

# Adhesive systems

Adhesive systems are used to attach composite filling material to hard tooth tissues and to close dentin tubules (denture wound treatment "ad integrum").

## Adhesion to enamel

Enamel has more mineral components than organic, its etching creates interprismatic spaces into which bond can flow better and thus hold microretention. It does not have to be hydrophilic. The bond strength is 30–40 MPa. A composite without a bond does not leak into interprismatic spaces and therefore does not hold itself, as it is too viscous.

**Binding quality** Enamel depends on:

**Avoiding contamination** – never let the patient rinse after we have etched the enamel. After etching, the enamel must not be contaminated. That's why we prefer to work with kofferdam. In case of accidental contamination, etch again (2–3 s), then rinse.

**Etching time** – 20–30 s (orthophosphoric acid), a little longer for temporary teeth. If we etch too long (60 s), the result is worse. The top layer of enamel prisms breaks off and the interprismatic spaces prepared for bond leakage are clogged.

**Type of etch, consistency** – it must not be too viscous, it must be a solution or a thin gel. If the etching agent was too viscous (thick gel), it would not flow into the whole cavity, into the subcurvature. We choose the type of etching according to the character of the cavity. For class I, we can choose a solution. On vertical surfaces, we will rather use gel. The gel etching (contains silica particles) must be rinsed longer.

**Skew** – the enamel must be slanted to ensure better cavity closure. Composite materials adhere better to enamel than to dentin. Temporary teeth are harder to etch than permanent ones (thanks to aprismatic enamel).

**The state of enamel before etching (machining)** – whether we etch aprismatic enamel (aprismatic enamel is located on the necks), milk teeth, fluorine-impregnated enamel. We must achieve the so-called appearance of shiny ice.

**Composition of enamel** – presence of aprismatic enamel, too fluoridated, demineralized, etc.

## Adhesion to dentin

The bond to dentin is threefold: chemical, micromechanical (today the most common) and mixed. Dentin etching is performed 5–10 s.

### Chemical bond

In 1956 a weak chemical bond to dentin (2–3 MPa) – 1st generation bonds. They could not maintain the contraction forces of the composite and the teeth died.

Micromechanical coupling

A hybrid layer is formed, which is made up of:

- collagen fibers (living matter);
- HEMA.

We penetrate the surface part of the dentin with an adhesive, after solidification we form a hybrid layer that holds it (about 2  $\mu\text{m}$  ~ 20 MPa thick). This micromechanical bond was not possible until hydrophilic materials, i.e. HEMA (does not shy away from dentin), were formed. HEMA is the basis of the primer. It penetrates into the surface part of the dentin and allows the penetration of the binding resin. Hydrophobic resin does not leak into the tubules.

**Mixed binding After the dentin is etched, a primer and adhesive are applied to penetrate the surface part of the dentin to form a hybrid layer (1–2  $\mu\text{m}$  thick) behind which it is held with a force of 15–20 MPa.**

### Create a Hybrid tier

Remove the smear-layer (grit after preparation), rinse the dentin and etch briefly. Then we impregnate the surface parts of the collagen fibers with a primer, which are erect, fluffed and remain erect even after the composite is applied. Let the primer act for 20–30 s and then blow lightly. It should shine. Next, dry the layer, apply bond resin, spread it and remove the excess. We enlighten and this leads to polymerization. Finally, we apply the composite resin.

The hybrid layer consists of:

- demineralized dentin (i.e. actually collagen – dentin is "collagen coated with a mineral"),
- the latter is impregnated with resin,
- resin bundles in tubules,
- microsheaves penetrating into lateral connectors between tubules

## Primer

Most primers include:

- binding resin (HEMA)
- Solvent: water, or acetone, or alcohol

### Primer with acetone

It is very volatile (must not be left open) and has a short expiration date. It is also sensitive to processing – acetone does not penetrate into dry dentin, is hydrophilic → needs wet bonding, penetrates well and dissolves regularly.

Wet bonding = application of the bond to wet (primerated) dentin

### Water primer

It is easy to process – not so sensitive to overdrying or wet. Even if the dentin is overdried, the primer rehydrates it and penetrates it. The disadvantage is that it dissolves the resin poorly.

### Primer with alcohol and water

It has properties between water and acetone, it is a reasonable compromise.

Note: before applying the primer with acetone solvent, we can leave the cavity wet until it shines in places. After primer primer, dry.

## Classification of adhesive systems

- by generation – from the third generation onwards, these are already modern systems;
- According to the method of dentin treatment – division into "total etch" and "self etch" systems. Within these two groups, adhesive systems can be further divided according to the number of steps (1, 2 and three-step).

### Total etching

\_\_It etches and bonds everything (enamel and dentin).

Three-step three-bottle total etching

It is the best total etching. Etching, primer and bond are used separately. E.g. Scotch Bond & P.

First we etch the enamel, then the dentin. Rinse perfectly about as long as we etched (20-30 s). Dry the dentin properly (beware of overdrying). Dentin should be moist. Apply primer to wet dentin and let penetrate/act for 20-30 s. If it does not penetrate long enough, micro-joints will form. HEMA with a solvent (water, acetone, alcohol) penetrates decalcified dentin. Collagen in the dentin will remain "sticking". We perform a perfect drying and apply a bond that penetrates into the prepared dentin and creates retention for us. We thin the bond layer by blowing – i.e. we blow less. We need to see the unevenness of the enamel. With a brush, you can wipe off excess bond from cavity. Subsequently, we polymerize the bond and apply the composite.

### Three-step two-bottle total etching

The first bottle is an etch, the second is a primer with a bond in one vial. We apply for the first time as a primer and the second time – from the same bottle – as a bond. There is a problem because while the primer we have to dry it perfectly – get rid of the solvent – Bond just needs to "thin out". To get rid of the solvent, I have to dry it again perfectly, which makes the bond too thin and also blows bubbles into it. The bonding is then worse.

### Two-step two-bottle total etching

The first bottle is an etch, the second is a primer with a bond in one vial. Etch, apply to dentin, let it work, blow properly, polymerize. However, the weave layer is too weak.

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### Self etching

\_\_The primer etches itself into the dentin.

- missing steps: etching, rinsing, drying dentin with acid;

- primer has a low pH of 2 – therefore it dissolves smear layer and etches dentin;
- primer does not rinse;
- After complete drying, Bond is applied and polymerized.

High bond to enamel without the need to etch enamel is especially in two-step ones. With one-step ones, the bond is weaker. The disadvantage of this system is the unaesthetic edge. OHA (hydroxyapatite) crystals still remain on the enamel. In addition, we added a primer. OHA crystals with primer create a tiny cushion that stands out after applying the composite as a gap filled with primer.

After preparing the cavity, we use a hydrophilic primer to do etching and priming at the same time. All the porridge that remains after etching (i.e. decayed hydroxyapatite crystals, and collagen residues) is left there (it is such mud saturated with primer), it is blown out, bonded and illuminated.

**Self etch two-step two-bottle** Contains self etch primer + bond (e.g. Adhese/Vivadent) – good bond but poor aesthetics (gap). For this system, the KI for III, IV, VI class.

**Self etch one-step two-bottle** The contents of two vials are mixed before application, poor binding and aesthetics. **Self etch one-step one-bottle**

For example, G-bond, basically the same as a one-step two-bottle bond.

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