room humidity. During this time period it was also noted that Vitrebond light-cure glass ionomer liner/base bond strengths did not seem to vary to the same degree over the course of a given year. It was found that incorporating the polyalkenoic acid copolymer from the Vitrebond liquid into the Scotchbond multi-purpose primer yielded a system that was very resistant to the detrimental effects of elevated relative humidity. The effect of copolymer addition is illustrated in Figure 10.

The effect of elevated relative humidity (95%) and temperature (35 °C) has been documented by two authors. Figure 11 presents test results published by Plasmans et al. (1993), while Figure 12 was presented by Fundingsland et al. (1992).
Ario et al. (1993) presented data illustrating the effect of the introduction of moisture contamination from a source such as saliva or an air syringe. Only when the contamination began to rinse off the primer was the bond severely affected. In this case, repriming the surface yielded renewed bond strength. Test results are illustrated in Figure 13.

Finally, Mitchem et al. (1993) presented test results of the Scotchbond multi-purpose adhesive system conducted under simulated physiological pressure. These tests were conducted on extracted human molars. An apparatus was constructed such that varying degrees of pressure could be placed on the pulp chamber, simulating conditions in an in vivo application. As illustrated in Figure 14, the Scotchbond multi-purpose adhesive system was able to resist moisture contamination via the dentinal tubules to a substantial degree.

External Contamination

Pulpal Flow
**Initial Bond Strength**  The Scotchbond multi-purpose adhesive system displays excellent initial bond strengths to dentin and enamel. Bond strengths are presented as a function of time in Figure 15 (Ario, 3M).

![Figure 15: Bond Strength vs Time](image)

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Enamel</th>
<th>Dentin</th>
<th>Enamel</th>
<th>Dentin</th>
<th>Enamel</th>
<th>Dentin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate (&lt;1 min)</td>
<td>12.9</td>
<td>10.0</td>
<td>131</td>
<td>102</td>
<td>1870</td>
<td>1450</td>
</tr>
<tr>
<td>15 min</td>
<td>19.0</td>
<td>18.0</td>
<td>194</td>
<td>183</td>
<td>2750</td>
<td>2600</td>
</tr>
<tr>
<td>30 min</td>
<td>18.6</td>
<td>20.9</td>
<td>190</td>
<td>213</td>
<td>2700</td>
<td>3030</td>
</tr>
<tr>
<td>1 hour</td>
<td>20.7</td>
<td>24.0</td>
<td>211</td>
<td>245</td>
<td>3000</td>
<td>3480</td>
</tr>
</tbody>
</table>

**Porcelain Repair**  Porcelain repair is accomplished using Scotchbond ceramic primer instead of the Scotchbond multi-purpose primer. A bond strength of 24 MPa was obtained. Often a porcelain repair will involve a metal surface. It is recommended that this surface be abraded with an intraoral sandblast technique. The Scotchbond multi-purpose adhesive system will bond to this surface. Instructions are provided for repair with either light-cure or self-cure composite or with prefabricated porcelain.

**Composite Repair**  Composite repairs may also be accomplished using the Scotchbond multi-purpose adhesive system. Bond strength with light-cure composite is 27 MPa. As in the case of porcelain repair, instructions are provided for composite repair using either light-cure or self-cure composite.

**Thermal Cycling**  The effect of thermal cycling on bond strength is illustrated in Figure 16. No significant effects were noted after approximately 750 cycles between 5 °C and 55 °C.
Microleakage was evaluated using a Class V model in extracted human molars. Preparations were approximately 2 mm in depth and 4 mm in diameter, and were restored using a single increment of composite in order to stress the bond. Staining with silver nitrate was performed after thermal cycling. After staining, the teeth were sectioned and leakage at the dentinal and enamel margins was measured using an optical microscope. Leakage of the Scotchbond multi-purpose adhesive system is illustrated in Figure 17 (Fundingsland, 3M). Note that with all products, leakage at the enamel margins is less than that at the dentinal margins. Dentinal leakage can be reduced by a substantial amount by incremental placement of composite.

Microleakage was also published by Crim (1993). Table 3 illustrates results of dentinal microleakage. No microleakage was noted at enamel margins.

<table>
<thead>
<tr>
<th>Composite/Adhesive</th>
<th>Mean penetration at gingival margin (mm)</th>
<th>Number of samples with no microleakage</th>
</tr>
</thead>
<tbody>
<tr>
<td>APH/IMPERVA</td>
<td>0.00</td>
<td>10</td>
</tr>
<tr>
<td>Z100/SBMP</td>
<td>0.00</td>
<td>10</td>
</tr>
<tr>
<td>FUJI II LC</td>
<td>0.00</td>
<td>10</td>
</tr>
<tr>
<td>APH/UB3</td>
<td>0.08 (0.14)</td>
<td>6</td>
</tr>
<tr>
<td>CHARISMA/DH</td>
<td>0.09 (0.07)</td>
<td>3</td>
</tr>
<tr>
<td>BISFIL/AB2</td>
<td>0.18 (0.22)</td>
<td>3</td>
</tr>
</tbody>
</table>

Film thickness concerns have been addressed in two ways. First and perhaps most significantly: when bonding indirect restorations no cured film is present until polymerization occurs with the luting material. Any resin present can, therefore, intermix with the luting material or simply be forced out of the way upon seating the restoration. With minimal seating pressure resulting film thickness has been measured at less than 5 microns.

Secondly, when placing light-cure composite onto a cured adhesive film, improved photoinitiator systems have been shown to reduce the detrimental effects of air thinning (Fundingsland 1993). This appears to relate to the thickness of the oxygen inhibited layer, which was found to be thinner with improved photoinitiator systems.
Estimated application times can provide some indication of the complexity of a dental adhesive system. Figure 18 presents estimates of the time needed to place a variety of dental adhesive systems for light-cure composite restorations. The time estimates begin with the first application of the adhesive system and end with a surface ready for application of composite.

![Figure 18: Estimated Adhesive Application Times for Direct Composite Placement](image-url)
Bonding Amalgam or Self-Cure Composite

The technique for bonding amalgam is illustrated on the left. Note that, as with all techniques, the vials are numbered sequentially in order of use. (An identical technique is used for bonding self-cure composite.)

As with the other techniques used with the Scotchbond multi-purpose plus adhesive system, bonding amalgam begins with a 15-second etch of enamel and dentin. The etchant is rinsed and dried using a brief, gentle air stream. It is recommended that tooth structure be left slightly moist after rinsing.

A single coat of Scotchbond multi-purpose plus activator is applied and dried. No waiting time is required before drying. As with all drying steps, a short exposure to a gentle air stream is recommended.

Next, a single coat of Scotchbond multi-purpose primer is applied and dried.

As a last step, one drop of Scotchbond multi-purpose plus catalyst and adhesive are mixed. Triturate amalgam at this time. A single coat of this resin mixture is applied to the tooth, and the amalgam is condensed.

Application time estimates for several amalgam bonding products are given in Figure 19. As illustrated, the Scotchbond multi-purpose plus adhesive system is quite time-efficient.

In our investigations, different bond values are obtained from different amalgam alloys. Tytin™ amalgam (Kerr), for example, typically yields higher bond values than does Dispersalloy™ amalgam (Caulk). Furthermore, differences in microleakage and removal force have been documented for different alloys (Mahler and Nelson 1994). In this report, bond studies were conducted with both Tytin and Dispersalloy amalgams.

Bovine teeth were potted in methacrylate and ground to expose enamel or dentin. The adhesive in question was applied to the exposed tooth surface. Teflon molds were clamped to the tooth and amalgam condensed into the 5 mm hole in the mold. Debonding was accomplished using an Instron machine after 24 hours in water at 37 °C.
Microleakage was evaluated using Tytin amalgam. Class V restorations were prepared in extracted human molars. Ten samples were prepared for each adhesive. After placing bonded amalgams, samples were thermal cycled for 700 cycles, 30 seconds each, between 5°C and 55°C. The restorations were then polished. Apices were sealed with luting cement and nail varnish, and the teeth were stained in 2% basic fuchsin for 24 hours. Figure 22 is a photomicrograph that illustrates an amalgam bonded with the Scotchbond multi-purpose plus adhesive system. Minimal staining is evident. Contrast Figure 22 with Figure 23, which illustrates leakage (L) at the dentinal margin associated with Copal varnish (Fundingsland, 3M).

After staining, teeth were sectioned and photographed. Because of the wide variation in the extent of dye penetration in the control (Copal varnish) group, the standard method of leakage measurement via optical microscopy did not yield realistic results. Instead, samples were rated as to the presence or absence of tubular dye penetration. The fraction of samples displaying this penetration is illustrated in Figure 24 (Fundingsland, 3M). All of the adhesive systems displayed significantly less leakage than the Copal varnish control. Differences between adhesives were not, however, significant.
**Tooth Strengthening**

The ability of the amalgam bonding procedure to strengthen and reinforce tooth structure was evaluated by placing large MOD restorations in extracted human molars and then subjecting these restorations to 8 different loads between 15 lb to 50 lb force applied via a steel sphere contacting the cusps. Deflection of buccal and lingual cusps was measured using strain gauges. In order to minimize the effect of the individual teeth on the results, all bonding systems were evaluated on each tooth. After one measurement was completed, the restoration was removed with a bur and a new restoration was placed. Deflection measurements were also made of the prepared tooth after each removal. In order to compensate for the gradual changes to the preparation and to compensate for differences between teeth, effectiveness was determined by calculating the ratio of the strain of the bonded amalgam to the strain of the MOD preparation. Five teeth were evaluated for each series of products. (Ario/Halvorson, 3M. Conducted at the Minnesota Dental Research Center for Biomaterials and Biomechanics.)

Test results are illustrated in Figures 25 and 26. Lower ratios indicate reduced deflection under load when compared to the MOD preparation itself. Bonded amalgams appeared to be able to reinforce the tooth structure. A bonded composite restoration was included for comparative purposes.
Self-cure or dual-cure composites can be bonded using the same technique as used to bond amalgams. Excellent bond strengths are obtained to both enamel and dentinal surfaces. Figures 27 and 28 illustrate the bonds to enamel and dentin, respectively (Ario, 3M). P-10 self-cure composite was applied using the various dental adhesive systems and allowed to cure protected from light. Also included as a control are the bond strengths obtained when the Scotchbond multi-purpose adhesive system was applied, light-cured and then P-10 composite placed and allowed to self-cure.

Figure 27: Bond of Self-Cure Composite to Enamel

Figure 28: Bond of Self-Cure Composite to Dentin
Indirect Bonding Procedures

As with all bonding procedures, bonding an indirect restoration begins with a 15-second etch of enamel and dentin. A single coat of activator is then applied and dried. Next, a single coat of catalyst is applied to the tooth structure and to the indirect restoration. After mixing and applying a self-cure or dual-cure composite luting material to the restoration, it can be seated. If using a dual-cure material, light-curing the margins is recommended to ensure maximum physical properties.

**Note that the catalyst is not mixed with the adhesive for indirect procedures.** This alleviates the potential of the adhesive setting before the restoration has been placed. The catalyst will not set until the restoration is placed and the composite luting material polymerizes. Hence, set time is dictated by the choice of luting material.

Although more involved than the procedures for bonding composite or amalgam, the indirect bonding procedure for the Scotchbond multi-purpose plus adhesive system is as follows:

**Applied to Preparation**
- Apply Scotchbond Etchant to enamel and dentin—wait 15 seconds then rinse. Dry gently for 2 seconds or blot dry. Leave moist.
- Apply Activator to enamel and dentin. Dry gently for 5 seconds.
- Apply Primer to enamel and dentin. Dry gently for 5 seconds.
- Apply Catalyst to enamel and dentin.

**Applied to Restoration**
- Apply Catalyst to the bonding surface of the restoration.
- Mix and apply a self-cure or dual-cure luting material to the bonding surface of the restoration.

Seat the restoration. If a dual-cure cement was used, light-cure the margins. Set time is dictated by the choice of luting material.

Notes:
- This technique can be used to bond inlays, onlays, crowns, and adhesive bridges fabricated of porcelain, metal or composite.
- To facilitate bonding, the bonding surfaces should be treated. Porcelain surfaces are typically HF etched by the dental lab and should be treated with a silane before placement. Metal surfaces benefit from sandblasting and a silane treatment. Composite surfaces can be roughened with a diamond.
- Core buildup materials should be cleaned prior to bonding, and then are treated at the same time as adjacent enamel and dentin.
- Composite luting materials can be accelerated by dual-cure adhesive systems. This effect should be investigated in the office prior to placing indirect restorations.

Notes:
- This technique can be used to bond inlays, onlays, crowns, and adhesive bridges fabricated of porcelain, metal or composite.
- To facilitate bonding, the bonding surfaces should be treated. Porcelain surfaces are typically HF etched by the dental lab and should be treated with a silane before placement. Metal surfaces benefit from sandblasting and a silane treatment. Composite surfaces can be roughened with a diamond.
- Core buildup materials should be cleaned prior to bonding, and then are treated at the same time as adjacent enamel and dentin.
- Composite luting materials can be accelerated by dual-cure adhesive systems. This effect should be investigated in the office prior to placing indirect restorations.
still as time efficient as possible. Figure 29 illustrates estimated application times for several products used to bond indirect restorations.

**Figure 29: Estimated Application Times for Bonding Indirect Restorations**

![Figure 29: Estimated Application Times for Bonding Indirect Restorations](image)

*Bond Strength Summary*  When used in conjunction with one of the indirect procedures outlined in the product instructions, the Scotchbond multi-purpose plus adhesive system is capable of bonding a wide variety of materials not only to tooth structure but to other non-vital surfaces. Table 4 (Ario, 3M) illustrates this ability. For reference, the performance of the All-Bond 2 adhesive system has been included for bonds to enamel and dentin. *Note: In all cases the 3M Opal luting composite was used in conjunction with the Scotchbond multi-purpose plus adhesive system.*

When bonding inlays, onlays, and crowns, the oral bonding surfaces may consist of enamel or dentin, glass ionomer liners, and core buildups of amalgam, glass ionomer, composite, or cast metal. The bond strength of the Scotchbond multi-purpose plus adhesive system has been measured for a very wide variety of interfacial combinations, as indicated in the table. For example, the bond of porcelain to glass ionomer is relevant to bonding a porcelain crown to a glass ionomer core. The bond strength of metal to amalgam is relevant to bonding a PFM crown to an amalgam core.

Furthermore, in certain situations it might be desired to rebond porcelain facings to a bridge. Bonding porcelain or metal orthodontic brackets to crowns is another potential situation where two non-vital surfaces need to be bonded. The predicted bonds of these non-vital surfaces to each other are included in Table 4.

*Scotchbond Ceramic Primer*  When bonding porcelain surfaces, the use of Scotchbond ceramic primer is recommended. Scotchbond ceramic primer proved to be excellent in its ability to prime porcelain surfaces (Diaz-Arnold et al. 1989). This silane is also, however, recommended for treating the surfaces of metals. Figure 30 (Ario, 3M) illustrates the effect of Scotchbond ceramic primer used during the procedure of bonding metal to enamel. Anagnostopoulos et al. (1993) also suggested that silanes can aid in bonding to Ni-Cr alloys.

**Figure 30: Effect of Scotchbond Ceramic Primer on the Bond of Metal to Enamel**

![Figure 30: Effect of Scotchbond Ceramic Primer on the Bond of Metal to Enamel](image)

*Table 4 (Ario, 3M)*

<table>
<thead>
<tr>
<th>Material</th>
<th>Enamel Adhesion (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enamel</td>
<td>20</td>
</tr>
<tr>
<td>Dentin</td>
<td>15</td>
</tr>
<tr>
<td>Glass Ionomer</td>
<td>30</td>
</tr>
<tr>
<td>Composite</td>
<td>25</td>
</tr>
<tr>
<td>Cast Metal</td>
<td>10</td>
</tr>
<tr>
<td>Amalgam</td>
<td>20</td>
</tr>
<tr>
<td>Glass Ionomer</td>
<td>25</td>
</tr>
<tr>
<td>Composite</td>
<td>15</td>
</tr>
<tr>
<td>Cast Metal</td>
<td>10</td>
</tr>
<tr>
<td>Amalgam</td>
<td>20</td>
</tr>
</tbody>
</table>
## Table 4: Indirect (Self-Cure) Bond Strengths of the Scotchbond Multi-Purpose Plus Dental Adhesive System

<table>
<thead>
<tr>
<th>Bond to Enamel</th>
<th>Porcelain</th>
<th>SBMP PLUS</th>
<th>Mean (MPa) ± SD</th>
<th>A2</th>
<th>Mean (MPa) ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Metal (Non-Precious)</td>
<td>25.8 ± 6.9</td>
<td>26.8 ± 5.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Metal (Semi-Precious)</td>
<td>14.1 ± 2.3</td>
<td>22.4 ± 6.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Metal (Precious)</td>
<td>21.4 ± 3.5</td>
<td>22.6 ± 5.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Precured Composite</td>
<td>26.0 ± 7.5</td>
<td>22.4 ± 3.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bond to Dentin</th>
<th>Porcelain</th>
<th>SBMP PLUS</th>
<th>Mean (MPa) ± SD</th>
<th>A2</th>
<th>Mean (MPa) ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Metal (Non-Precious)</td>
<td>14.6 ± 5.5</td>
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<td></td>
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<tr>
<td></td>
<td>Metal (Semi-Precious)</td>
<td>14.0 ± 2.0</td>
<td>18.3 ± 2.5</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Metal (Precious)</td>
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<tr>
<td></td>
<td>Precured Composite</td>
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<table>
<thead>
<tr>
<th>Bond to Light-Cure Glass Ionomer Core</th>
<th>Porcelain</th>
<th>SBMP PLUS</th>
<th>Mean (MPa) ± SD</th>
<th>A2</th>
<th>Mean (MPa) ± SD</th>
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</thead>
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<tr>
<td></td>
<td>Metal (Non-Precious)</td>
<td>18.9 ± 3.9</td>
<td>18.3 ± 3.0</td>
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<tr>
<td></td>
<td>Metal (Semi-Precious)</td>
<td>18.3 ± 3.0</td>
<td>19.2 ± 3.8</td>
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<tr>
<td></td>
<td>Metal (Precious)</td>
<td>19.2 ± 3.8</td>
<td>18.9 ± 3.0</td>
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<tr>
<td></td>
<td>Precured Composite</td>
<td>10.4 ± 3.3</td>
<td>10.4 ± 3.3</td>
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<tr>
<th>Bond to Amalgam Core</th>
<th>Porcelain</th>
<th>SBMP PLUS</th>
<th>Mean (MPa) ± SD</th>
<th>A2</th>
<th>Mean (MPa) ± SD</th>
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<tr>
<td></td>
<td>Metal (Non-Precious)</td>
<td>19.1 ± 5.3</td>
<td>16.9 ± 5.2</td>
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<td>Metal (Semi-Precious)</td>
<td>16.9 ± 5.2</td>
<td>13.3 ± 3.7</td>
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<tr>
<td></td>
<td>Metal (Precious)</td>
<td>13.3 ± 3.7</td>
<td>12.1 ± 3.7</td>
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<td></td>
<td>Precured Composite</td>
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<td>12.1 ± 3.7</td>
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<thead>
<tr>
<th>Bond to Composite Core</th>
<th>Porcelain</th>
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<th>Mean (MPa) ± SD</th>
<th>A2</th>
<th>Mean (MPa) ± SD</th>
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<td>Metal (Non-Precious)</td>
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<td>Metal (Semi-Precious)</td>
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<td>Metal (Precious)</td>
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<tr>
<td></td>
<td>Precured Composite</td>
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<td>15.5 ± 2.9</td>
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<tr>
<th>Bond to Porcelain</th>
<th>Porcelain</th>
<th>SBMP PLUS</th>
<th>Mean (MPa) ± SD</th>
<th>A2</th>
<th>Mean (MPa) ± SD</th>
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</thead>
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<td>Metal (Semi-Precious)</td>
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<tr>
<td></td>
<td>Metal (Precious)</td>
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<table>
<thead>
<tr>
<th>Bond to Non-Precious Metal</th>
<th>Porcelain</th>
<th>SBMP PLUS</th>
<th>Mean (MPa) ± SD</th>
<th>A2</th>
<th>Mean (MPa) ± SD</th>
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</thead>
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<td></td>
<td>Metal (Non-Precious)</td>
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<td>Metal (Semi-Precious)</td>
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<td>27.5 ± 2.7</td>
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<tr>
<td></td>
<td>Metal (Precious)</td>
<td>27.5 ± 2.7</td>
<td>15.9 ± 3.0</td>
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<td>Precured Composite</td>
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<thead>
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<th>Bond to Semi-Precious Metal</th>
<th>Porcelain</th>
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<th>A2</th>
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<td></td>
<td>Precured Composite</td>
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<th>Mean (MPa) ± SD</th>
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<td>Metal (Non-Precious)</td>
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<td></td>
<td>Metal (Precious)</td>
<td>12.3 ± 2.9</td>
<td>12.3 ± 2.9</td>
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<td>Precured Composite</td>
<td>12.3 ± 2.9</td>
<td>12.3 ± 2.9</td>
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</tr>
</tbody>
</table>


**Bond of Metal to Enamel and Dentin**

A direct comparison of three systems designed for luting metal to tooth structure was made. Prefabricated metal cylinders were luted to polished enamel and dentin. Bond values were measured after 24 hours in water at 37 °C. Test results are presented in Figures 32 and 33. The systems evaluated displayed the ability to bond to both enamel and dentin (Ario, 3M).

**Figure 32: Bond of Metal to Enamel**

![Graph showing bond strength](image)

**Figure 33: Bond of Metal to Dentin**

![Graph showing bond strength](image)

**Microleakage**

Figure 34: Indirect Composite Restoration

Since indirect bonding procedures do not have to contend with the bulk polymerization shrinkage present with direct composite placements, it is reasonable to expect less force on the margins resulting in less chance for gaps and less microleakage. In a microleakage comparison of direct composite placement and indirect composite inlays, this indeed proved true. Figure 34 illustrates the excellent seal of one of the composite inlays. Little or no leakage is evident at either enamel or dentinal margins. Test results are summarized by Figure 35 (Fundingsland, 3M). None of the samples displayed leakage at the enamel margin. Although the microleakage resistance of the Scotchbond multi-purpose adhesive system is excellent, indirect procedures can offer even more protection from microleakage.

**Figure 35: Microleakage of Direct and Indirect Composite Restorations Bonded Using the Scotchbond Multi-Purpose Plus Adhesive System**

![Graph showing microleakage](image)
The ability to bond endodontic posts is another attribute of the Scotchbond multipurpose plus adhesive system. To evaluate this attribute, stainless steel parallel sided endodontic posts were bonded into extracted human incisors using a variety of adhesives. Again, 3M Opal luting composite was used. After 24 hours in water at 37 °C, the extraction force of the posts was measured.

Extraction forces are illustrated in Figure 36 (Fundingsland, 3M). The excellent bonds of the Scotchbond multi-purpose plus adhesive system to metals and to dentin are evident.

This concludes the technical discussion of the Scotchbond multi-purpose plus adhesive system. This product combines the ability to bond direct light-cure applications using a very effective and time efficient protocol. With the addition of activator and catalyst components to the Scotchbond multi-purpose adhesive system, the product becomes a dual-cure system capable of bonding amalgam and a wide array of indirect bonding procedures.
Questions and Answers

How does the Scotchbond multi-purpose plus adhesive system differ from the Scotchbond multi-purpose adhesive system?
The Scotchbond multi-purpose plus adhesive system is composed of the Scotchbond multi-purpose adhesive system plus the activator and catalyst components required for bonding amalgam and for indirect applications. A ceramic primer is also included.

The Scotchbond multi-purpose adhesive system is designed for light-cure applications only. When you add the activator, catalyst and Scotchbond ceramic primer to the Scotchbond multi-purpose adhesive system you have the Scotchbond multi-purpose plus system. Note that for light-cure applications both systems are used in the same way.

Are the catalyst and base components of the Scotchbond multi-purpose plus system compatible with my Scotchbond multi-purpose adhesive system?
In order to obtain dual-cure functionality with the Scotchbond multi-purpose plus adhesive system, an additional amine (initiator component) was added to the Scotchbond multi-purpose adhesive. This adhesive is in both the current Scotchbond multi-purpose and the current Scotchbond multi-purpose plus adhesive kits. The catalyst, however, is not compatible with the older Scotchbond multi-purpose adhesive. To aid in recognition, the new adhesive vial will be gray instead of black. The catalyst is compatible with Scotchbond multi-purpose adhesive in gray bottles.

What is the set time when used for bonding amalgam or self-cure composite? . . . when bonding indirect restorations?
When bonding amalgam, catalyst and adhesive resins are mixed. The room temperature set time of this mixture is approximately 3-5 minutes. At oral temperature this changes to approximately 2-3 minutes.

When bonding indirect restorations, only the catalyst is used. Set time is dictated by the choice of composite luting material.

Can the Scotchbond multi-purpose plus adhesive system accelerate my luting composite?
Yes, components of the Scotchbond multi-purpose plus system can accelerate the set of luting composites. This is the reason that it is recommended that the luting composite be placed on the restoration rather than on the preparation.

Why do you use place only the catalyst resin on the tooth when bonding indirect restorations?
This is a situation similar to that just discussed pertaining to the luting material. If the catalyst and resin were mixed and placed on the prepared tooth, one runs the risk of having the mixed resin polymerize while the indirect restoration is being prepared for seating. The catalyst alone, however, will not set until it comes in contact with the mixed composite luting material.

Do you recommend light-curing exposed margins after placing an indirect restoration?
Yes. Whenever using a dual-cure luting material, it is recommended that exposed margins be light-cured to yield the best possible physical properties to the luting material.
How can I prevent the adhesive from bonding to the metal matrix band during bonded amalgam procedures?
We recommend rubbing the matrix band with hard wax to prevent inadvertent bonding. Other lubricating agents may also be used.

What is the shelf life of the kit?
The shelf life of the kit is 3 years at room temperature.

Can Activator and Primer be dried simultaneously?
We recommend separate, brief drying times for each of these applications as indicated in the instructions. The test results in this profile are based on this application technique.

What comes in the kit?
The contents of a Scotchbond multi-purpose plus dental adhesive kit are listed below:

<table>
<thead>
<tr>
<th>KIT CONTENTS</th>
<th>Qty</th>
<th>Item No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7545S Kit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scotchbond™ Etchant; Phosphoric Acid; (3 ml Syringe)</td>
<td>2 @ 3 ml</td>
<td>7523</td>
</tr>
<tr>
<td>Scotchbond Multi-Purpose Primer</td>
<td>8 ml</td>
<td>7542</td>
</tr>
<tr>
<td>Scotchbond Multi-Purpose Adhesive</td>
<td>8 ml</td>
<td>7543</td>
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<tr>
<td>Scotchbond Multi-Purpose Plus Activator</td>
<td>4 ml</td>
<td>7546</td>
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<tr>
<td>Scotchbond Multi-Purpose Plus Catalyst</td>
<td>4 ml</td>
<td>7547</td>
</tr>
<tr>
<td>Scotchbond Ceramic Primer</td>
<td>5 ml</td>
<td>2721</td>
</tr>
<tr>
<td>Instructions for Use</td>
<td>1 ea</td>
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<tr>
<td>Technique Guides</td>
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<tr>
<td>Brush Handles</td>
<td>3</td>
<td>1919</td>
</tr>
<tr>
<td>Brush Tips</td>
<td>60</td>
<td>1919B</td>
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<tr>
<td>Syringe Tips</td>
<td>50</td>
<td>7523T</td>
</tr>
<tr>
<td>3-Well Mixing Tray</td>
<td>1</td>
<td>7544</td>
</tr>
</tbody>
</table>
References Cited


Instructions for Use

Scotchbond™ Multi-Purpose Dental Adhesive Plus Instructions:

General information:
The Scotchbond multi-purpose plus system is a versatile system for bonding all classes of direct composite restorations as well as for indirect procedures involving metal, porcelain, or composite crowns, inlays, and onlays. The Scotchbond multi-purpose plus system also bonds amalgam and self-cure composite and can be used to bond orthodontic brackets to crowns.

Bonding light-cure composite requires only the Scotchbond multi-purpose etchant, primer and adhesive components (1,2,3). This system is recommended for all classes of restorations. Direct composite placement involves etching, priming, and application of a light-cure adhesive. When bonding light-cure composite to porcelain or alloys, Scotchbond ceramic primer is used instead of the Scotchbond multi-purpose primer.

The addition of Scotchbond multi-purpose plus activator (1.5) and Scotchbond multi-purpose plus catalyst (3.5) extends the applications to include indirect bonding procedures and bonding amalgam and self-cure composite. For indirect bonding procedures, oral surfaces are prepared and etched. Scotchbond multi-purpose plus activator is applied and dried. Next, Scotchbond multi-purpose primer is applied and dried. Lastly, Scotchbond multi-purpose plus catalyst is applied. Using only the catalyst rather than a mixture of adhesive and catalyst ensures that the adhesive will not be setting while the indirect restoration is being prepared and placed. The indirect restorative is surface treated as appropriate for the material chosen, followed by application of the Scotchbond multi-purpose plus catalyst and the dual-cure or self-cure luting material. Set time is dictated by the choice of composite luting material. Note: Adhesive systems such as the Scotchbond multi-purpose plus system can accelerate the cure of composite luting materials, reducing the net working time. If a dual-cure luting material is used, it is recommended that the margins be light-cured to yield the highest physical properties to the luting material.

Bonding amalgam or self-cure composite begins with an etch of enamel and dentin. Scotchbond multi-purpose plus activator is then applied, followed with an application of Scotchbond multi-purpose primer. Scotchbond multi-purpose adhesive and catalyst are mixed and applied, and the restorative material is placed. In this case adhesive and catalyst are mixed because no luting cement is present.

Recommendations:
Use Vitrebond™ light-cure glass ionomer liner/base in areas of deep cavity excavation such as Class I and II restorations. If a pulp exposure has occurred, use a minimum amount of calcium hydroxide followed by an application of Vitrebond liner/base. Scotchbond multi-purpose adhesive will bond to Vitrebond light-cure glass ionomer liner/base whether or not the ionomer was treated with etchant and primer. If a temporary material was used on the Vitrebond glass ionomer liner/base, an alcohol wipe is required after removal of the temporary cement.

The Scotchbond multi-purpose system includes an etch of enamel and dentin as part of the procedure. It is recommended that the surfaces be left moist after the rinse. Excess surface moisture can be removed with a brief exposure to an air syringe or by blotting.
The Scotchbond multi-purpose primer is applied after the etching step, and can be dried immediately without agitation or waiting time. Do not rinse off the primer. The primed surface should appear shiny. With gentle drying this will occur with only one application of the primer.

Light curing time assumes the use of a 3M light curing unit or other dental visible light curing unit of comparable intensity.

Air used for drying the various components should be free of oil and water contaminants.

Components:
Scotchbond etchant etches the enamel and removes the dentinal smear layer. Either Scotchbond 10% maleic acid etchant or 35% phosphoric acid etchant can be used. Use of an etchant is critical on both enamel and dentinal surfaces. If etched surfaces are contaminated it is recommended that the surfaces be re-etched and rinsed.

Scotchbond multi-purpose plus activator is needed only for self-cure or dual-cure applications such as bonding amalgam or indirect restorations. The activator reacts with the primer to facilitate curing.

Scotchbond multi-purpose primer facilitates the wetting of the adhesive onto the prepared tooth structure. Use on dentinal surfaces is mandatory for optimum adhesion.

Scotchbond multi-purpose adhesive is the light-cure component of the system. It bonds to etched enamel and to dentin when conditioned using the etchant and primer. It will not self cure without the addition of Scotchbond multi-purpose plus catalyst.

Scotchbond multi-purpose plus catalyst, when combined with Scotchbond multi-purpose adhesive, results in a dual-cure resin suitable for bonding amalgam and self-cure composite. The catalyst is also used alone in indirect bonding applications.

Precautions for dental personnel and patients:
Scotchbond etching gel contains 35 weight % phosphoric acid. Protective eyewear for patients and dental staff is recommended when using etchants. Avoid contact with oral soft tissue, eyes and skin. If accidental contact occurs, flush immediately with large amounts of water. For eye contact, also contact a physician.

Scotchbond multi-purpose plus activator and Scotchbond ceramic primer contain ethanol. Activator and ceramic primer may cause eye irritation upon contact. Avoid contact with eyes.

Scotchbond multi-purpose primer contains HEMA (2-hydroxyethylmethacrylate). Scotchbond multi-purpose adhesive and Scotchbond multi-purpose plus catalyst contain HEMA and BIS-GMA. HEMA is a known contact allergen. A small percentage of the population is known to have an allergic response to acrylate resins. To reduce the risk of allergic response, minimize exposure to these materials. In particular, exposure to uncured resin should be avoided. Use of protective gloves and a no-touch technique is recommended. If primer, adhesive or catalyst contacts skin, wash immediately with soap and water. Acrylates may penetrate commonly used gloves. If primer, adhesive or catalyst contacts
glove, remove and discard glove, wash hands immediately with soap and water and then reglove. Primer, adhesive and catalyst may cause eye irritation upon contact. Avoid contact with eyes. If accidental contact occurs, flush immediately with large amounts of water. If irritation persists, consult a physician.

Sensitivity:
Some patients may experience transitory postoperative sensitivity. The risk of sensitivity can be minimized by the following measures: Remove minimal tooth structure. Use proper isolation. Use of a rubber dam is highly recommended. Use adequate pulp protection. Use a glass ionomer cavity liner/base in areas of deep excavation. Place restorative material in increments, curing each increment separately. Adequately cure restorative according to instructions for shade and thickness of restorative and light exposure time. Adjust occlusion carefully. Check for hyperocclusion, particularly in lateral excursion contacts.

Etchant syringe assembly:
1. Protective eyewear for patients and dental staff is recommended when using the delivery system.

2. Prepare delivery system: Remove cap from etching gel syringe and SAVE. Twist a blue disposable tip securely onto the syringe. Holding the tip away from the patient and any dental staff, express a small amount of etching gel onto a dispensing pad or a 2 x 2 gauze to assure that the delivery system is not clogged. If clogged, remove the dispensing tip and express a small amount of etching gel directly from the syringe. Remove any visible plug, if present, from the syringe opening. Replace dispensing tip and again express etching gel. If clog remains, discard dispensing tip and replace with a new one.

   Bend the dispensing tip to a desired angle. Place bend midway along tip. Do not bend dispensing tip at its hub. The small chamfered hole in the three-well tray was designed for bending syringe tips.

3. Delivery system storage: Remove used dispensing tip and discard. Twist on storage cap. Storage of the delivery syringe with a used dispensing tip or without the storage cap will allow drying of the etching gel and consequent clogging of the system. Replace storage cap with a new dispensing tip at next use.

4. If desired, the etching gel may be extruded onto a dispensing pad and applied with a brush or other appropriate instrument.

5. If a liquid etchant is desired, the etching gel may be dispensed into a dappen dish and stirred to increase its fluidity.

6. Disinfection: Discard used dispensing tip. Replace syringe storage cap. Disinfect the capped syringe in the same manner as nonimmersible handpieces, air/water syringe and ultrasonic scalers following American Dental Association (ADA) and Centers for Disease Control (CDC) recommendations. (Council on Dental Materials, Instruments and Equipment and Council on Dental Therapeutics. Infection control recommendations for the dental office and the dental laboratory. JADA 116(2):241-248, 1988.)
Instructions for direct light-cure restorations in enamel and dentin:
1. Isolation: Rubber dam is the preferred method of isolation.


3. Etching: Apply Scotchbond etchant (phosphoric or maleic) to enamel and dentin. Wait 15 seconds. Rinse for 15 seconds. Dry for 2 seconds.

4. Priming: Apply Scotchbond multi-purpose primer to etched enamel and dentin. Dry gently for 5 seconds.

5. Adhesive application: Apply Scotchbond multi-purpose adhesive to the primed enamel and dentin.


7. Restorative placement, cure and finishing: Refer to manufacturer’s instructions for placement, cure and finishing of restorative material.

Instructions for direct light-cure restoration of noncarious cervical lesions:
To restore noncarious cervical lesions, clean the lesion and adjacent enamel with a plain pumice/water slurry. Do not use prophylaxis pastes containing oils. Remove excess surface moisture with a brief exposure to an air syringe or by blotting. Leave dentin moist.

Follow the procedural steps 1 though 7 above limiting step #2 to beveling enamel adjacent to the erosion.

Instructions for direct light-cure restorations in enamel only:
In all-enamel preparations, use of the primer is not required. Application of the primer will neither adversely affect nor significantly enhance the bond of the adhesive to etched enamel surfaces. For restorations in enamel only, follow the procedural steps above omitting step #4.

Instructions for bonding amalgam or self-cure composite to tooth structure and existing amalgam or composite.
1. Isolation: Rubber dam is the preferred method of isolation.

2. Cavity preparation: Prepare a standard amalgam preparation. If previous amalgam or composite has not been totally removed, roughen the residual restorative with a sandblast technique or a bur.


4. Matrix application: Lightly rub the internal surface of the matrix band with wax before placement.

5. Activation: Apply Scotchbond multi-purpose plus activator to all etched surfaces. Dry the activator with a gentle air stream for 5 seconds. Do not rinse off the activator.

6. Priming: Apply Scotchbond multi-purpose primer to activated surfaces. Dry the primer with a gentle air stream for 5 seconds. Do not rinse off the primer.
7. Adhesive application: Mix one drop each of Scotchbond multi-purpose adhesive and catalyst. Triturate amalgam. Apply the mixed adhesive to the primed surfaces.

8. Condense and burnish the amalgam or place the self-cure composite in the usual way.

Instructions for bonding porcelain veneers:
1. Silane Treatment: Porcelain bonding surfaces should have been etched with hydrofluoric acid by the dental laboratory. Apply Scotchbond ceramic primer to the bonding surface of the restoration. Dry for 5 seconds.

2. Clean the prepared teeth in preparation for seating and bonding using a plain flour of pumice slurry. Rinse and dry thoroughly and isolate from moisture.

3. Etching: Apply Scotchbond etchant (phosphoric or maleic) to both enamel and dentin. Wait 15 seconds. Rinse for 15 seconds. Dry for 2 seconds. The etched enamel should display a “frosty white” appearance. An additional 15 second etch time may be appropriate for teeth that were not prepared using a diamond or bur. Residual organic matter can also require additional etch time.

4. Priming: Apply Scotchbond multi-purpose primer to etched enamel and dentin. Dry gently for 5 seconds.

5. Adhesive application to the tooth: Apply Scotchbond multi-purpose adhesive to the primed enamel and dentin. Do not light-cure.

6. Adhesive application to veneer: Apply Scotchbond multi-purpose adhesive to the silane treated bonding surface of the veneer.

7. Luting material application to veneer: Apply luting material to the bonding surface of the veneer.

8. Seating and curing: Carefully seat the veneer. Clean excess luting materials from the veneer margins. Cure each area of the veneer for times recommended by the luting cement manufacturer. We recommend curing the gingival margin first, followed by the body and the incisal margin. Avoid direct contact with the light-guide during initial curing.

Instructions for bonding inlays, onlays, crowns and Maryland (adhesive) bridges:
1. Prepare the bonding surface of the indirect restoration and the core buildup, if applicable. Porcelain bonding surfaces should have been etched with hydrofluoric acid by the dental laboratory. Metal and amalgam bonding surfaces should be roughened, preferably using a sandblast technique. Composite surfaces also benefit from roughening with a diamond. Light-cure glass ionomer buildups should be pumiced.

2. Silane Treatment: Apply Scotchbond ceramic primer to the bonding surface of the indirect restoration. Dry for 5 seconds.

3. Clean the prepared teeth in preparation for seating and bonding using a plain flour of pumice slurry. Rinse and dry thoroughly and isolate from moisture.

4. Etching: Apply Scotchbond etchant (phosphoric or maleic) to enamel,
dentin, and the core material. Wait 15 seconds. Rinse for 15 seconds. Dry for 2 seconds.

5. Activation: Apply Scotchbond multi-purpose plus activator to etched enamel, dentin and core material. Dry the activator with a gentle air stream for 5 seconds. Do not rinse off the activator.

6. Priming: Apply Scotchbond multi-purpose primer to activated enamel, dentin and core material. Dry gently for 5 seconds.

7. Catalyst application to the tooth: Apply Scotchbond multi-purpose plus catalyst to the primed enamel, dentin and core material.

8. Catalyst application to the indirect restoration: Apply Scotchbond multi-purpose plus catalyst to the treated bonding surface of the indirect restoration.

9. Apply dual-cure or self-cure luting material to the bonding surface of the restoration.

10. Seat the restoration. Remove excess paste from the margins. If using a dual-cure luting material, light curing the margins is recommended to ensure maximum physical properties. Set time is dictated by the choice of luting material.

**Instructions for bonding cast and prefabricated endodontic posts:**

1. Prepare the endodontically treated tooth to receive the post. Trial fit and adjust the post as needed.

2. Etching: Apply Scotchbond etchant (phosphoric or maleic) to the prepared tooth. Wait 15 seconds. Rinse for 15 seconds. Dry for 2 seconds. Use a paper point to remove any excess water in the canal.

3. Activation: Apply Scotchbond multi-purpose plus activator to the canal using a paper point. Dry for 5 seconds.

4. Priming: Apply Scotchbond multi-purpose primer to the canal using a paper point. Dry for 5 seconds.

5. Catalyst: Apply Scotchbond multi-purpose plus catalyst using a paper point.

6. Post Preparation: Apply a coating of Scotchbond multi-purpose plus catalyst to the post. Mix and apply the luting agent to the post.

7. Seat the post. If a dual-cure cement was used, cure from the occlusal surface to allow immediate preparation of the post. Set time is dictated by the choice of luting material. Core material can now be bonded to post and tooth structure.

**Bonding porcelain and metal orthodontic brackets to porcelain, metal and composite crowns:**

Porcelain or metal orthodontic brackets may be bonded to crowns using the Scotchbond multi-purpose system. Bonding to silane treated porcelain can result in very high bonds, and debonding may remove areas of porcelain from a porcelain fused to metal crown. In this event the crown surface can be repaired using the porcelain repair procedure.
1. Prepare the bonding surface of the orthodontic bracket. Apply Scotchbond ceramic primer to the bonding surface of the bracket. Dry for 5 seconds.

2. Clean the crown in preparation for seating and bonding using a plain flour of pumice slurry. Rinse and dry thoroughly and isolate from moisture.

3. Etching: Apply Scotchbond etchant (phosphoric or maleic) to the prepared surface of the crown. Wait 15 seconds. Rinse for 15 seconds. Dry for 2 seconds.

4. Silane priming: Apply Scotchbond ceramic primer to the prepared surface and dry.

5. Activation: Apply Scotchbond multi-purpose plus activator to the etched surface of the crown. Dry the activator with a gentle air stream for 5 seconds. Do not rinse off the activator.

6. Priming: Apply Scotchbond multi-purpose primer to etched surface of the crown. Dry gently for 5 seconds.

7. Catalyst application to the crown: Apply Scotchbond multi-purpose plus catalyst to the primed surface of the crown.

8. Catalyst application to the orthodontic bracket: Apply Scotchbond multi-purpose plus catalyst to the bonding surface of the bracket.

9. Apply dual-cure or self-cure luting material to the bonding surface of the orthodontic bracket.

10. Seat the orthodontic bracket. Remove excess paste from the margins. If using a dual-cure luting material, light-cure the margins to ensure maximum physical properties. Set time is dictated by the choice of luting material.

**Instructions for porcelain repair using light-cure composite:**

1. Clean the surface to be repaired with a slurry of plain flour of pumice. Rinse and dry thoroughly and isolate from moisture.

2. Porcelain preparation: Use a diamond to remove all weakened porcelain and roughen the surfaces to be bonded. Bevel the margin and remove 1 mm of surface glaze beyond the margin.

3. Metal preparation: Roughen areas of exposed metal with diamond or sandblast technique.

4. Surface treatment: Cleanse the metal and porcelain surfaces by applying Scotchbond etchant (phosphoric or maleic) for 15 seconds, followed by rinsing and drying.

5. Silane priming: Apply Scotchbond ceramic primer to the prepared surface and dry.


8. Restorative placement, cure and finishing: Refer to manufacturer’s instructions for placement, cure and finishing of restorative material.

For porcelain repair using self-cure composite:
Follow steps 1-5. Apply Scotchbond multi-purpose plus activator and dry for 5 seconds. Apply Scotchbond multi-purpose primer and dry for 5 seconds. Apply a 1:1 mixed solution of adhesive and catalyst. Place self-cure composite.

Instructions for composite repair using light-cure composite:
1. Clean the composite surface and tooth structure using a plain flour of pumice slurry. Rinse and dry thoroughly and isolate from moisture. Note: if bonding only to composite, pumice the composite, apply primer and adhesive as indicated below (etching is not necessary in this case).
2. Roughen composite surfaces with bur or diamond.
3. Etching: Apply Scotchbond etchant (phosphoric or maleic) to both enamel, dentin and composite. Wait 15 seconds. Rinse for 15 seconds. Dry for 2 seconds.
4. Priming: Apply Scotchbond multi-purpose primer to etched enamel, dentin and composite. Dry gently for 5 seconds.
5. Adhesive application: Apply Scotchbond multi-purpose adhesive to the primed tooth structure and composite.
7. Restorative placement, cure and finishing: Refer to manufacturer’s instructions for placement, cure and finishing of restorative material.

For composite repair using self-cure composite:
Follow steps 1-3. Apply Scotchbond multi-purpose plus activator and dry for 5 seconds. Apply Scotchbond multi-purpose primer and dry. Apply a 1:1 mixed solution of adhesive and catalyst. Place self-cure composite.

Instructions for bonding porcelain or metal to existing porcelain, metal or composite:
1. Prepare the new bonding surfaces. Porcelain bonding surfaces should have been etched with hydrofluoric acid by the dental laboratory. Metal and amalgam bonding surfaces should be roughened, preferably using a sandblast technique. Composite surfaces also benefit from roughening. Apply Scotchbond ceramic primer to the new bonding surfaces and dry. The surface will appear dull.
2. Clean the existing oral bonding surfaces in preparation for seating and bonding using a plain flour of pumice slurry. Rinse and dry thoroughly and isolate from moisture.
3. Etching: Apply Scotchbond etchant (phosphoric or maleic) to existing oral bonding surfaces. Wait 15 seconds. Rinse for 15 seconds. Dry for 2 seconds.
4. Apply Scotchbond ceramic primer to the oral bonding surfaces. Dry for 5 seconds.
5. Activation: Apply Scotchbond multi-purpose plus activator to existing oral bonding surfaces. Dry the activator with a gentle air stream for 5 seconds. Do not rinse off the activator.


7. Catalyst: Apply Scotchbond multi-purpose plus catalyst to the primed existing oral bonding surfaces.

8. Catalyst application to the indirect restoration: Apply Scotchbond multi-purpose plus catalyst to the bonding surface of the indirect restoration.

9. Apply dual-cure or self-cure luting material to the bonding surface of the restoration.

10. Seat the restoration. Remove excess paste from the margins. If using a dual-cure luting material, light-cure the margins. Set time is dictated by the choice of luting material.

Instructions for bonding light-cure composite to set amalgam:
1. Prepare tooth as desired.

2. Roughen the set amalgam surface using a sandblast technique. The remaining steps duplicate the use of Scotchbond multi-purpose system for direct composite placement.

3. Etching: Apply Scotchbond etchant (phosphoric or maleic) to both enamel, dentin and set amalgam. Wait 15 seconds. Rinse for 15 seconds. Dry for 2 seconds.

4. Priming: Apply Scotchbond multi-purpose primer to etched enamel, dentin and set amalgam. Dry gently for 5 seconds.

5. Adhesive application: Apply Scotchbond multi-purpose adhesive to the primed tooth structure and amalgam.


8. Restorative placement, cure and finishing: Refer to manufacturer’s instructions for placement cure and finishing of restorative material.

Additional notes:
1. Brush handles and mixing wells can be disinfected in the same manner as nonimmersible handpieces, air/water syringe and ultrasonic scalers following American Dental Association (ADA) and Center for Disease Control (CDC) recommendations. (Council on Dental Materials, Instruments and Equipment and Council on Dental Therapeutics. Infection control recommendations for the dental office and the dental laboratory. JADA 116(2):241-248, 1988.)

Storage and use:
1. The Scotchbond multi-purpose adhesive system can be stored at room temperature.

2. Scotchbond multi-purpose plus activator and Scotchbond ceramic primer are ethanol solutions and should be recapped immediately after dispensing to reduce evaporation.
3. Do not expose materials to elevated temperature or intense light.
4. Do not store materials in proximity to eugenol-containing products.
5. This system is designed to be used at room temperature of approximately 21-24 °C or 70-75 °F.
6. Shelf life at room temperature is 36 months. See outer package for expiry date.
7. For cleanup, Scotchbond multi-purpose etchant and primer can be removed with water, while the activator, uncured adhesive and catalyst can be removed with alcohol.

Warranty:
3M will replace product that is proved to be defective. 3M does not accept liability for any loss or damage, direct or consequential, arising out of the use of or the inability to use these products. Before using, the user shall determine the suitability of the product for its intended use and user assumes all risk and liability whatsoever in connection therewith.