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The New Bulk-Fill Composites: What are they and where should they be used?

Gordon’s Clinical Observations: It is well known that inadequate light curing of restorative resin is one of the major challenges in restorative dentistry. Often manufacturers are overly optimistic about the light curing capabilities of their resins, and the restorative team believes the extravagant claims. How do you best ensure adequate curing of the resin in deep Class II box forms? Would dual-curing resins solve the challenge when light cannot reach the depth of the resin? Are dual-cure resins the answer to polymerization shrinkage stress pulling the resin to the coronal light and opening the cervical margin? *CR has studied this challenge and has initial results in this issue.*

It is well established that conventional light-cured composites are strongest and most durable if placed in 2–3 mm increments. Some practitioners learn to do this efficiently, but others feel it is too time consuming. In an effort to remedy this, manufacturers have reformulated these conventional chemistries and created composites marketed with the ability to place and cure the entire preparation in a single step. They appear to be able to back up their claims, but are there trade-offs? **CR evaluates these products and offers suggestions about where they are best employed—and when they should be avoided.**



Incremental Layering

A “best practice” for composite placement in posterior Class II preparations is as follows:

1. Etch, if preferred for bonding system
2. Two one-minute applications of a HEMA/glutaraldehyde disinfectant/desensitizer
3. Apply preferred bonding agent and light cure
4. Place and light cure initial layer (0.5 to 1 mm) and follow with 2 mm increments thereafter

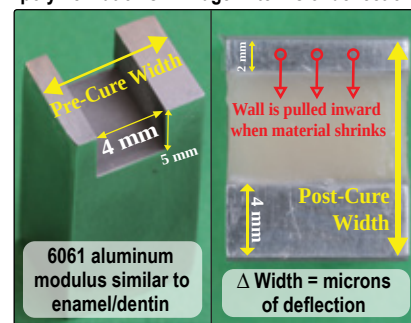
Advantages include greater control of composite at margins and interproximal contacts, improved esthetics, and the ability to sculpt the occlusal layer prior to polymerization (reducing overall finishing time). Cariogenic patients can benefit from glass-ionomer or RMGI layers under the composite (sandwich technique). Challenges can include time-consuming steps, dry field maintenance throughout procedure, and required attention to detail.

Bulk Filling

The placement technique is simplified by filling all or most of the preparation space with a single layer of composite and curing in a single step. Several concepts exist to address the challenges of both placement and polymerization of a large mass of resin.

- **Viscosity:** Flowable resins are more easily syringed into the preparation.
- **Mode of Polymerization:** Because of light attenuation, delivery of light of sufficient intensity at depths greater than 2 mm in conventional composites is challenging. Addition of a chemical mode of polymerization (dual cure) ensures complete polymerization throughout restoration. Use of less filler as well as changes to filler type combat attenuation.
- **Addition of more flexible/stress-relieving resins to reduce polymerization stress:** Many manufacturers have added more flexible monomers to their formulations while companies like 3M have engineered new resins called “Addition Fragmentation Monomers” (AFM) that fracture under stress and heal once relaxed. Stress caused by curing resin was tested with the method shown in Figure 1.

Figure 1: Measuring the effects of polymerization shrinkage in terms of deflection



Aluminum blocks used to simulate polymerization shrinkage stress in 4×5×8 mm MOD. CR would like to offer a special “Thank You” to Keyence Corp. of America for the use of their LM1100 Series Image Dimension Measurement System.

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A Trade-Off in Material Properties

Methacrylate resins shrink when cured in bulk. The ensuing stress leads to marginal failure, sensitivity, and tooth fractures. To combat this, bulk-fill resins are more elastic, but as seen in the table below, this appears to have come at the cost of strength and hardness. (Products are listed in alphabetical order.)

Brand, Manufacturer	Approximate Cost per ml	Cost per Single 4×4×8 mm Restoration*	Curing Mode DC = dual cure; LC = light cure	Shades	Viscosity	Radiopacity % aluminum equivalency; dentin=96; enamel=175	µm of Deformation (2 mm AI) As per manufacturer instructions	µm of Deformation (2 mm AI) CR Method (Figure 2)	Flexural Strength (MPa) Higher is stronger	Flexural Modulus (GPa) Lower is more elastic	Compressive Strength (MPa) Higher is stronger	Depth of Cure †	Material Hardness Higher is harder
Bulk EZ PLUS, Zest Dental Solutions	\$29.43	\$9.67	DC	6	Flowable	328	7.1	6.6	122	6.0	303	4+ mm	40.4 VH
Filtek One Bulk, 3M	\$57.67	\$7.38	LC	5	Packable	274	10	9.7	156	12.2	292	4+ mm	71.2 VH
HyperFIL DC, Parkell	\$11.20	\$3.71	DC	2	Flowable	234	11.4	10.1	150	10.5	323	4+ mm	70.5 VH
Predicta Bioactive Bulk, Parkell	\$25.80	\$8.47	DC	2	Flowable	255	17.7	15.1	124	8.7	296	4+ mm	55.7 VH
SDR Flow Plus Bulkfill, Dentsply Sirona	\$51.63	\$6.61	LC	4	Flowable	206	13	11.2	133	8.1	239	4+ mm	43.4 VH
Control: Filtek Supreme Ultra, 3M	\$80.55	\$10.31	LC	36	Packable	256	18.2	16.0	160	10.4	344	4+ mm	88.6 VH

* Includes mixing tip waste.

† Recommended minimum intensity of 1000 mW/cm² for manufacturer recommended curing time.

4+ mm measurements were generated under ideal conditions in vitro.

Deciphering the Data: The Most Pressing Concerns

1. Do bulk-fill composites exert less shrinkage stress?

YES. Bulk-fill materials tested were successful in achieving lower shrinkage stress as shown by lower amounts of deformation, at least to some degree. Some, like BulkEZ PLUS (Zest Dental Solutions) and Filtek One Bulk (3M), showed a 50% reduction (or more) in deflection. However, studies have shown restoratives with low moduli of elasticity and flexural strength have elevated correlation with tooth fracture, sensitivity, and increased rates of wear.

2. Do bulk-fill materials fully polymerize at depths?

YES. All materials tested, regardless of curing mode (LC or DC), sustained consistent Vickers hardness values at depths of at least 4 mm. However, overall hardness and maximum hardness values were significantly lower* with bulk-fill composites (DC materials being the lowest).

*Exceptions: Filtek One Bulk (3M) and HyperFIL DC Bulk (Parkell)—although still lower than the control, significantly higher than all others in the class.

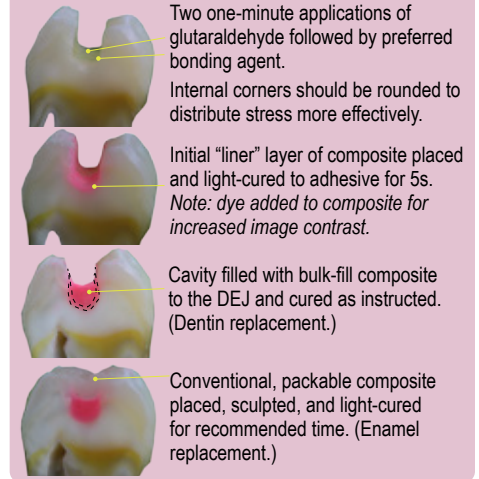
3. Does the use of “bulk-fill” materials cut chair time?

YES. Overall chair time to place and cure bulk-fill materials is slightly lower than with a layering placement. However, occlusal and interproximal surfaces are challenging to sculpt before polymerization, making final finishing more difficult and time consuming.

4. Are there concerns with dual-cure resins?

Chemically initiated systems will not likely adhere to photo-initiated adhesive systems without the addition of a catalyst primer in either the adhesive or the composite. Products with a built-in chemical initiator include Scotchbond Universal Plus (3M) adhesive and BulkEZ Plus (Zest Dental Solutions) dual-cure composite.

Figure 2: CR suggested bulk-fill placement method



Clinical Tips

A popular hybrid technique (as illustrated in Figure 2, page 2) uses *bulk-fill* composite as dentin replacement material with a layer of packable conventional composite as enamel replacement. Benefits include:

- Placement of thin “liner” layer followed by short light exposure ensures thorough cross-linking between light-cure adhesive and composite
- Reduction of “C-Factor” and improved shrinkage stress distribution
- Reduction in layering/curing time while ability to sculpt occlusal “cap” saves on finishing time
- Material properties of conventional composite more suited for occlusal forces and improved wear profile



The New Bulk-Fill Composites: What are they and where should they be used? *(Continued)*

CR CONCLUSIONS:

- CR suggests practitioners consider staying with their conventional materials and techniques. If the new bulk-fill products are used, CR suggests using the hybrid approach outlined and incorporating glass ionomer or RMGI in deeper preps for high caries risk patients.
- The new bulk-fill/dual-cure technologies are encouraging. However, manufacturers' efforts to reduce polymerization shrinkage stress and increase light transmission have come at the cost of flexural and compressive strengths and stiffness—which increases the risk of tooth flexure/fracture, possibly more postoperative sensitivity, and higher wear.
- Occlusal adjustments, finishing and polishing, and achieving proper contacts are more difficult and more time-consuming when using a flowable bulk-fill composite when compared to conventional composite formulations.
- Anterior applications for bulk fill are minimal; this is primarily a material for posterior restorations.

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