The Keys to… Successful, Predictable, and Efficient Direct Posterior Composite Restorations

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The Challenge of Direct Class II Composite Restorations

- What are we trying to achieve with Direct Restorative Dentistry?
- Immediate results → Long term success
- Symptom FREE patients
- Maximizing natural tooth structure
- Achieving the best DENTIN substitute
- Achieving the best ENAMEL substitute

Composite Composition

- Resin matrix
- Filler package
- Coupling Agent
- Pigments/ UV absorbers
- Inhibitors
- Photoinitiators
- Polymerization mechanism

THEN	&	NOW
Filler particles quite large, not silanated → particles to break out, ditching, increased wear.	**Filler Particle Size**	**Silanated micro-, micro-hybrid, nano particles** → allows chemical adhesion, decreased wear, increased polishability.
Cured in quantities of 2mm or less → lengthy technique-sensitive process	**Incremental Curing**	**Bulk cured up to 5mm** → eliminating need for incremental curing
Volumetric shrinkage of 7% was common → Various placement techniques to minimize effects of leakage and debonding	**Polymer shrinkage**	**Much lower polymerization shrinkage**
Few shades and lack of translucency	**Shades**	**More shade options varying in translucency and opacity**
Much less filled → Decreased wear resistance, increased shrinkage upon curing	**Flowable Composites**	**Much more highly filled** → Used not only as bases but also universally in most restorative applications.

How long should posterior composites last?

In a recent study… [J Adhes Dent. 2012 Aug;14(5):407-31.]

- Meta-analysis (59 studies, >5000 restorations)
- Overall success rate was approximately 90% after 10 years
- The main reasons for failure were
  - Fracture
  - Caries adjacent to the restoration

Longevity of composites

Biggest factor influencing longevity of composites is whether you change dentists!

- When patients changed dentists they had a 40% replacement rate after 7 years
- When patients didn't change dentists they had a 7% replacement rate after 7 years

Replacement

- 5-7 years: caries (location of the caries was not noted)
- 10+ years: fracture-related

Repair vs. Replace?

- >50% of the procedures dentists perform are replacement of defective restorations
- 90% of schools in US, Canada, Scandinavia, UK, Ireland, and Germany teach repair techniques as a part of restorative curriculum
- Replacement is the most expensive and destructive option!

Repair vs. Replace?

- MONITOR – minor shortcomings, stain, small crack or sub-optimal margin
- REFURBISHMENT – adjusting without adding, recontour or remove stains or overhangs
- REPAIR – adding of new material with/without additional preparation
- REPLACE – complete removal

In Today's Dental Landscape……

- The most common direct composite procedure in dentistry is posterior amalgam replacement
- The average posterior composite lasts 6 years (?)
  - Estimated annual failure rate of Class I and Class II posterior composites is 1-3%
- Cavity forms for many amalgam replacements and large carious lesions prove too time consuming to fill with vertical incremental layering
- What does the future look like?
  - "Bulk Fill" placement increment
  - Simplified shading
  - Fast polishing
  - Stain resistance

Direct Composites

- Esthetically pleasing to most patients, therefore patient acceptance is high!
- Recent advances in wear resistance and strength have proven composites to be an acceptable alternative to amalgam
- Cohesive bonding may reduce potential of fractures compared to amalgam????
- More conservative preparations are indicated

Conservative Composite Preparations

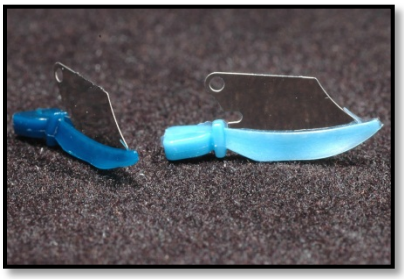
- No "Extension for Prevention"
- No extension into the "Self-Cleansing" area unless dictated by decay or unsupported enamel
- Do not, without reason, destroy centric contacts

DENTSPLY Caulk Class II Solution

Focusing on current trends and developing solutions to make the clinician more efficient and more profitable while elevating the standard of care

What are the Challenges facing the Dentist for a Class 2?

- Isolation from the "hostile environment"
- Abrading the adjacent tooth during preparation
- Getting the band into place
- Sealing the gingival margin with the matrix band
- Sealing the line angles in the box
- Creating the ideal hybrid layer
- Proper light curing
- Achieving an "ideal contact"
- Adaptation of the material within the box
- Proper finishing and polishing



Palodent Plus WedgeGuard

Palodent Plus Matrices

Palodent Plus Pin Tweezers

Palodent Plus Wedges

Adhesives

Role of Adhesives in Daily Practice

- Direct bonding of composite restorations
- All cavity classifications with varying substrate
- Bonding of crowns using resin based cements
    - Traditional Resin (Calibra, Multilink, Nexus NX3)
    - Self-Adhesive (SmartCem2, Rely-X Unicem, Maxcem Elite)
- Application of post and core materials
    - Light accessible vs. dark curing (SCA)

Adhesives Market Data

$100 Million market
Market is split almost evenly between TE and SE
In 2012, adhesive category is +2.9% according to latest data

- Total etch +0.3%
- Self etch -4.8%
- Universal +172.6%

New category of Universal Bonding Agents started in early 2011 (Optibond XTR → Scotchbond Universal → Prime & Bond Elect)

Adhesive User Information

- 60% of dentists use 2 or more adhesives
- The clinical situation (preparation, substrate and location) are biggest decision driving factors
- 70% of clinicians acknowledge that the remaining substrate after excavating decay will influence the adhesive product used
- Dentists very divided on sensitivity impact of etchants and phosphoric acids
- 74% of clinicians will use phosphoric acid with self-etch products…..expecting to improve clinical results!

If we had to have a rule it would be…… "anterior applications require etching"
"etch enamel whenever you can"

Top Reasons for Post-Operative Sensitivity

- Over-etching dentin
- Over-drying dentin
- Solvents not removed during drying step
- Incomplete material coverage
- Under curing (importance of lights)
- Polymerization shrinkage and stress (SDR)

Evolution of Dental Adhesives

- The earliest "generations" of adhesives tried to chemically stick to it
- 4th and 5th "generation" adhesive systems recommend removing it
- 6th and 7th generation adhesive systems incorporate it into the bond
- 8th generation – the dentist now decides!

What is a "Smear Layer"

- Freshly cut surface of dentin created by rotary instruments
- Generally 1 – 5 microns thick, but extends into tubules in the form of amorphous "plugs"
- Smear layer components
    - Hydroxyapatite crystals
    - Partially denatured collagen
- Weakly attached to dentin surface (2-6 mPa's)
- Is partly porous, but dramatically reduces fluid flow from the underlying dentin tubules

The Evolution of Dental Adhesives – Continued…

The first dental resins were methyl methacrylates

- 10% polymerization shrinkage
- 90% changes from thermal cycling
- No adhesion to tooth → percolation

➢ 1949: Sevitron Cavity Seal (first adhesive system)

- used glycerophosphoric acid dimethacrylate and sulphinic acid as the catalyst and was capable of bonding acrylic resin to a tooth cavity

1St Generation: Use of a bifunctional molecule to bond dentin to restorative material

- Used NPG-GMA (N-phenylglycine and glycidyl methacrylate)
- Very low bond strengths (1-3 mPa)
- Example: Cervident (SS White)

2nd Generation: (late 1970's)

- Used unfilled resins BisGMA and HEMA
- Low bond strengths (4-6 mPa) because bond was to smear layer
- Examples: Scotchbond (3M), Prisma Universal Bond (Dentsply Caulk), Bondite (Kerr)

3rd Generation: (late 1980's)

- 3 parts: conditioner, primer, adhesive
- Acid etching of dentin
- Modified smear layer, increased dentin permeability
- Low concentration of maleic acid or phosphoric acid
- Bond strengths 12-15 mPa
- Clinical failure from marginal staining
- Examples: Scotchbond Multipurpose (3M), XR Bonding System (Kerr), Gluma (Heraeus-Kulzer), Tenure (Den-Mat), Syntac Classic (Ivoclar)

4th Generation Etch and Rinse Systems
- 3 Step-Total Etch
- Examples: ProBond (Dentsply), Scotchbond Multipurpose Plus (3M)

5th Generation Total Etch
- 2 component-Traditional
- Examples: Prime & Bond NT (Dentsply), Optibond Solo Plus (Kerr)

6th Generation- Self Etching
- 2 Bottle System
- Examples: Clearfil SE (Kuraray), Xeno III (Dentsply)

7th Generation Self Etching
- 1 Bottle System
- Examples: Xeno IV (Dentsply), Adper Easy Bond (3M), Optibond All-In-One (Kerr)

Universal Dental Adhesives
- Total or Self Etch Options
- Examples: Prime & Bond Elect (Dentsply), Scotchbond Universal (3M), Optibond XTR (Kerr)

Self-Etching Systems
- Etching, demineralization and infiltration of primers all occur simultaneously
- Smear layer and demineralized hydroxyapatite become incorporated into the bond
- Reaction is self-limiting: The pH of the product is neutralized by dentinal Ca+
  - pH of SEA approximately 2.5
  - pH of phosphoric acid is < 1

Polymerization Stress

Stress vectors created during light cured polymerization
Shrinkage is the process of volumetric contraction upon curing of the composite
Stress is the force that the shrinking composite exerts on the surrounding tooth structure
Stress = Modulus X Shrinkage

*"*shrinkage stresses are transferred to the surrounding tooth structure because the elastic modulus of tooth is far greater than the restorative material*"*

To measure Shrinkage… Composite is cured unconstrained
To measure Stress… Composite is <u>Always</u> bonded

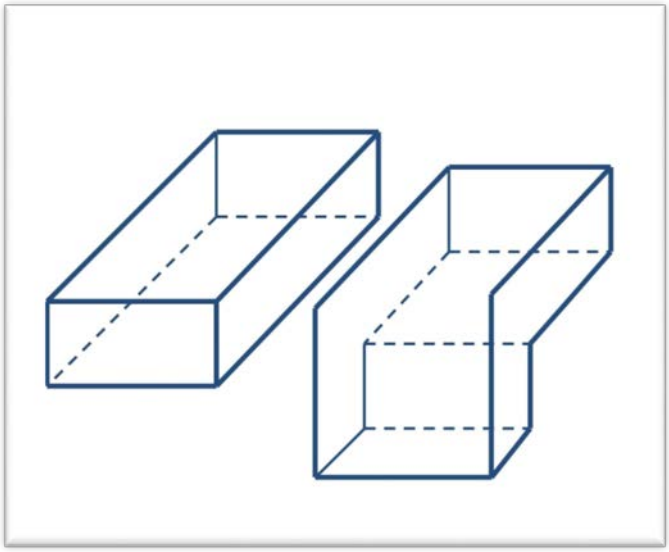
Considerations for Minimizing Contraction Stress, C-Factor

Ratio of bonded to unbounded surfaces. Class I and II are the highest and should be susceptible to microleakage, adhesive de-bonding, recurrent caries, marginal stain, and post-op sensitivity

	Generation	Etch	Application	Light Cure (secs)
ProBOND	4 2-bottle TE	Yes	Generously apply primer to thoroughly wet the exposed dentin without scrubbing the surface. Be sure to keep the tooth surface wet with primer for 30 seconds. Air dry for 5 seconds to remove solvent. Apply a thin layer of adhesive, blow thin.	10
P&B NT	5 1-bottle TE	Yes	Immediately brush on generous amounts of P&B NT adhesive to thoroughly wet the cavity surface. This surface should remain wet for 20 seconds. Remove solvent with a 5-second air drying.	10
XP Bond	5 1-bottle TE	Yes	Wet all the tooth surfaces uniformly. This surface should remain undisturbed for 20 seconds. Remove solvent with a 5-second air drying.	10
Xeno IV	7 1-bottle SE	No	Two 15 second scrubs (Use 20 second scrubs for larger preps). Remove solvent with a 5-second air drying.	10
P&B Elect	8 1-bottle Univ	Yes/No	Agitate for 20 seconds. Remove solvent with a 5-second air drying.	10

Total-Etch vs. Self-Etch vs. Selective-Etch

Preparation	Clinical Example	Recommended Enamel & Dentin Pre-treatment
Mostly enamel – may have small areas of exposed dentin	**-Indirect Veneer Cementation -Small/shallow Direct Restorations**	**Total-Etch; phosphoric acid application to enamel and dentin**
Mostly dentin – with available enamel, especially enamel margins	**-Direct restorations (all cavity classes), -Uninstrumented enamel, - Indirect Inlay/Onlay Cementation**	**Selective-Etch; phosphoric acid application to enamel, incidental dentin contact**
Mostly dentin – little or no enamel	**Indirect full-coverage crown, endodontic post Cementation**	**Self-Etch; No application of phosphoric acid**



SureFil SDR *flow*
SDR = "Stress Decreasing Resin"

- Low-stress resin matrix
- The low stress resin matrix and the moderately filled formulation decrease stress on the bond interface upon curing…
- Even in 4mm increments!
- Can be used for bulk base placement in all posterior cavity forms

MUST be covered with a durable hybrid composite in all stress bearing areas

Importance of Radiopacity (Note: enamel = 2.0 mm Al, dentin = 1.0 mm Al)

	Depth of Cure (mm)	Radiopacity (mm Al)
Surefil SDR Flow (Dentsply Caulk)	4	2.2
Filltek Bulk Fill (3M ESPE)	4	2.18
Venus Bulk Flow (Heraeus – Kulzer)	4	1.5
X-tra Base (Voco)	4	2.2
Sonic-fil (Kerr)	5	1.86
Filtek Supreme Ultra Flow (3m ESPE)	2	1.8
Esthet-X Flow (Dentsply Caulk)	2	1.5
Dyract Flow (Dentsply Caulk)	2	2.0
Revolution Formula 2 (Kerr)	2	1.0
Grandio Flow (Voco)	2	1.0

DENTSLY Caulk Composites

Composite Handling Challenges

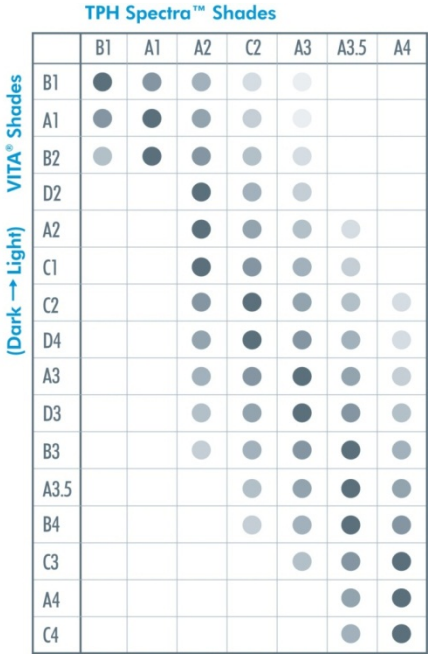
- A sticky material will be difficult to manipulate and leave the doctor feeling like the material is not well adapted to the cavity preparation
- Compensate by wiping instruments with alcohol, dipping in adhesive or lubricant blocks, using titanium or plastic instruments

Composite Handling

What's unique about TPH Spectra?

- A change to the filler package to impact handling-surface treatment of particles and physical agglomeration
- Handling is more sensitive to filler composition than physical properties
- 2% filler variation caused less than 10% change in physical properties (statistically equivalent)
- Ability to modify or "create" a desired handling
- Similar physical properties with significantly different handling characteristics
- Dual viscosities (LV and HV)
- Simplified shading system
- Chameleon effect of material-shade blending
- Excellent stain resistance
- High Polish

Does Handling = Clinical Indication? Is creamy for the anterior and tiff for the posterior?

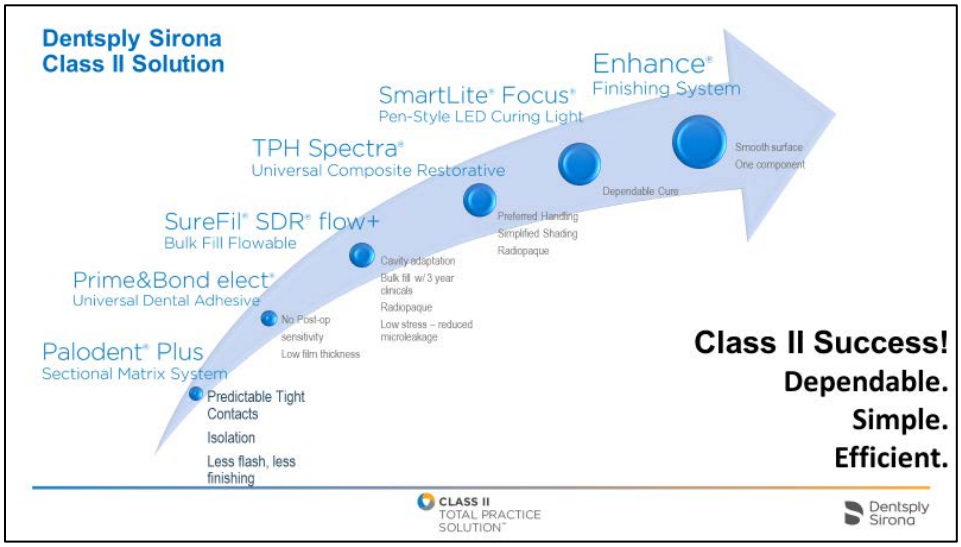


	TPH Spectra	TPH3	Esthet-X
Fracture Toughness ($MPa*m^{1/2}$)	1.69	1.9	1.6
Flexural Strength (mPa) (ISO 4049)	137	145	130
Flexural Modulus (mPa)	9636	8800	8400
Compressive Strength (mPa)	351	392	345
Volumetric Shrinkage (%)	2.6	2.97	2.46
Radiopacity (mm Al) (ISO 4049)	2.1	2.01	1.87
Number of Shades	7 (19)	26	31
Filler Content (% weight / &volume)	LV (75.5 / 54.6) HV (77.2 / 57.0)	75 / 55	77 / 60

To “Take a Shade”

- Remove all extrinsic stain from the tooth
- Tooth should be wet
- Use natural background color (gray or white)
- Compare tooth color to the shade guide using various types of incident light (examination light, room light, sunlight, etc.
- Determine the value (lightness-darkness) first, then hue and saturation
- Glance at the shade tab and tooth only for a brief moment to avoid saturation of your retinal cones
- Have the assistant and/or patient help with shade determination
- Perform the shade determination on several visits (or several times during one visit); record the shade each time
- Record the composite or porcelain shade used for the restoration in the patient’s chart

Remember, get the shape right and you can “miss” the shade match



Conclusions

- Despite frequency of direct composite placement, successful completion of composite resins is tedious and technique sensitive
- Longevity of a direct composite restoration is related to the successful completion of all the steps discussed
    - Preparation, isolation, adhesion, composite placement, finishing, polishing
- Procedural solutions – using materials designed and intended to be used together to generate optimized clinical outcomes