Resin-based Composites

PART 2

Light -activation sources:

1. Ultraviolet light source:

UV radiation cause possible eye problems that might develop in office personnel and the possibility of selectively altering the oral flora of the patient's mouth through exposure to ionizing radiation.

2. Visible light sources:

A. Quartz-Tungsten-halogen (QTH) light source:

The wavelengths around 470 nm are strongly absorbed by the Composite.

B. Argon laser lights

The argon-ion laser provides high output energy at 488 nm for rapid polymerization of commercially available dental restorative

C. Short-Arc Xenon Sources (Plasma-Arc Curing lights (PAC):

Alternative for rapid light curing. Manufacturers claimed that these sources can effectively reduce clinical exposure duration to only 1-10 seconds or some manufacturers claimed that composites could be adequately polymerized in less than 1 second.

D. Blue light- emitting diode curing units (LED):

Instead of the hot filaments used in halogen bulbs, LED, use junction of doped semiconductors for generation light.

Polymerization:

Resin composite restoratives solidify by means of the chemical process termed polymerization. The polymerization of the resin matrix produces a gelation in which the restorative material is transformed from a viscous-plastic

into a rigid-elastic phase. During the early stages of polymerization, monomers are mainly converted into polymeric chains.

After a certain degree of conversion has been attained, the predominant reaction is the cross-linking of the polymeric chains, resulting in a strong polymeric network.

Factors affecting polymerization shrinkage stress:

1-Factors related to the cavity design:

Stress developed during curing can be minimized by consideration of the ratio between the bonded and unbonded surface area (c- factor). When this ratio increases, as in Class I and Class V situations, increase the shrinkage stress loading on the tooth- resin interface leading to de bonding.

2-Factors related to the placement technique:

The second factor that might reduce polymerization shrinkage is to insert resin composites in increments to reduce the volume of the resin that is shrinking during polymerization.

3-Factors related to the composite formulation:

Nonbonded microfiller particles have been found to produce significant decreases in polymerization stress by acting as stress-relieving sites within the composite.

Acid Etching:

- A physical process that creates a microscopically rough enamel surface (enamel tags)
- acid used is 37% ortho-phosphoric acid
- sometimes referred to as conditioner

Smear Layer: When a rotary or handheld instrument is used on dentin it creates a special surface texture called smear layer that closes off the dentinal tubules. This layer is lightly adhered to the dentin surface and contains tooth cuttings, saliva, bacteria, and other surface debris.

Enamel Etching

Enamel consists of organic and inorganic components. Application of 37% phosphoric acid removes about 10 microns of enamel to expose prisms of enamel rods and create the classic honeycomb effect. Acid also increases surface energy for better wetting of the enamel. Resins flow into micromechanical retentive areas. Resin tags fill microscopic holes to provide retention. Retention is about 30 MPa.

Acid etching is done for a minimum of 15 to 30 seconds. Thorough rinsing for 10 seconds removes acid and dissolved calcium phosphates.

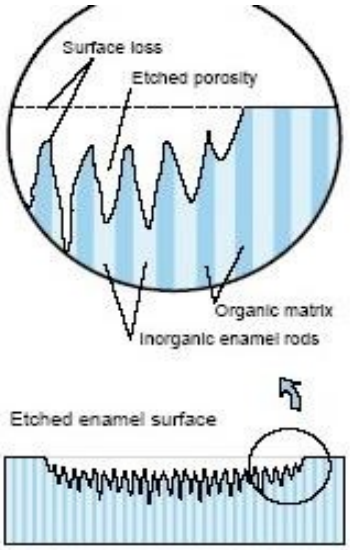


Figure 8–3. Schematic diagram depicting how acid etching produces microporosities in enamel.

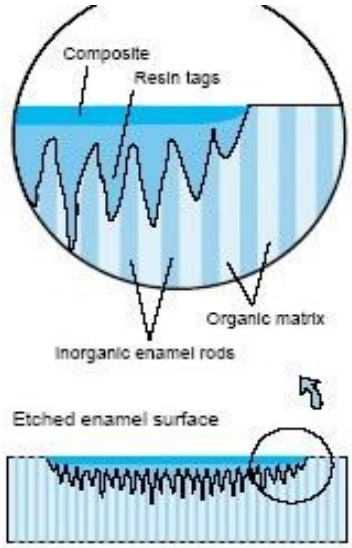


Figure 8–4. Schematic diagram depicting how resin tags penetrate the microporosities produced by acid etching of enamel.

- Over-etching results to formation of crystals (precipitates) that inhibits bonding
- Built-in quality control check – if properly etched it appears frosty or chalky white.

Dentin Etching

- 37% ortho-phosphoric acid
- removes the smear layer from the surface of the of the dentin.
- decalcifies a layer of dentin several microns thick. Time:10-15 seconds

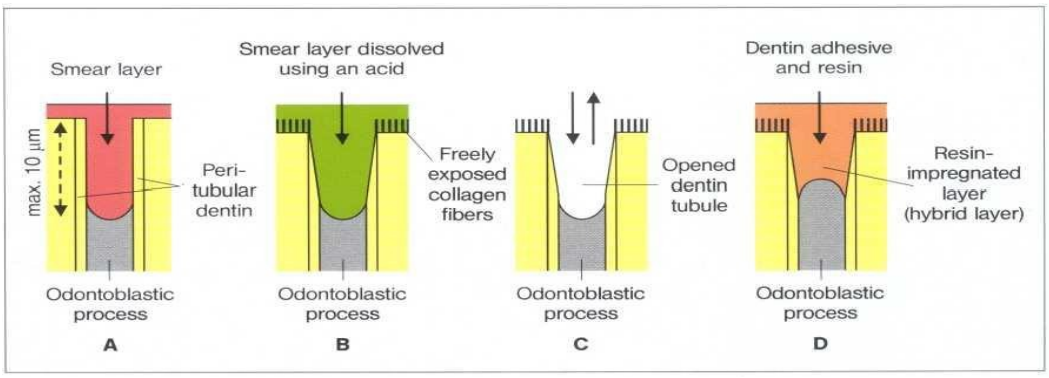
If the etched tooth surfaces are contaminated with saliva or blood, they need to be retched. Such a retching procedure requires only 5 seconds.

Primer (P): -

- Includes bifunctional molecules hydrophilic and hydrophobic).
- Envelops the external surface of collagen fibrils.
- Re-establishes surface free energy to levels compatible with more hydrophobic restorative materials

Bonding Agent (B): (Adhesive resin)

- Includes monomers that are mostly hydrophobic such as Bis-GMA
- Adhesion to Dentin protects the pulp, because after removal of the smear layer with a mild acid (conditioner) the opened dentin wound was sealed with a hydrophilic resin, for example, HEMA (primer) and a bonding agent (adhesive). During this treatment a dentin surface impregnated with resin (hybrid layer) is formed that guarantees an optimal dentin wound closure which is acid resistant and prevents bacteria penetrating.



Current strategies for Adhesion of Resin to Dentin:

I- Total etch adhesive

A- Three step total etch adhesive:

Etchant (E) + Primer (P) + Bonding Agent (B)

B- One-bottle total –etch (two step total-etch adhesive):

Etchant (E) +Primer and Bonding agent (PB)

II- Self-etch adhesive:

A- Two –bottle self-etch:

Etchant and Primer (EP) + Bonding (B)

B- All-in-one self-etch (EPB) we call it single application:

- a multi-coat approach is recommended.