INTRO

• Composites: a physical mixture of any phases - metals, ceramics, or polymers

• Composed of a matrix, filler, additives
HISTORY

• Developed because of the need for esthetic materials
• Early composites were self-cured, and mixed before use.
  • Methylmethacrylate (MMA) based: organic unfilled resins
    • Polymers of methylmethacrylate = PMMA
    • PMMA (polymer, powder) + methylmethacrylate (monomer, liquid) =
      • ACRYLIC! (unfilled resins)
• Disadvantages:
  • Voids
  • Discoloration over time
  • Shrinkage
  • Pulp reactions (exothermic)
  • Lack in strength
HISTORY (CONT.)

- Dr. Bowen, in 1963, discovered treatment of silica glass particles (inorganic filler) with vinyl silane (coupling agent) allows it to bond to bis-GMA (organic monomers of MMA bound by bisphenol-A, an epoxy resin)
- This allowed the development of FILLED resins (organic + inorganic)
- Since its discovery, additives have been included, and ratios have been changed.
- Today, the basic formula is: bis-GMA + silica glass + additives
COMPOSITION

- Filler = silicate glass particles
  - Mechanical reinforcement
  - Enamel-like translucency
  - Allows better wear resistance and polishability
- Matrix: (bis-GMA) monomer + lower viscosity monomers such as (TEGDMA)
  - Allows initial workability, fluidity
  - Polymerization: monomers become polymers
- Additives
  - Lithium and aluminum ions \(\rightarrow\) easier to crush glass to make smaller particles
  - Barium, zinc, boron, zirconium, and yttrium \(\rightarrow\) for radiopacity
  - Camphorquinone \(\rightarrow\) photoinitiator
  - Amines \(\rightarrow\) accelerates polymerization (but increases discoloring over years)
COMPOSITION RATIOS

• Filler volume: typically ~40-85% of total composition
  • More filler = more fracture toughness, less elasticity, less micro cracking
    • But this leads to HIGH VISCOSITY
  • Less diameter = more surface area = even more viscosity

<table>
<thead>
<tr>
<th>Composite type</th>
<th>Filler size (µm)</th>
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<td>Macrofilled</td>
<td>10 – 40</td>
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<td>&lt; 0.01 (10 nm)</td>
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• Monomer volume:
  • More monomer = more fluidity
  • bis-GMA (~70%) is much more viscous than TEGDMA (~30%)
DIRECT RESTORATIVE MATERIALS

- Old: compomers, giomers, resin ionomers, ormocers
- New: glass ionomers, RMGIs, composites

Composites:
- Macrofilled
- Microfilled
- Hybrids
- Microhybrids
- Nanohybrids
MACROFILLS

- First type of composite (1960s)
- Large, hard fillers (10-40 micrometers)
- Rough surface texture
- Good physical and mechanical properties
  - Very high strength
  - Very high stiffness
  - Poor esthetics
  - Poor polish
  - Poor wear resistance
- Applications: core buildups

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MICROFILLS

- 0.01-0.1 micrometers

Properties:
- Good wear resistance
- Long term high polish
- Poor fracture resistance

Applications:
- Class V
- Veneers
HYBRIDS

• Combines positive physical and mechanical properties of macrofills with the smooth surface and esthetic properties of microfill composites
• 15-20 and 0.01-0.05 micrometers
• Superior mechanical properties
• Properties:
  • High tensile strength
  • High stiffness
  • Good polishability
  • Good wear resistance
• Applications: universal

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**NANOFILLED COMPOSITES**

- Large + small + medium + nano sized particles
- Nanofiller = < 10 nanometers
- Properties:
  - Good wear resistance
  - Good strength
  - Good polishability
  - Low shrinkage
- Applications:
  - universal

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SPECIALIZED COMPOSITES

• Flowable composites
  • 40-55% filled
  • Low viscosity
  • Poor wear resistance
  • High shrinkage
  • Used for sealants, small class I restorations, margin repairs, liners, etc.
  • Limitations: bulk fill, or under areas of occlusal load

• Packable composites
  • Highly filled, condensable
  • High viscosity
  • Low shrinkage
  • Fair wear resistance
  • Used for class II restorations, bulk fill
  • Limitations: depth of cure, voids, rough surface texture
SPECIALIZED COMPOSITES (CONT.)

- Core buildups
  - Usually macrofills
  - Usually opaque/radiopaque
  - Usually inexpensive
  - Usually dual cured to overcome light curing limitation

- Wetting resins
  - Lightly filled
  - Oxygen inhibited
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<th>Composite Type</th>
<th>Clinical Indication</th>
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<td>Microfill</td>
<td>Enamel replacement in class III, IV, and V restoration Minimal correction of tooth form and localized discoloration</td>
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<tr>
<td>Hybrid</td>
<td>Posterior resin – based composite restoration Class V restoration Dentin build-up in class III and IV restoration</td>
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<tr>
<td>Microhybrid</td>
<td>Posterior and anterior direct composite restoration Veneer Correction of tooth form and discoloration</td>
</tr>
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<td>Packable</td>
<td>Posterior resin-based composite restoration</td>
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<td>Pit and fissure restoration Liner in class I, II and V restoration (dentin)</td>
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TRENDS

- Reduction in filler size
- More nanofiller
- Self cured → light cured
WHATS NEW?

SUREFIL® SDR® FLOW
POSTERIOR BULK FILL FLOWABLE BASE

THE PROCEDURE.
It’s amazing! Faster, easier procedures with a 4mm fill.

SureFil® SDR® Flow material is a one-of-a-kind breakthrough. It’s a low-stress flowable composite you can bulk fill (4mm) and cure for faster and easier restorations. The pre-measured Compula® Tip allows you to simply dispense and cure, saving up to 40% in placement time.

- Easy placement technique with self-leveling handling eliminates steps before curing and provides excellent cavity adaptation
- Chemically compatible with conventional methacrylate-based adhesives and composites
- Contains fluoride that’s released to the oral environment
- Radiopaque – easily distinguishable on an x-ray

Indications:
- Base in cavity Class I & II direct restorations
- Liner under direct restorative materials – Class II box liner
- Pit & Fissure Sealant
- Conservative Class I restorations
- Filling of defects and undercuts in crown, inlay and onlay preparations (Core Buildup)

“SureFil® SDR® flow performed the best overall among flowables”
**Procedures Time**

**Conventional Procedure**

1. Flowable Liner  
   - Placement Time: 20s  
   - Curing Time: 40s
2. Universal Composite (Increment 1)  
   - Placement Time: 30s  
   - Curing Time: 10s
3. Universal Composite (Increment 2)  
   - Placement Time: 30s  
   - Curing Time: 20s
4. Universal Composite (Increment 3)  
   - Placement Time: 1m 00s  
   - Curing Time: 10s
   **Total**  
   - Placement Time: 3m 30s

**Surefil SDR Flow Procedure**

1. Flowable Base (Universal Shade)  
   - Placement Time: 30s  
   - Curing Time: 20s
2. Universal Composite/Capping Layer  
   - Placement Time: 1m 00s  
   - Curing Time: 10s
   **Total**  
   - Placement Time: 2m 00s
“SonicFill will change the way composites are done forever!
Simplicity and perfection in one step!”

*Dr. Robert Lowe, DDS*

**True Bulk Fill**
Unidose® tip fills up to a 5mm cavity in a single increment that requires no additional high viscosity composite layer.

**Speed**
Unique tip design permits easy, voidless placement in challenging areas. Ultra-efficient curing characteristics ensure optimal, full 5mm depth of cure in 20 seconds*.

**Adaptability**
Sonic activation lowers viscosity to allow for easy adaptation; after placement, the composite quickly returns to a non-slumping, sculptable state.

**Handling**
Creamy, non-sticky handling makes establishing margins and contouring of occlusal anatomy fast and efficient.

**Strength**
Highly-filled composite composition ensures superior strength and outstanding mechanical properties for posterior restorations.
LIGHT CURING

- Limitations to light curing:
  - Composite thickness > 1.5-2mm may be too thick to produce complete curing
  - Filler particles scatter/absorb light in the first 1-2mm
  - Access to light cure interproximal areas is limited
  - Opacacity in composite affects curing depth
    - i.e.: 5mm for A2/A3, 1.5-2mm for darker shades, 1mm for darkest shades
  - Good idea to post cure to ensure thorough polymerization
LED

- Generates a **well-controlled wavelength** with minimal heating
- May have different wavelength outputs
  - Allows for curing of composite with incompatible photoinitiators (absorb different wavelengths)
- Uniform cure

- Most composites cure at ~460-480nm
- Quartz-tungsten-halogen bulbs: ~400-500nm
  - Broad spectrum
  - Bulb can wear out, decreasing intensity
- LED outputs ~450-490nm
  - Narrow spectrum
  - Generally higher intensity
    - Caution with heat with faster curing lights
PROBLEMS WITH COMPOSITES

- Polymerization shrinkage
- C-factor
- Incompatible rates of expansion/contraction
POLYMERIZATION SHRINKAGE

- Decrease in net volume as monomers (PMMA, bis-GMA, TEGDMA) polymerize
  - SHRINKAGE = disruption in marginal integrity
  - effects are related to configuration factor (C-factor)
C- FACTOR

- Ratio of surface area of bonded walls vs unbonded walls
- Dental restorations: 0.1 to 5
- Higher values (>1.5) indicate a more likelihood of high interfacial stresses
TOOTH EXPANSION/CONTRACTION

• Rates of expansion:
  • Tooth: 9-11 ppm/degree
  • Unfilled acrylcs (PMMA): 72 ppm/degree
  • Amalgam: 25 ppm/degree
  • Composites: 28-45 ppm/degree

• Extreme intraoral thermal changes can lead to stresses at the tooth-restoration margin
  • $\rightarrow$ microleakage

• “Slow start” polymerization can help, instead of high intensity curing
CLINICAL CONSIDERATIONS

- Color matching
  - Hydrate tooth before shade match
  - Less filler content = more staining over time
  - Beveling margins can help with color transition
- Anatomic wear
- Marginal integrity
  - Technique sensitive
  - Beveled margins
- Post-op sensitivity
  - Due to expansion/contraction and interaction with tubules
- Biocompatibility
  - Concerns about bisphenol A (from unpolymerized bis-GMA), lacking evidence
- Case selection
  - Large vs narrow tooth preparation
  - Prep design considerations
ISOLATION

- Composites are very technique and moisture sensitive
- Proper isolation is KEY
- BAD = water, saliva, heme, crevicular fluid, vapors
- GOOD = rubber dam, isolite, isodry, kona, cotton rolls, dry angles, four-handed dentistry
- COST: Isolite (~$1700), Isodry (~$800), Kona (~$50), Isolite mouthpieces (~$2.50)
COMPOSITES AT EMCP

- TPH (Dentsply/Caulk): 20 pack = $31
  - Nanohybrid
    - Universal uses
- Esthet-X (Dentsply/Caulk): 20 pack = $37
  - Microhybrid
    - Universal use but good for anteriors
    - High long term polish, lower fracture resistance
- Wave (SDI): 20 pack = $36
  - Flowable, fluoride release nanotechnology
    - Use in pit and fissures, liners, repairs
- Fluorocore (Dentsply/Caulk): 4 tubes = $147
TAKE HOME MESSAGE

The ideal composite

1) High fracture resistance
   - increases with high filler content

2) Handling properties
   - fluidity increases with more monomer (or... more TEGDMA vs bis-GMA)

3) Depth of cure

4) Longevity
   - marginal integrity
   - radiopacity

5) Esthetics
   - TPH vs Esthet-X
A COUPLE RECENT CASES
REFERENCES

• Bowen, RL. “Properties of a silica-reinforced polymer for dental restorations.” JADA, Vol. 66, No. 1, 57-64.


• Anders Lindberg, “Resin Composites: Sandwich restorations and curing techniques.”


• Davidson, Carel L; de Gee, Anton J; Feilzer, Albert J (1984 Dec;63(12):1396-9.), The competition between the composite-dentin bond strength and the polymerization contraction stress., J Dent Res

• Special thanks to UOP clinical faculty, and Kevin Lim, DMD.