Dentin Bonding
* Regardless of the type dentinal adhesive used, the primary mechanism for adhesion is still establishment of the hybrid layer. As seen below in the elegant TEM from Dr. Bart Van Meerbeek, the hybrid layer is a resin-reinforced layer that “connects” the underlying intertubular dentin to the adhesive resin (Fig. 1).

Figure 1

* For traditional dentin bonding techniques (etch-prime-bond) that require “wet bonding,” the dentin must not be dehydrated at the time of primer application, or bond strengths will be compromised.

Rewetting/Desensitization
* Probably the best way to desensitize the tooth when using a total-etch adhesive is to use Gluma Desensitizer, or one of the new Gluma-like materials (see examples listed below), as a rewetting agent. As seen in Fig. 2 below, the Gluma is placed after acid etching, but before placing the resin primer. The Gluma disinfects, seals the dentinal tubules, and also enhances bond strengths, because it is a very effective cross-linking agent. It may also reduce MMP activity. Gluma Desensitizer is particularly effective as a rewetting agent according to research reports (Li et al. JDR 2000; 79:509, Abstr # 2928), and results in profound concomitant desensitization. G5 by Clinician’s Choice, Calmit by Caulk or Microprime G from Danville are great, inexpensive Gluma substitutes for re-wetting that also afford great desensitization.

Figure 2
Bonding Systems
*Currently, four basic types of dentinal adhesives exist: Two total-etch (multi-bottle systems & one-bottle) and two self-etch systems (two-step and all-in-ones). The steps involved in each system are seen below in Figure 3.

Multi-Bottle Systems
* Classic multi-bottle adhesive systems such as and All Bond 2 (BISCO), OptiBond FL (Kerr), and Scotchbond MP Plus (3M ESPE), are still the “gold standards” in adhesive dentistry (Figure 4). Their clinical performance has been validated with clinical trials that reveal superior results when compared to virtually all subsequent adhesive systems. Newer versions of some of these materials have since been re-introduced, some in unidosed versions. Many are also now radiopaque.

One Bottle Systems/Primer Types
* Two primary primer types are used in DBA’s today: ethanol and acetone.
* Examples of ethanol-based one bottle DBAs include Adper Single Bond (3M ESPE), OptiBond Solo Plus (Kerr), and Excite (Vivadent). See Figure 5-A.

* Examples of acetone-based one bottle DBAs include One Step Plus (Bisco), Prime and Bond NT (Caulk), and Gluma Comfort Bond (Heraeus Kulzer). See Figure 5-B.
* For most one-bottle systems, the bond strengths are not as high as for their multi-bottle precursor. However, the differences are not thought to be clinically significant for most products.
**Self Etching Primers**

* Self-etching primers simultaneously condition (etch) and prime the dentin (and enamel?).

* Two primary types of self-etching primers exist:
  - Two-step, self-etch adhesives, where an acidic self-etch primer is used instead of phosphoric acid to etch the enamel and dentin, followed by the application of the adhesive.
  - One-step "all-in-one" adhesives where etching, priming and bonding occur simultaneously through application of the self-etch primer.

Examples of two-step self-etch materials include Clearfil SE Bond (Kuraray), Tyrian (Bisco), Adhese SE (Vivadent). Examples of "all-in-one" self-etching primers include Adper Prompt L-Pop (3M-ESPE), Xeno IV (Caulk), i-Bond ( Heraeus Kulzer), S3 Bond (Kuraray) and Optibond All-in-One (Kerr). Most other manufacturers are following suit with their own versions. (See Figures 6-A & B).

![Figure 6-A](image1.png)

![Figure 6-B](image2.png)

**Advantages of Self-Etching Primers:**

- Simple to use. Don't underestimate this quality. These are virtually "idiot proof."
- Eliminates variables associated with “wet bonding” (eg. how wet is wet? Etc.)
- Depth of etch is self-limiting.
- Sensitivity is reduced, even with incomplete coverage (smear plugs still intact in areas not covered).

**Disadvantages of Self-Etching Primers:**

- Bond strengths to enamel are typically lower than for total-etch adhesives.
- Clinical performance not yet time proven; bond durability questionable, especially for all-in-one types (hydrolysis?).

NOTE: The most important bond for clinical success is the enamel bond; problem is most self-etch materials do not offer great enamel bonds, especially to uncut enamel. If you elect to use a self-etch material, a “selective etch” of enamel with phosphoric acid is not a bad idea. However, total-etch systems used with a Gluma-type desensitizer are still best.
Good News! New Promising SE Systems are Being Introduced.

Fortunately, new very promising SE systems are being introduced that address the concerns regarding bonds to enamel and durability. 3M ESPE’s Universal Bond, Apex Dental’s Surpass, and Kerr’s Optibond XTR are all very promising. Of particular note is the high bond strength exhibited by Optibond XTR to enamel (Swift et al., 2011). This material in particular is surprisingly effective based on studies to date. But as with all new materials, clinical validation is ultimately needed.

Compatibility with Self-Cured Composites

* As noted above for self-etching adhesives, categorically light-cured adhesives of any type that are inherently acidic are not very compatible with self-cured composites (Swift, et al. J Prosthodont 1998; 7:256-260 and Sanares et al. Dent Mater 2001; 17:542-556). For that reason, some adhesives offer dual-cured versions that consist of the adhesive and a self-cure activator that affords the resulting adhesive some compatibility with self-cured composites (core materials, etc.). BISCO’s One Step Plus is one of the notable exceptions to this rule, since it is effectively neutral in pH and is compatible with both light and self-cured resin materials.

Stress Breaking Liners/Tooth Flexure

* Stress breaking liners are filled bonding agents or GIC liners that provide a thicker adhesive layer that can help resist polymerization or flexural stresses.

* Examples of stress breaking liners include: OptiBond Solo Plus (Kerr), Clearfil Liner Bond 2V (Kuraray), Vitrebond Plus (3M ESPE), and Fuji Bond LC (GC).

* Do teeth really flex? Yes, numerous studies have documented that teeth flex under centric and eccentric loading. For the restoration of Class V lesions, a material with a lower elastic modulus (eg. microfilled resins) that allows for better flexural qualities may perform better long-term in patients that exhibit evidence of stressful occlusion or parafunction. Elastic materials may better accommodate tooth biodynamics.

* Some more fluid flowable composites have favorable elastic qualities and the ability to “wet” tooth surfaces well. They, too, can be used as very effective stress breaking liners. However, if using flowable composites under packable posterior composites, KEEP THEM THIN (less than 0.5 mm thickness). Flowable composites exhibit as much as 2-3x the polymerization shrinkage of hybrids, higher CTE’s, and higher water sorption than hybrid composites.

* Based on clinical trials, it is clear that Class V retention failures are highest among patients exhibiting stressful occlusion (wear facets, history of bruxism, etc.) or who have highly sclerotic root surfaces.

* In “high risk” patients, Class V preparations should include additional retention form from placement of a gingival retention groove prepared with a No. ¼ round bur.

Lower durability when bonding to dentin compared with enamel:

* Despite improvements in dentin bonding agents, bonding to enamel is still far more predictable and durable long-term. When given the option (veneer preps, for example), always opt for preparations in enamel.


**Less predictable when bonding to caries affected or sclerotic dentin:**


**Great Sources for Objective, Unbiased Dental Information:**

**Dental Evaluation and Consultation Service or CES** (formerly the USAF Dental Investigation Service) See website: [https://decs.nhgl.med.navy.mil](https://decs.nhgl.med.navy.mil)

**Journal of Esthetic and Restorative Dentistry**
- Peer reviewed journal that is searchable on-line; included in Index Medicus; has impact factor.
- Features clinical, review and research papers on adhesive, esthetic and restorative dentistry with high quality color illustrations.
- Includes regular features such as "Contemporary Issues," "Critical Appraisal" that all include "Bottom Line," evidence-based information on products and techniques.


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**DISCLOSURE**
Dr. Heymann has no financial interest in any of the companies whose products are mentioned in this handout, but is a past consultant for Procter and Gamble and Colgate, and is a past scientific advisor for Clinician’s Choice Dental Co. and his son is an employee of Sybron Kerr. Dr. Heymann is the paid Editor-in-Chief of the Journal of Esthetic and Restorative Dentistry noted above.
Tooth Preparation


Preparation Design:

* Facial reduction is approximately 0.5-0.75 mm mid-facially, terminating at the gingival margin with a heavy chamfer and a reduction depth of 0.3-0.5mm (Figure 1). Incisal reduction is typically 1.0-1.5 mm.
* Facial reduction is best achieved using a series of three horizontal "hemi-preps" so that reduction depths can be seen in cross-section.
* An incisal lapping preparation is most frequently used (see Figure 1 below).

* If interproximal tooth contact is present, the margins of the preparation are positioned just facial to the contact area to maintain an optimal contact relationship (Figure 2).
* Interproximal contacts are not stripped or eliminated with this preparation design.
* Gingival margins are maintained at the level of the crest of the gingival tissue if the discoloration or defects extend into the gingival one-third of the tooth. If the gingival one-third is free from defects, the gingival margin can be placed supra-gingival for optimal tissue health.
Impression
* If gingival embrasures are wide open, block them out from the lingual to prevent interlocking of the impression material facio-lingually and tearing of the impression.
* Leave small diameter retraction cords in place. Carefully remove from impression if they are attached.

Temporization
* Most often, no temporaries are needed with intra-enamel preps.
* If temporaries are needed, they can best be made using a clear polyvinyl impression material (Clearly Affinity from Clinician’s Choice is super) for pre-op matrix and a bis-acryl temporary material attached by spot etching small area of prep. A complete veneer temporization kit is also available from Clinician’s Choice.

Veneer Fabrication
* Incrementally built veneers from feldspathic porcelain are still recommended because of their phenomenal esthetic qualities, and their ability to be effectively etched with hydrofluoric acid, however, newer pressed ceramics such as eMax show significant promise. Note, however, that pressed ceramics generally require special etchants; hydrofluoric acid generally does not work well with pressed ceramic materials.

Try-In and Cementation
* Try in veneers to assess marginal fit and relationship to one another mesially and distally. Minor adjustment to proximal margins can be made atraumatically with a coarse Soflex Disc (3M ESPE).
* To assess shade, try in a central incisor veneer wetted to tooth surface with water. Select value of veneer cement based on try-in with water. I use translucent shade of veneer cement 95% of the time unless dark staining of tooth exists.
* After try-in, dry veneer thoroughly before proceeding with bonding. Apply silane to tooth side of veneer.
* Turn down operatory light prior to bonding. Bond the two central incisor veneers first. Apply resin bonding agent to etched veneer and etched enamel surfaces, and load veneer with uniform thickness of veneer bonding cement. Seat veneer prior to light curing any of the resin components. Use a light-cured resin cement, NOT a dual-cured resin cement. Light-cured resin cements are far more color-stable over time.

Finishing and Polishing
* Use a #12 blade (not 12-B!) in a Bard-Parker surgical handle to remove most of the marginal excess of cured cement. Be sure to use a good finger rest!
* Using a diamond instrument (flame for facial, oval for lingual), “dress” any marginal areas of the veneer where overhangs, bulbous areas or rough spots
**Finishing and Polishing (continued)**

exist. Margins should be smooth and confluent with surrounding tooth contours. Adjust the occlusion with an oval diamond instrument.

* Use a 30-fluted carbide finishing bur to smooth any areas dressed with the diamond to plane the porcelain surfaces and to remove any residual striations produced by the diamond.
* Use porcelain polishing cups and points (Dialite system from Brasseler USA is great) to polish any areas that have been adjusted.
* Caution: patient must avoid hard foods or objects to prevent chipping of veneers. A processed acrylic biteguard is often recommended as well to help protect veneers.

**Recommended Instruments and Materials**

* **Tooth preparation**: Brasseler USA #856 016 diamond is recommended for the veneer preparation.

* **Retraction cord**: Size O, Ultra-Pak by Ultradent.

* **Veneer temporaries**: Clearly Affinity by Clinician’s Choice with bis-acryl temp material.

* **Veneer Bonding Cements**
  - Rely-X Veneer Cement by 3M ESPE
  - Nexxus by Kerr
  - Calibra by Caulk Dentsply
  - Ensure by Cosmedent

* **Veneer finishing and polishing**:
  - Soflex Discs by 3M ESPE (coarse) for proximal adjustment prior to cementation if needed.
  - Fine diamonds by Brasseler USA for dressing margins: flame- #8862 for facial areas; oval- #7379 for lingual areas; ultra-thin flame- 8889 for interproximal areas and incisal embrasures.
  - 30-fluted finishing bur (#H133UF- Brasseler USA or #9803- Midwest division of Kerr) to plane surfaces contoured by diamond prior to diamond polishing.
  - Dialite Porcelain Polishing points and cups by Brasseler USA for final polishing.

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Brasseler USA  
TEL: (800) 841-4522

Caulk Dentsply  
TEL: (800) 532-2885 Ext. 794

Clinician’s Choice Dental Products  
TEL: (519) 641 3066

Cosmedent  
TEL: (800) 621-6729

Kerr Corporation  
TEL: (734) 946-7800

3M ESPE  
TEL.: (800) 634-2249

Ultradent Products, Inc.  
TEL: (801) 553-4178

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