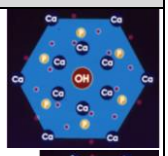
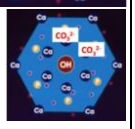
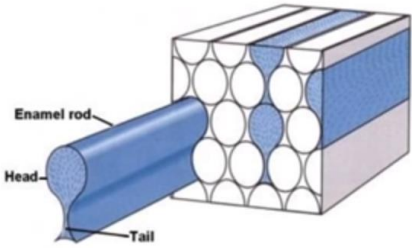
Mental Dental - Operative Dentistry

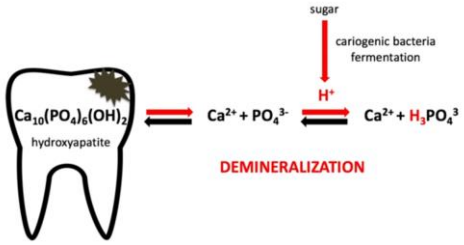
S.M Notes

Dental Caries

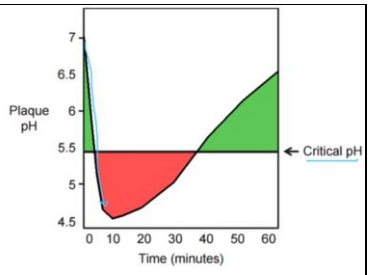
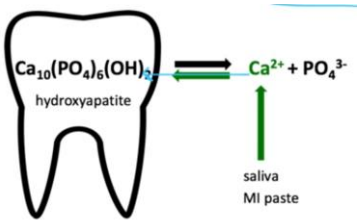
Tooth Structure

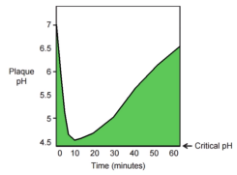
Apatite = Mineral Group	
Hydroxyapatite (HA)	- Hexagonal - White Powder - Low bio-resorption (doesn't quite mimic the inorganic material of our teeth)  *Carbonate Substituted Hydroxyapatite* - Main component of enamel and dentin - Carbonate substitution ↑ Solubility of hydroxyapatite (Easier to decay) - CHA mostly found at DEJ, and on the surface of the tooth it is mostly Fluorapatite - 85% Hydroxyapatite by volume and 95% by weight   - Ameloblasts lay down thes units into long Crystalites -> turn into Enamel Rods  *Enamel Rods*: - Have Head and a Tail -> Tail has less mineral content and is more susceptible to decay

Decay



- There is a balance/equilibrium formed between HA of the tooth structure and Ca^{2+} and PO_4^{3-} in the saliva
- When we incorporate sugar, Cariogenic bacteria in the mouth ferment it and form lactic acid -> This Lactic Acid (H^+) preferentially donates a proton to Phosphate ion to form phosphoric acid.
- Drives the entire reaction to the right (Removes Ca and PO_4 ions out of the tooth) = Decay

Stephan's Curve	= Curve of oral pH charted over time - Normally the mouth sits at a neural pH of 7 - When exposed to cariogenic foods or acidic foods that cariogenic bacteria can ferment -> pH drops to about 4.5 within 10 minutes - ***pH 5.5*** = Critical pH of enamel, below this and we get demineralization - After about 30 minutes the saliva will buffer the pH back to normal -> this time ↓ w/ chewing Xylitol gum or other salivary stimulation and ↑ with Xerostomia   By buffering the acids in the mouth and ↑ the pH we shift the equilibrium to Remineralize the tooth - Fluoridated Toothpaste and water -> Creates Fluorapatite (↑ resistance to acid damage) - Minerals in saliva - MI Paste



Fluorapatite produces a more robust Stephens Curve
- ***Critical pH of FA is 4.5.***
- Need a much stronger acid challenge to drop the pH that low and cause demineralization

Critical pH's to Know	
Enamel (Fluorapatite)	4.5
Enamel (Carbonate Substituted Apatite, Normal)	5.5
Dentin and Cementum	6.2-6.7

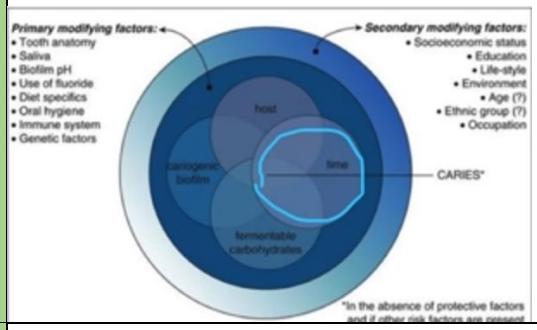
Fluoride Mechanism

Benefits:
- Remineralization (Shift equilibrium to left)
- ↓ enamel solubility (↓ critical pH)
- Interferes with metabolic activity of cariogenic bacteria

Caries

What is it?

= Multifactorial, transmissible infectious dynamic oral disease
- Result of interaction between: ***Biofilm, Diet, Host factors, and Time***



-> Modified Keye's Jordan Diagram

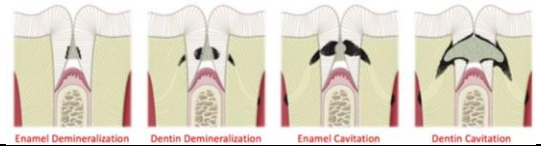
Progression of Lesions

Pit and Fissure Lesions	Inverted V-shape - Starts narrow, and widens as it deepens
Smooth-Surface Lesion	V-Shape - Starts wide and narrows until it reaches DEJ - Spreads wide again at the DEJ
Root Surface	V Shape - Progresses rapidly because there is no Enamel

Infected Dentin
- Superficial, Wet, Soft, Mushy, Necrotic
- Must be removed

Affected Dentin
- Deeper, Dry, Leathery, Demineralized but not invaded by bacteria
- Usually ok to leave this at the base of the prep, especially if close to the pulp

Intact surface is essential for remineralization -> Once cavitated, it is an irreversible process that needs resto
- May take 1-2 years for enamel cavitation to form



Caries Terms	Incipient/Reversible = Smooth surface, appears opaque white when air dried and disappears when wet Cavitated/Irreversible = Enamel surface is broken and lesion has advanced into dentin **Lesions** Simple = Covers 1 surface Compound = 2 surfaces Complex = 3+ surfaces **Location** Primary = Original lesion Secondary/Recurrent = occurs at junction of tooth and restoration (indicative of microleakage) Residual = Caries that remains in a completed tooth prep **Rate** Acute/Rampant = Rapidly damages tooth structure, light-colored, soft, infectious Chronic/Slow = Demineralized tooth structure that is almost remineralized, discolored, fairly hard Arrested = Brown/black, hard, caries resistant if exposed to fluoride (dentin has sclerotic dentin)
Microbiology of Caries	Streptococcus mutans -> Enamel caries - Gram +'ve cocci - Produces **Glucosyltransferase** (GTF) -> converts sucrose to glucans and fructans. Extracellular polysaccharides that help the bacteria to stick to the tooth - **Acidogenic** and **aciduric** -> Coverts sucrose to lactic acid + likes to live in acidic environment - Produces **bacteriocin** -> Kills off competing microbes Lactobacillus -> Dentinal Caries Actinomyces -> Root Caries
Salivary Components	Glycoproteins - Large molecules that agglutinate bacteria together to help eliminate them through swallowing Urea + Bicarbonate - Dilute bacterial by-products to buffer acid Lysozyme - Destroys cell walls Lactoferrin - Actively binds iron which is necessary for bacterial enzymes (inactivates iron) Lactoperoxidase - Inactivates some bacterial enzymes Salivary IgA - Salivary antibody against bacteria Minerals - Ca, PO_4,F to aid in remineralization

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Diagnosis and Treatment Planning

Clinical Exam (Caries Detection)	
Visual Changes	- Keep things very dry -> Incipient lesions are invisible when wet - Hypocalcification does not disappear when wet
Tactile	Place cotton rolls in the vestibules and remove excess saliva with suction - Be VERY careful not to cavitate an incipient lesion with sharp explorer tips - Sharp tips can also catch on small things that are not caries but make you think you have a cavitation Consider using a perio probe which has less chance of making things worse
Radiographs	**Very important** White Spot lesions = Hardly visible on radiograph Enamel cavitation = Evident Dentinal lesion = Clearly evident *Lesions are always smaller radiographically than clinically* - Tooth needs 30-40% mineral loss to be detected radiographically
Transillumination	Shine bright light through contact areas of anterior teeth - Shadows can indicate interproximal caries Also useful in distinguishing craze lines vs cracks - Cracks will prevent a large portion of the tooth from illuminating

Amalgam Exam	- Bluish hue due to corrosion is NOT indicative of defective (corrosion actually helps seal) - Check proximal and marginal overhang - Marginal gaps/ditching >0.5mm = Caries prone and should be redone (<0.5mm is fine because corrosion will help seal) - Check for voids or fracture
Tooth Exam	Erosion - Caused by acidic foods/beverages - Caused by gastric acid - NOT caused by bacteria - *Cupping of occlusion, and restorations standing above the occlusal surface* Abrasion - Loss of tooth structure by mechanical wear Attrition - Occlusal wear from functional contacts w/ opposing natural teeth Abfraction - Loss of tooth structure in cervical areas b/c of tooth flexure Hypersensitivity - Result of exposure of dentinal tubules in root surface - ***Hydrodynamic theory***: Pain results from dentinal fluid movement stimulating mechanoreceptors near the predentin - Causes of fluid movement: Temp Change, Air-drying, osmotic pressure change - **GLUMA** = Desensitizing agent that occludes the dentinal tubules and ↓ sensitivity

Treatment Planning

What the patient needs most is what needs to be done first

1. Urgent Phase
   - Acute infection, Pain, Swelling
2. Control phase
   - Caries, Oral Hygiene change
3. Re-evaluation phase
4. Definitive Phase
   - Ortho, Prosth, Surgery
5. Maintenance Phase

Criteria for Restorations	High Caries Risk - 2+ Active caries - Large numbers of restos - Poor dietary habits - ↓ salivary flow - Poor OHE - Low Fluoride Exposure - Unusual tooth morphology Lesions extending to the DEJ Cavitation
Preventative Dentistry	Encourage remineralization (Incipient smooth surface lesions) - Fluoride use - ↓ high caries risk factors Fissure sealants for deep pits and fissures

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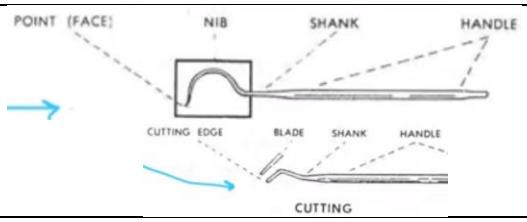
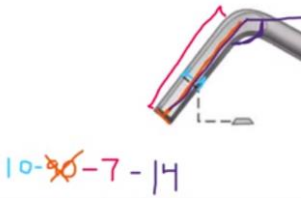
Instrumentation

Hand Instruments

Instrument Design	Handle Shank Working End - Blade & Cutting End (cutting) - Nib and Face (non-cutting)



Non Cutting Instruments	- Mirror - Explorer - Periodontal Probe - Amalgam Condenser - Ball Burnisher
Cutting Instrument	- Scalers -> Calculus - Excavators -> Dentin - Chisels -> Enamel - Other -> Restoration Modification **Dimensions Formula** - **1st Number**: Blade Width in 10ths of mm (10=1mm) - **2nd Number**: Cutting edge angle to the long axis of the blade (omitted if it is perpendicular to the blade (90°)) - **3rd Number**: Blade Length (7 = 7mm) - **4th number**: Blade angle relative to the handle (14 = 14° of 360°)  **Scalers** - Universals - Graceys (specific area) - Sickle Scalers (Supragingival calculus) - Curette (subgingival calculus) **Spoon Excavators** - 11.5-7-14 - Black Spoon: 15-8-14 **Enamel Hatchet** - 10-7-14 - Used for planing and bevelling enamel **Bin-Angle Chisel** - 10-7-8 - Two different angles. Blade is perpendicular to the blade of the enamel hatched **Gingival Margin Trimmer** - Distal: 10-95-7-14 - Mesial: 10-80-7-14 - Cutting edge is not perpendicular to the long axis of the blade - Allows proper bevel of the gingival floor **Discoid-Cleoid Carver** - Used for carving and contouring amalgam **Hollenback Carver** - Used for placing carving and contouring amalgam
Rotary Instruments	Slow Speed - <12,000 RPM - Large round bur for safe removal of caries -> This is the best way to carefully remove **affected** dentin close to the pulp - Polishing restorations Medium Speed - 12,000 – 200,000 - Not really used High Speed - >200,000 RPM - Used for tooth preparation Hazards - Pulp: Vibration, Heat, Desiccation - Soft Tissue: Lips, Tongue, Cheek - Eyes: Use glasses with side shields - Ears: Potential hearing damage (Depends on dB), Frequency (Hz), and duration (time), and susceptibility - Inhalation: Rubber dam protects patient, Masks protect personnel

Burs

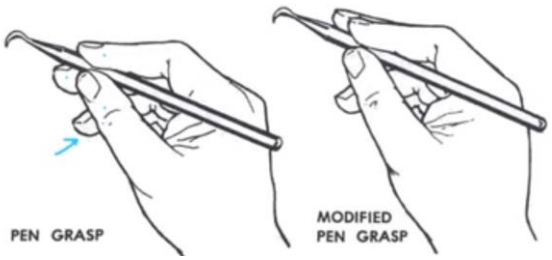
Tungsten-Carbide

- Better for End-cutting, Cutting Amalgam, smoothening walls
- Produce ↓ heat
  - Curtting: 6 blades
  - Finishing: 12 blades
  - Fine Finishing 18-24 blades
  - Ultrafine finishing: 30-40 blades

Diamond Burs

- Better for side-cutting
- More effective cutting
- Generates ↑ heat

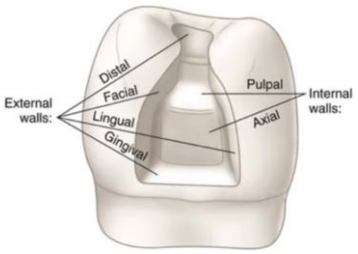
Common Burs		
245 (Carbide)	- 3mm x 0.8mm - Pear Shaped	
330 (Diamond)	- 1.5mm x 0.8mm - Pear Shaped - Smaller size is useful for peds	
169L (Carbide)	- Tapered Fissure	

Instrument Grasp		
Facts	Pen Vs. Modified Pen grasp - Modified uses the middle finger to grasp the instrument (more modern technique) *All grasps require firm finger rests - Adjacent teeth - Maxilla - Mandible *Use short working strokes - More control, accuracy and protection	

GV Black Restoration Classification

Class I 	Pits and Fissures
Class II 	Proximal or posterior teeth
Class III 	Proximal of anterior teeth (W/o incisal edge)
Class IV 	Proximal of anterior teeth (W/ incisal edge)
Class V 	Cervical 3rd
Class VI 	Only incisal edge of anterior OR cusp tip of posterior

Cavity Preparations



Cavosurface margin = where cavity prep meets the original tooth surface
External Walls = Contact the cavosurface margin
Internal walls = Axial and Pulpal wall
Line Angle = Junction between 2 walls of a prep
Point Angle = Junction between 3 walls

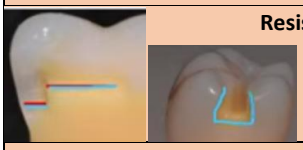
Preparation Steps

Outline Form

= External outline of the tooth surface to be included in the prep along the **cavosurface** margin
- Defined by the **extent of the lesion**
- All weakened and unsupported enamel should be removed
- Extension to sound tooth structure at an initial depth of 0.2mm into dentin (Focused on length and width of the prep, not the depth…caries can be deeper)
- Extend gingival floor to get 0.5mm clearance from adjacent tooth (Opening the gingival box)
- Extend facial and lingual proximal walls to get 0.5mm clearance UNLESS it would require unreasonable removal of sound tooth structure to break the contacts

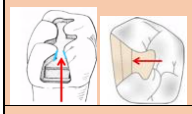
Friable Enamel = Demineralized, bonding is not as effective
Unsupported = Undermined and weaker, high possibility for fracture

Resistance Form



= Prevention of tooth/restoration fracture from occlusal forces
- Flat pulpal and gingival floor
- If extension of prep is >1/2 the cuspal ridge height -> consider capping/shoeing the cusp
- Rounded internal line angles

Retention Form



= Prevention of displacement of restorative material
- Convergent walls prevent occlusal displacement
- Dovetail prevents proximal displacement

If using composite -> rely on bonding

Convenience Form

= Improve the access and visibility as needed

Caries Removal

Initial prep may remove all caries, but if it doesn't, then remove all infected dentin now

Pulpal Protection

= If you are close to the pulp!
- Indirect Pulp Cap -> Use Base material
- <1mm exposure and asymptomatic -> Direct Pulp Cap
- >1mm exposure and symptomatic -> RCT

Sealer/Desensitizer
- Used for sensitivity, occludes dentinal tubules by cross-linking tubular proteins
- 2mm + of dentin remaining between floor and pulp

Ex: GLUMA
- 5% Glutaraldehyde
- 35% HEMA
- Water

Liner
- Used for direct or very close pulp exposures
- Provides a barrier to protect dentin from residual reactants of restoration and oral fluids
- Electrical insulation
- Thermal protection
- Formation of 3° dentin

Ex: CaOH (Dycal) or RMGI

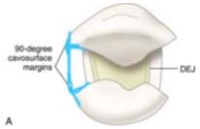
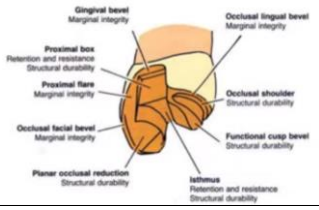
Base
- Used for metal restoration and when liners are used
- Prevents liners from being washed out
- Thermal protection (Especially under amalgam or gold)
- Distributes local stress across all underlying dentin

Ex: RMGI (Vitrebond)

	Summary Table **Amalgam**: Remaining Dentin Thickness - ≥2mm = Sealer - 0.5-2mm = Base + Sealer - <0.5mm = Liner + Base + Sealer **Composite**: Remaining Dentin Thickness - ≥ 0.5mm = Bond - <0.5mm = Liner + Base + Bond **Gold or Ceramic**: Remaining Dentin Thickness - ≥ 2mm = Cement - 0.5-2mm = Cement (2mm thick) - <0.5mm = Liner + Base + Cement

Secondary Resistance and Retention Features	- Retentive Grooves
	- Beveled enamel margins
	- Slots
	  - Minimum 1mm deep and 1mm long
	  - 0.5mm inside DEJ
	- Pins
	  - Self-threaded pins are the most common
	  - Used where a vertical wall is missing
	 

Specific Preps

Amalgam Preparations	Use Carbide burs -> Creates smoothest walls **Retention** - Occlusal convergence - Grooves, slots, pins if needed **Resistance for Tooth** - 90º cavosurface margin - Maintain cuspal structure and marginal ridges - Remove unsupported enamel - Flat floors - Rounded internal line angles - Pins **Resistance for Amalgam** - 90º amalgam margin - 1.5-2mm depth for adequate thickness strength 
Composite Preparation	Use Coarse Diamonds -> Creates rough walls for micromechanical retention *Same as amalgam Except: - No need for retentive features, occlusal convergence, and can be shallower (1-1.5mm)
Gold Onlay Prep	Collar = Beveled shoulder around capped cusps for bracing Skirt = Feather-edge margin around capped cusp Provide secondary R&R Form 

Amalgam

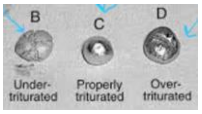
Composition	= Mixture of elemental liquid mercury with other metals
	Eame's Ratio
	- 50% Mercury
	- 50% Metal Alloy
	  - *Silver* -> Strength
	  - *Tin* -> Corrosion
	  - *Copper* -> Strength
	  - *Zinc* -> Deoxidizer in manufacturing. Can lead to excess expansion if moisture contamination, so modern amalgams have ↓ Zinc

Trituration

= Mixes the amalgam components within the capsule where the alloy particle is coated completely with mercury

- γ (Gamma) = Unreacted Ag-Sn
- γ_1 (Gamma – 1) = Strong Ag-Hg matrix -> What we want
- γ_2 (Gamma -2) = Weak Sn-Ag -> Susceptible to corrosion and creep

Normal Mix = Shiny, Smooth
Over-trituration = Warm, wet, soft, sets too quick
Under-triturated = Dry, dull, crumbly, sets too quickly



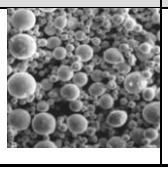
Placement time = 2-4 minutes
Working time = 2-4 minutes

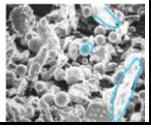
Alloy Subtypes

Low-Copper	High-Copper
<12% Cu in the alloy - Results in γ, γ_1, and γ_2	≥ 12% Cu in alloy - Results in only the γ and γ_1 (↓ corrosion and creep ☹)

Alloy Particles

Spherical	Admixed
- Microspheres of various sizes - **Easier to condense** - **Stronger** - Sets faster	- Mixture of irregular lathe cut and spherical pieces - ↑ **condensation force needed** - **Improved proximal contacts**





Indications for Amalgam

- Moderate to large lesions
- Heavy occlusal loading
- Hard to isolate
- Lesion extending onto the root surface
- Foundation or abutment

Contraindication

- Very small class VI lesions
- High esthetic demands
- Allergy to metals

Clinical Tips

Carving

- Discoid-cleoid -> Occlusal surface
- Hollenbeck Carver -> Occlusal
- Explorer tip -> Occlusal Embrasure
- Amalgam Knife -> Gingival excess

Marginal Ridge Fracture

- Common if the axiopulpal line angle is not rounded
- Marginal ridge is too high
- Occlusal embrasure form is incorrect
- Improper removal of matrix
- Over-carving

Class V Amalgams

- Prep walls diverge occlusally (enamel rod orientation)
- 4 corner coves, occlusal and gingival line angle grooves or circumferential grooves for retention

Mercury Toxicity

Inhalation is the biggest risk
- If spill occurs = special vacuum system and then apply sulfur powder on the floor

Acute Mercury toxicity

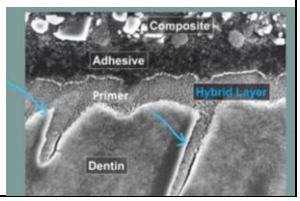
- Muscle weakness (Hypotonia)
- Loss of hair (Alopecia)
- Weight Loss/GI disorders
- Exhaustion

Mercury Forms

- Methymercury = Organic (found in fish), Most toxic
- Elemental = Liquid metallic, in dental amalgam
- Mercury salts = inorganic

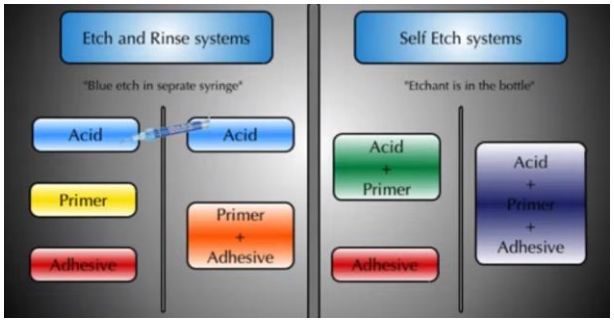
Composite Resin & Glass Ionomer

Enamel Bonding	= Reliable and predictable - Etching turns low surface energy surfaces into rough high energy surfaces with ↑ wetting >20 MPa of shear bond strength!
Dentin Bonding	= Equally as strong as enamel, but not as reliable or predictable **Why is it hard?** - *Composition*: Dentin has ↑ organic matter and water and ↓ mineral vs Enamel - *Structure*: Enamel rods are parallel, collagen in dentin is like a "bowl of spaghetti" - *Depth*: Fluid-filled dentinal tubules are much larger and more numerous near the pulp. Deeper you go the ↓ the bond strength - *Smear Layer*: "Sawdust" from cutting ↓ dentin permeability (by almost 90%) so its way harder to bond to

Step 1: Etch	= 30-40% Phosphoric Acid - Etch for 15 seconds **Purpose**: - Cleans surface debris - Removes smear layer from enamel and dentin Etched Enamel -> Chalky/frosted appearance = microporosities Etched dentin -> Exposes layer of collagen, widens dentinal tubules Rinse with Water for 10 seconds - Leave it between soaking wet and bone dry to "fluff" the collagen fibers in dentin
Step 2: Primer	HEMA (Hydroxyethyl Methacrylate) - Monomer + solvent - **Can cause allergic contact dermatitis** - Amphipathic molecule (Hydrophobic and Hydrophilic end) -> Hydrophilic end contacts tooth surface - Infiltrates the enamel prisms and dentinal tubules - Prevents collagen collapse Solvent: - Acetone, Ethanol, or Water
Step 3: Bond/Adhesive	Bis-GMA (Bisphenol A-glycidyl methacrylate) - Chemically bonds to underlying primer AND the overlying composite resin via MMA bonds **Hybrid Layer** - Key to great bond strength = Micromechanical Bond - Mechanical interface between tooth and adhesive - Resin Tags = Adhesive resins lock into the microporosities of etched enamel and intertubular dentin 

Different Bonding Systems

Self Etch Systems:

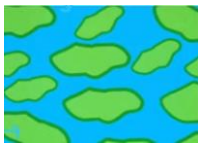


- Less powerful etchant = ↓ post op sensitivity, but weaker bond because it doesn't completely remove the smear layer
- Recommended to use carbide burs only with these systems b/c they leave behind less smear layer

Composite Resin

Composition

Resin matrix (Bis-GMA)
- Leaching of bisphenol A (BPA) can occur through wear of composite or w/ uncured resin
- Potential negative health effects are negligible



Filler Particles (Silica)
- Radiopaque
- Affect properties of the composite

Coupling Agent (Silane)
- Promotes adhesion between Filler and resin

Composite Types

Macrofill
- 80% filler
- 8um particle size
- Very strong
- Rough and ↑ wear ☹

Microfill
- 40% filler
- 0.04um particle size
- Weak
- Good polish and good wear resistance 😊

Hybrid Fill
- 80% filler
- 1um particle size
- Best of both worlds

Nanofill
- 0.005-0.01 um (5-10 nm) particle size -> These conglomerate to form a spectrum of sizes

Nanohybrid
- Incorporates the conglomerate sizes of 0.005-0.01um (5-10nm) particles
- Most popular now (ie: Filltek)

Flowable
- Very low filler amount
- ↓ wear resistance

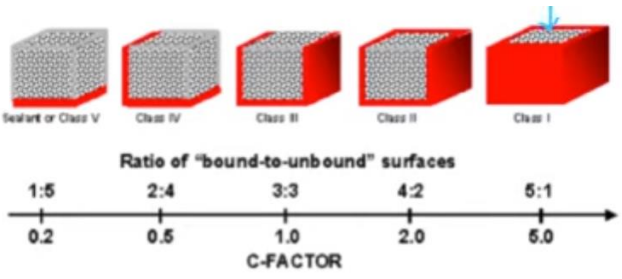
Packable
- High filler amount (very viscous)

Larger fillers have ↑ Strength, but don't wear or polish as well
Higher filler content = ↓ water absorption

Cure Types

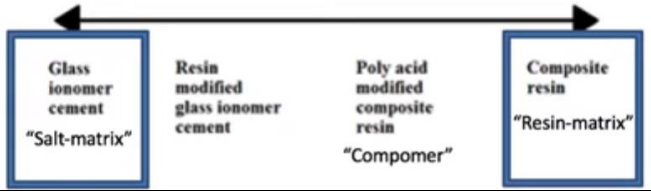
Self-Cure	Light-Cure
- Two – paste system **Initiator**: Benzoyl Peroxide **Activator**: Tertiary amine	- Single-Paste system **Initiator**: Camphorquinone - 468nm light needed to initiate polymerization *You like to take **photo**'s when you go **camping***

Polymerization Shrinkage
- Composites shrink as they polymerize (2-3%)
- Configuration (C) Factor = ratio of bound to unbound surfaces
  - ↑ C-Factor = ↑ chance for shrinkage, microleakage and post operative sensitivity



GIC vs Composite Resin

Glass Ionomer	Composite Resin
Acid = Polyacrylic Acid *Base* = Fluoraminosilicate Glass *Retention*: Chemical bond to the tooth - Self adhesive to the tooth (no prime and bond) *Strength*: Weaker vs composite Fluoride release 😊	*Matrix*: Bis-GMA *Filler* = Barium Silicate Glass *Curing*: Light or Self Cure *Retention*: Relies on micromechanical bond *Strength*: Stronger vs GIC No Fluoride Release ☹



Resin Modified GIC	Set by Acid-Base reaction + Free-radical addition polymerization (Light +/- Chemical Cure) - More rapid polymerization b/c of free radical initiation - Fluoride release
Compomers (Polyacid-Modified Resin composites)	= Anhydrous (water free) single pastes that contain major ingredients of both Composites and GI except for water - Attractive in orthodontics b/c of slower polymerization (allow time to clean up excess) - Keep area dry to avoid the acid-base polymerization reaction - Fluoride release