HIERARCHY OF BONDABILITY: A paradigm shift in Biomimetic Restorative Dentistry

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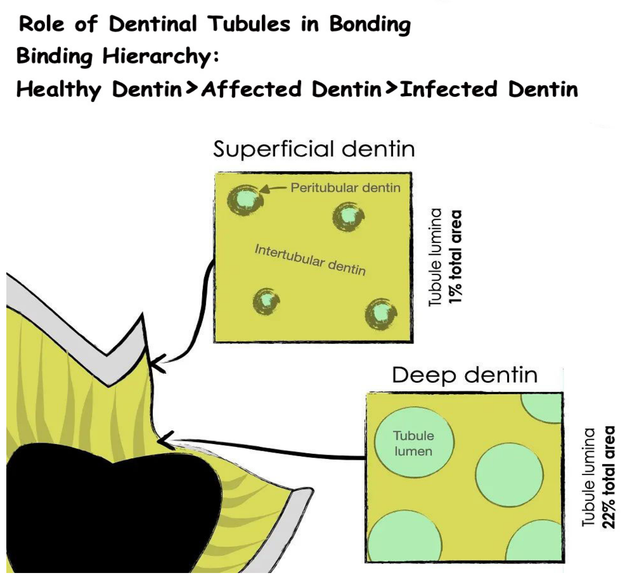
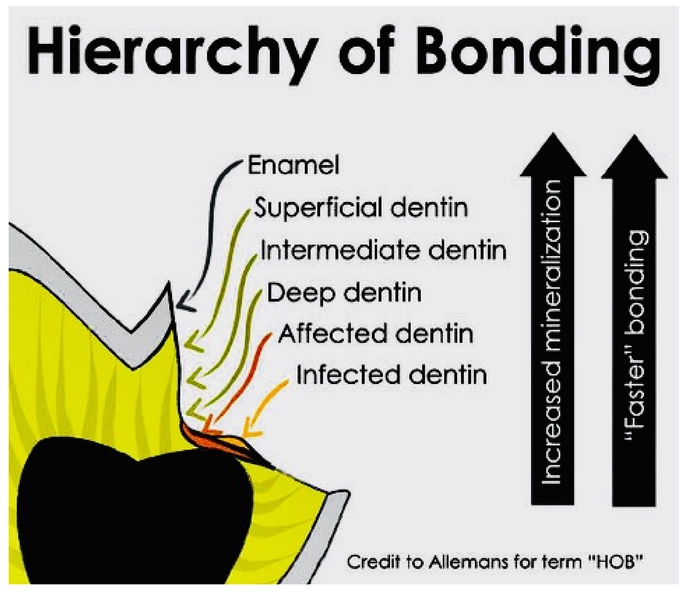
INTRODUCTION

Bonding to the tooth is a very intricate process. Bond strength varies based on the direction of dentinal tubules or enamel rods across the tooth, as well as intertubular dentin and moisture levels. **Dr. David Alleman** coined the term **"Hierarchy of Bondability"** to help us shed light on how dentin bonding agents act in context. This concept allows us to appreciate the different bond potentials throughout the tooth and how they affect the scenario in which we bond our composite.

The direction of shrinkage of composite layers and the amount of stress concentrated on the developing dentin hybrid layer are determined by the hierarchy of bondability. **During polymerization, the shrinkage of the composite goes towards the most mineralized and dry walls of the preparation and away from the moistest and organic walls of the preparation. The majority of the decoupling happens at the box's base, which can be prevented by either waiting for a full-strength bond to form or adding small incremental layers.**

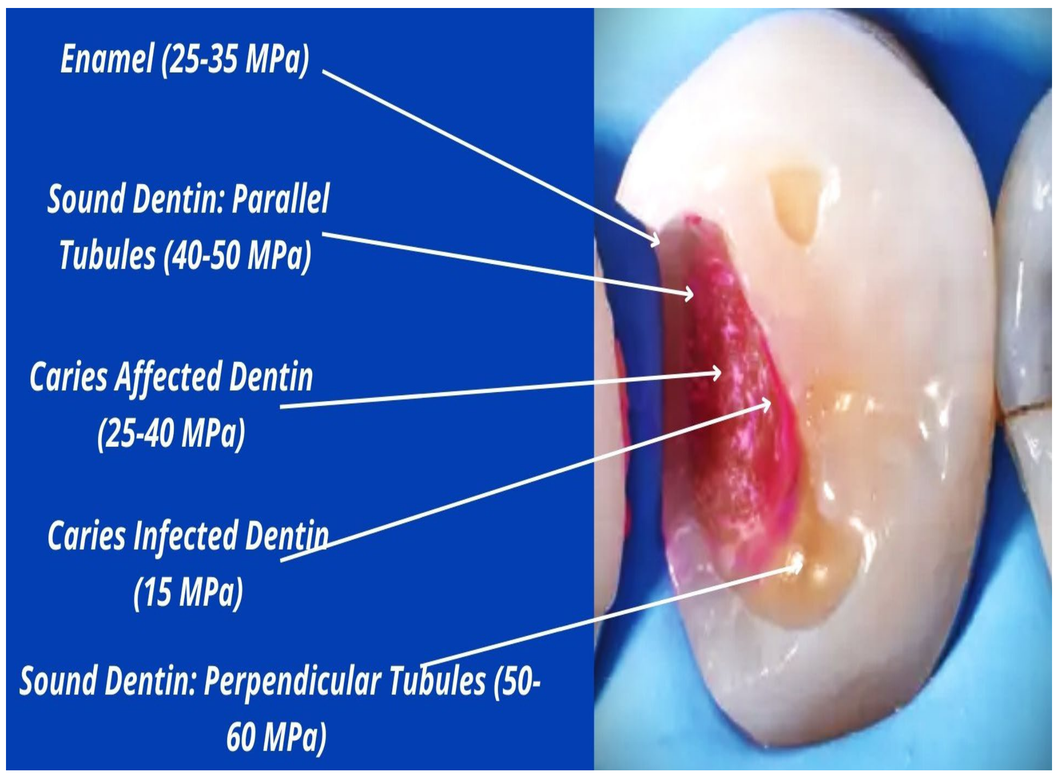




BOND STRENGTHS

When bonding the tooth, two substrates must be considered: **enamel and dentin**. Because of its homogeneous, dry, inorganic hydroxyapatite structure, bonding to enamel is easier. The surface area of acid etched enamel increases, allowing the adhesive to seep into the pores and establish a rapid and stable bond. Enamel bonding, on the other hand, has a limit because of its brittle nature, which results in an average capped bond strength of nearly **30 MPa**. The bond strength to enamel is limited, but bonding to dentin has a higher potential for bond strength.

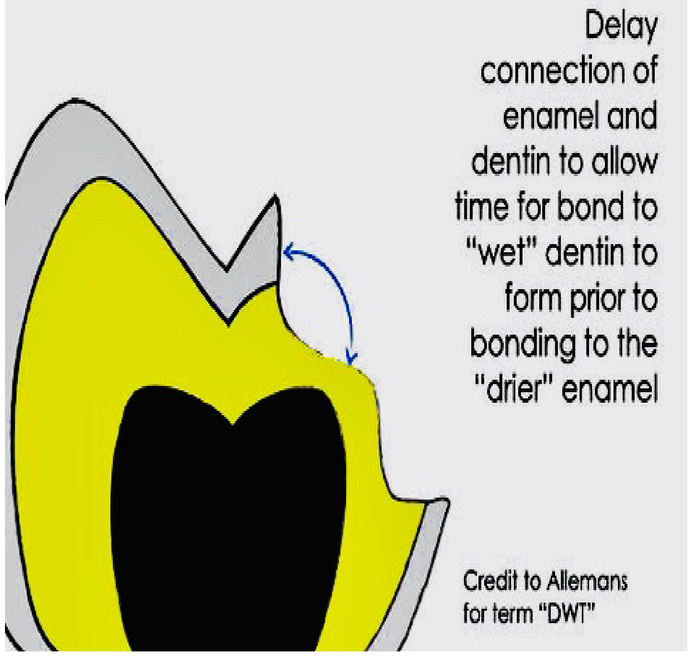
Dentin is moist and flexible, making it more difficult to encapsulate with the developing resin polymers of the dentin bonding system being used. **It requires roughly twice as much time to develop a strong bond to dentin as it does to develop a strong bond to enamel, but when a mature bond to dentin is established, it is roughly twice as strong as the bond to enamel.** When tested for gold standard bonding systems, air-abraded dentin showed higher bond strength than the **51MPa** target, which is the microtensile bond strength of the DEJ. There are different bond potentials within the dentin itself. In sound, caries-free dentin, the bond strength will vary based on the depth of dentin and the orientation of dentinal tubules. **The dentin bond is much stronger when there is the most intertubular dentin, as this dentin is collagen-rich.** In deep dentin, the bond strengths were overall lower than in superficial dentin, but it is still possible to bond to these substrates. **Finally, the binding to affected dentin is lower than the bond to healthy dentin, and it is even lower to infected dentin.** As a result, linking deep dentin to other surfaces may cause the composite to strip away from the deep dentin. **Decoupling With Time is a technique for overcoming the Hierarchy Of Bondaibility.**

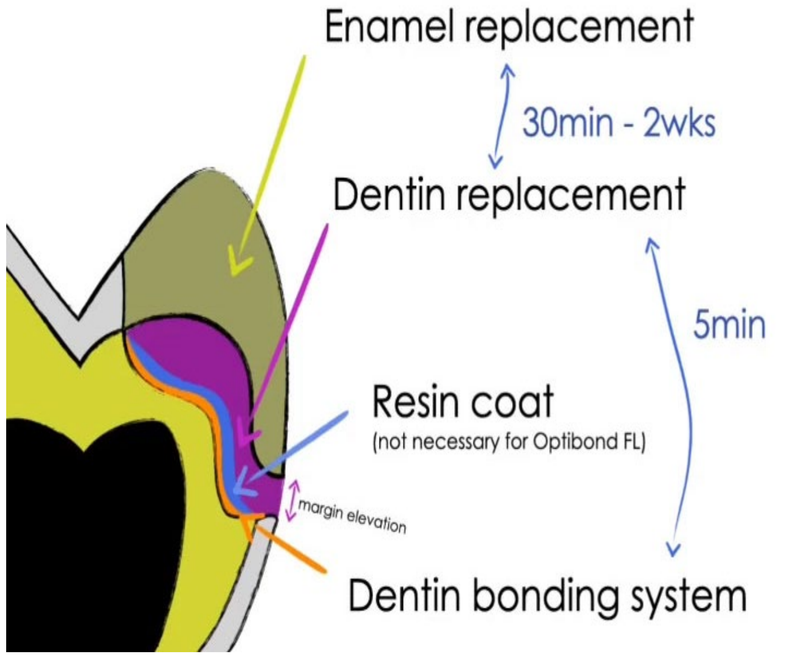


DECOUPLING WITH TIME

This protocol states that polymerization shrinkage stress to the developing dentin bond of the hybrid layer should be minimized for a certain period of time **(5 to 30 minutes)** by keeping initial increments to a minimum thickness (less than 2 mm). **This minimal thickness prevents the connection, or "coupling," of deep dentin to enamel or superficial dentin before the hybrid layer is matured and close to full strength. This procedure neutralizes the Hierarchy of Bondability.**

If some surfaces develop their bond more slowly than others (deep dentin), you could apply adhesive/composite in layers that only connect those surfaces and then wait for them to form their bond before connecting them to other surfaces. There is a waiting period before joining dentin and enamel. If you are doing an onlay, you may have to wait several hours or even days. I believe this time management becomes more difficult when creating a direct composite. **The idea is to wait 5 minutes for the adhesive to adhere to the tooth before adding layers of composite to bond it with more superficial dentin.**





IMPLICATIONS OF HIERARCHY OF BONDABILITY

Stress Reduced Direct composite technique:

Restore the dentin with thin horizontal layers of composite 1 mm or less. This ensures that decoupling with time is adequately achieved, and the flow of the composite is not moving away from the deep dentin during the early stage of horizontal layer development. This is the solution to the problem of a preparation's complex geometry and the resulting configuration stresses-"C-Factor" stresses. Small increments are always associated with small ratios of bonded to unbonded. Thus, high C-Factor stresses can be reduced to "micro C-Factor" stresses.

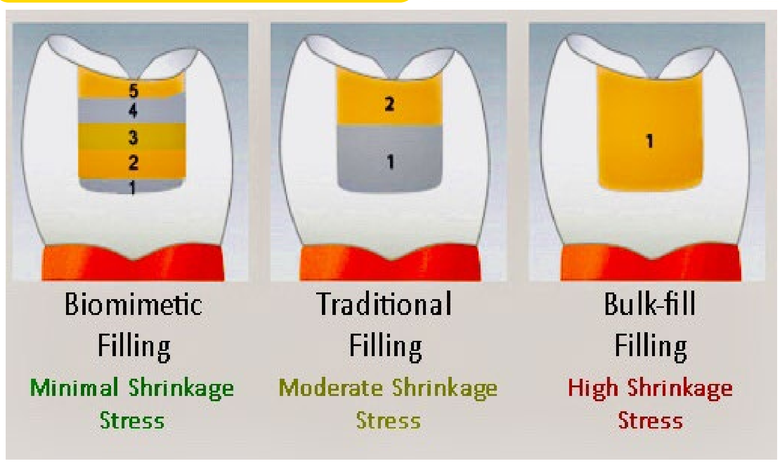
Fiber-reinforced Technique:

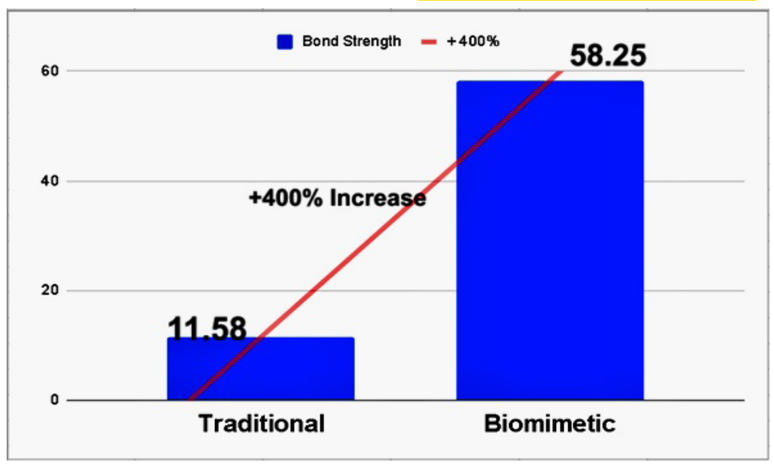
Always place fiber inserts or fiber-reinforced composites for extensive restorations on the pulpal floor and axial walls. It has been shown to minimize stress on the developing bond strength of the hybrid layer. Fiber nets allow the composite on either side of the net to move in different directions. **This means shrinkage is not applied to the hybrid layer when the polymer network is curing.**

Deep marginal elevation, combined with immediate dentine sealing, resin coating, and a composite dentine replacement, is referred to as creating your ideal **Biobase**. **All these procedures give proper time for the maturation of the hybrid layer in indirect restorations. It also increases the microtensile bond strength by 400%.**

When bonding to a tooth, if there is an extensive area to be replaced, indirect or semi-indirect restorations produce a far lower stress level at the interface. There is a significantly reduced volume of shrinkage of restorative material and a more favorable outcome.

INDIRECT RESTORATIONS | **FIBER REINFORCEMENT** | **AIR ABRASION** | **SLOW START CURING**





SMALL INCREMENTS OF COMPOSITE | **400% INCREASE IN BOND STRENGTH**

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