

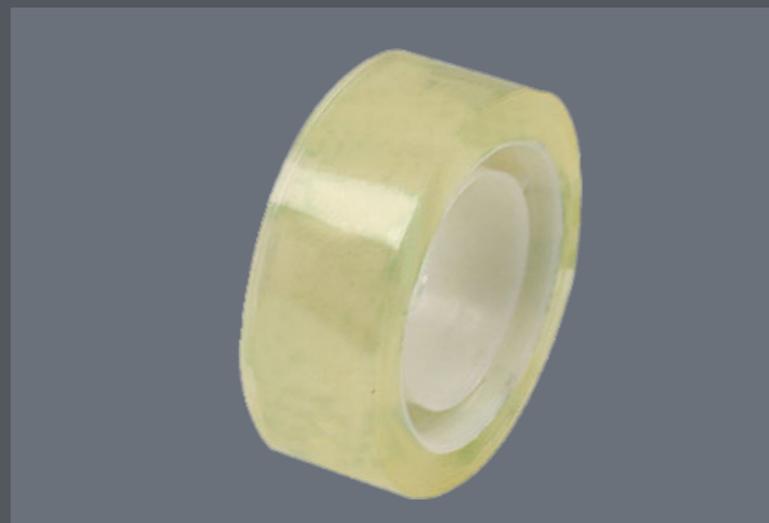
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# DENTAL ADHESIVES

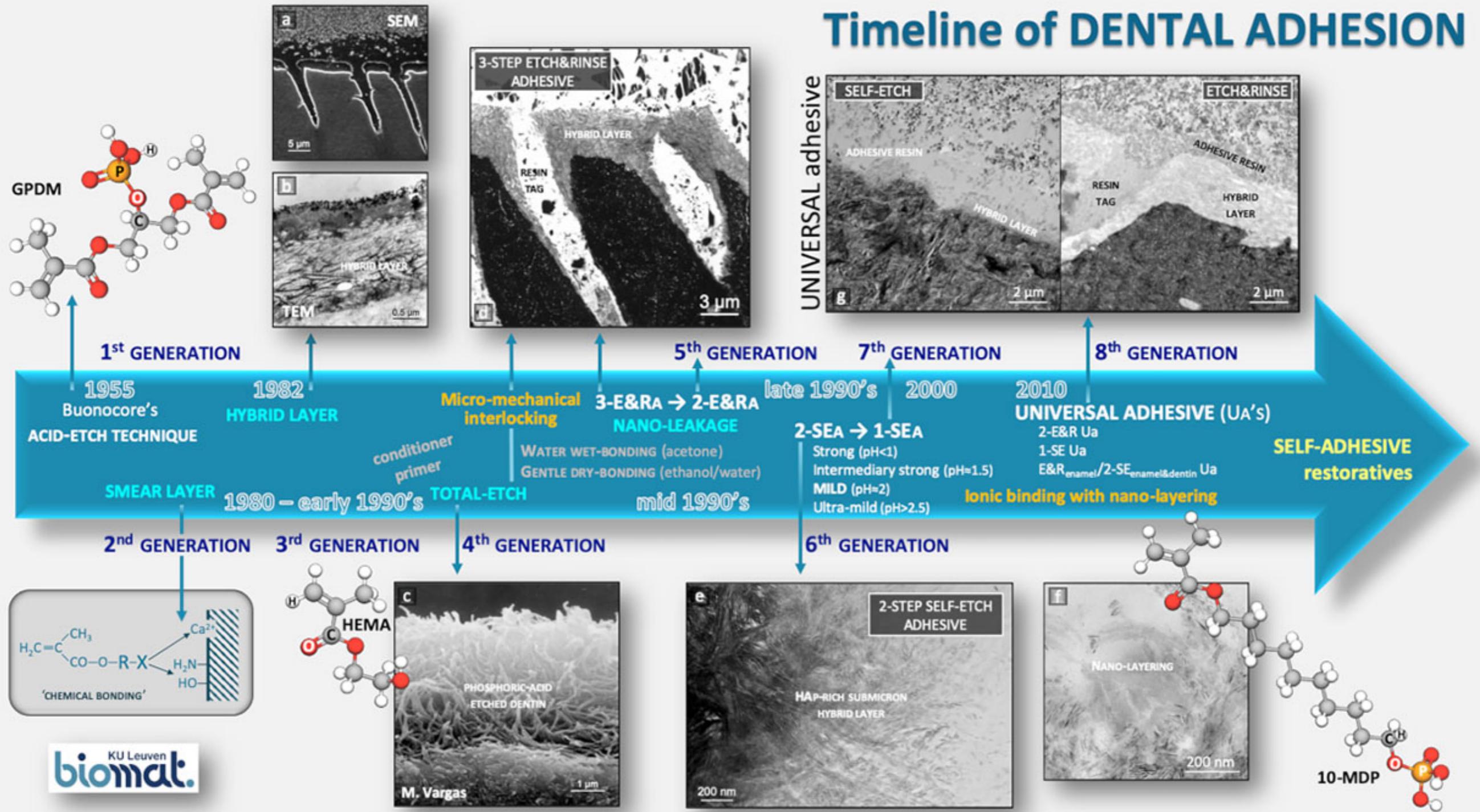
**GÜLBIKE DEMİREL, DDS, PhD**

# ADHESION

The action or process of adhering to a surface or object

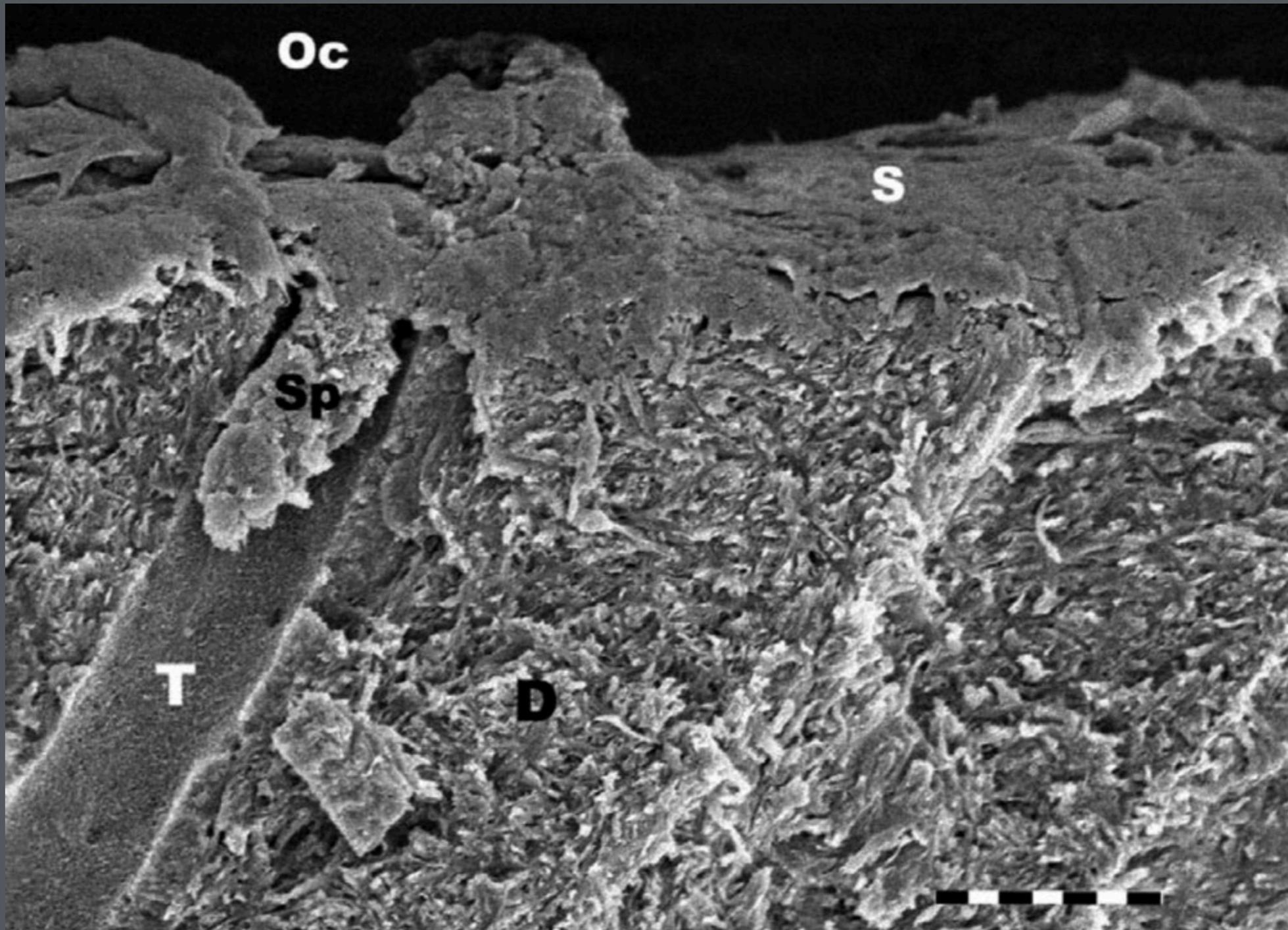


# Timeline of DENTAL ADHESION



Van Meerbeek B et al. (2020) From Buonocore's Pioneering Acid-Etch Technique to Self-Adhering Restoratives. A Status Perspective of Rapidly Advancing Dental Adhesive Technology. Journal of Adhesive Dentistry.

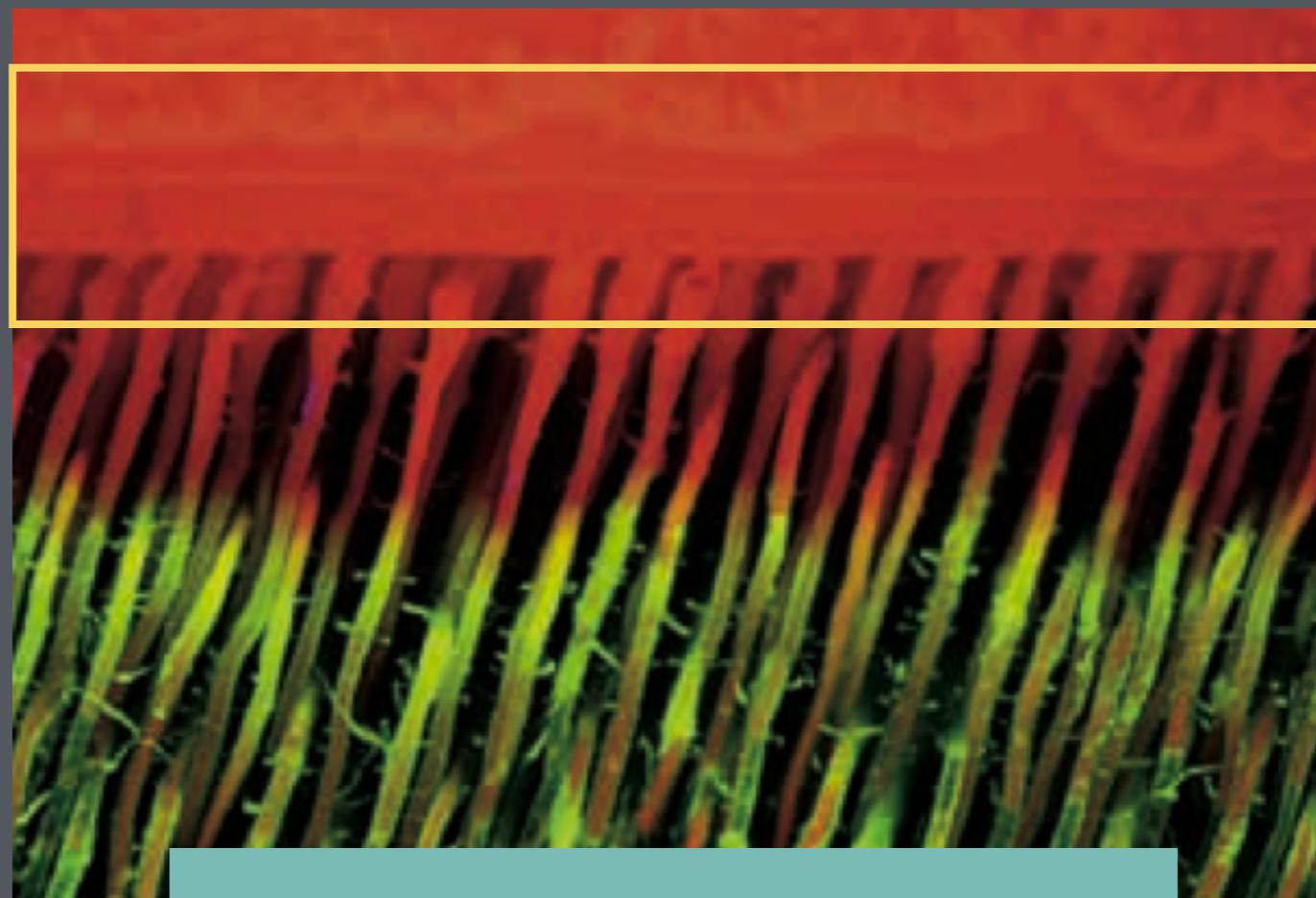
# Smear Layer



(A) Micrograph of smear layer created with a diamond but in high-speed with water refrigeration. Oc, occlusal surface; D, normal dentin; T, dentinal tubule; S, smear layer; Sp, smear plug. Micron bar = 2  $\mu$ m; Original magnification = X10,000

# Mechanisms Of Adhesion/ Micromechanical Interlocking

diffusion-based micromechanical interlocking



Mineral

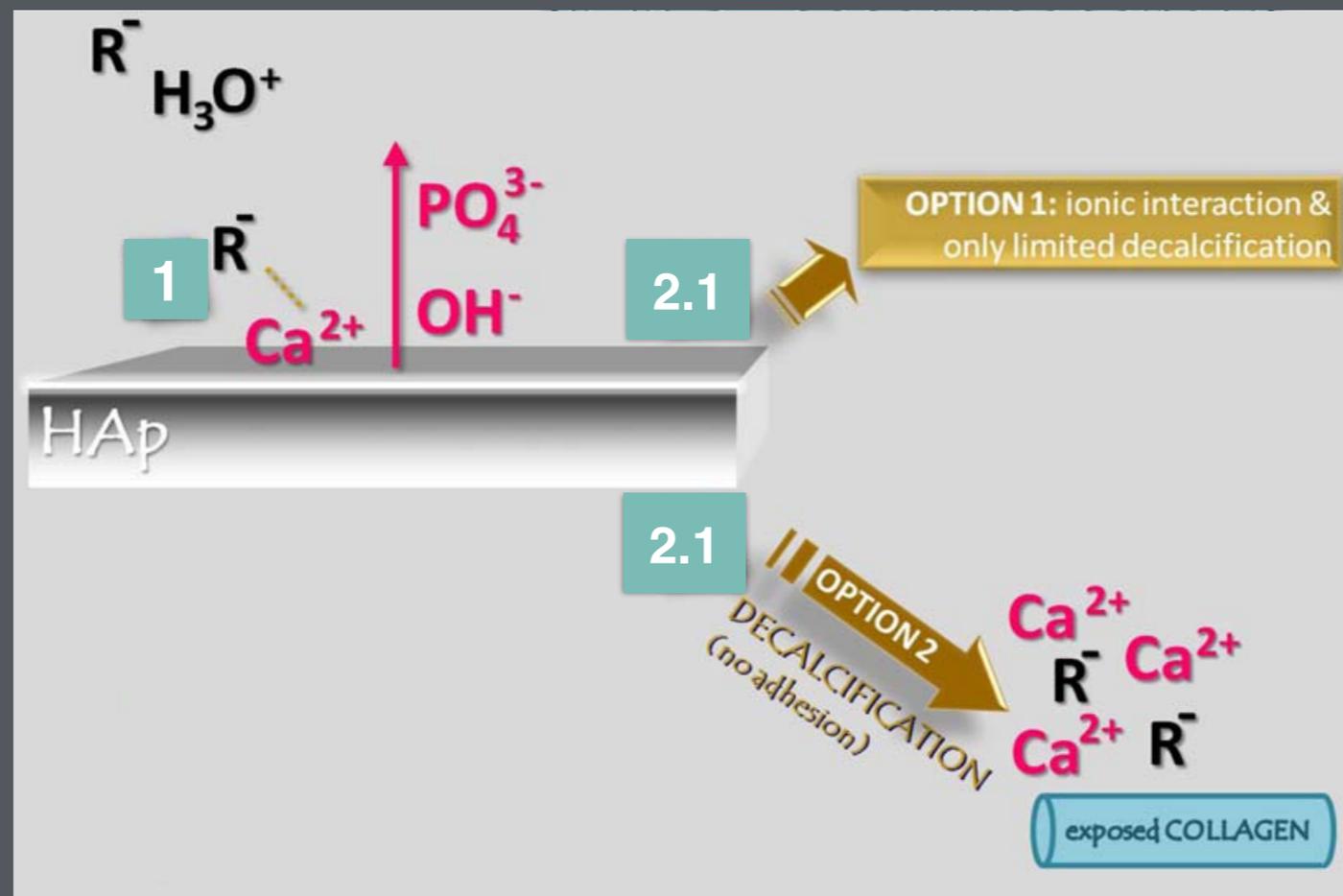
Resin

Hybridization



# Mechanisms Of Adhesion/Chemical/Ionic Bonding

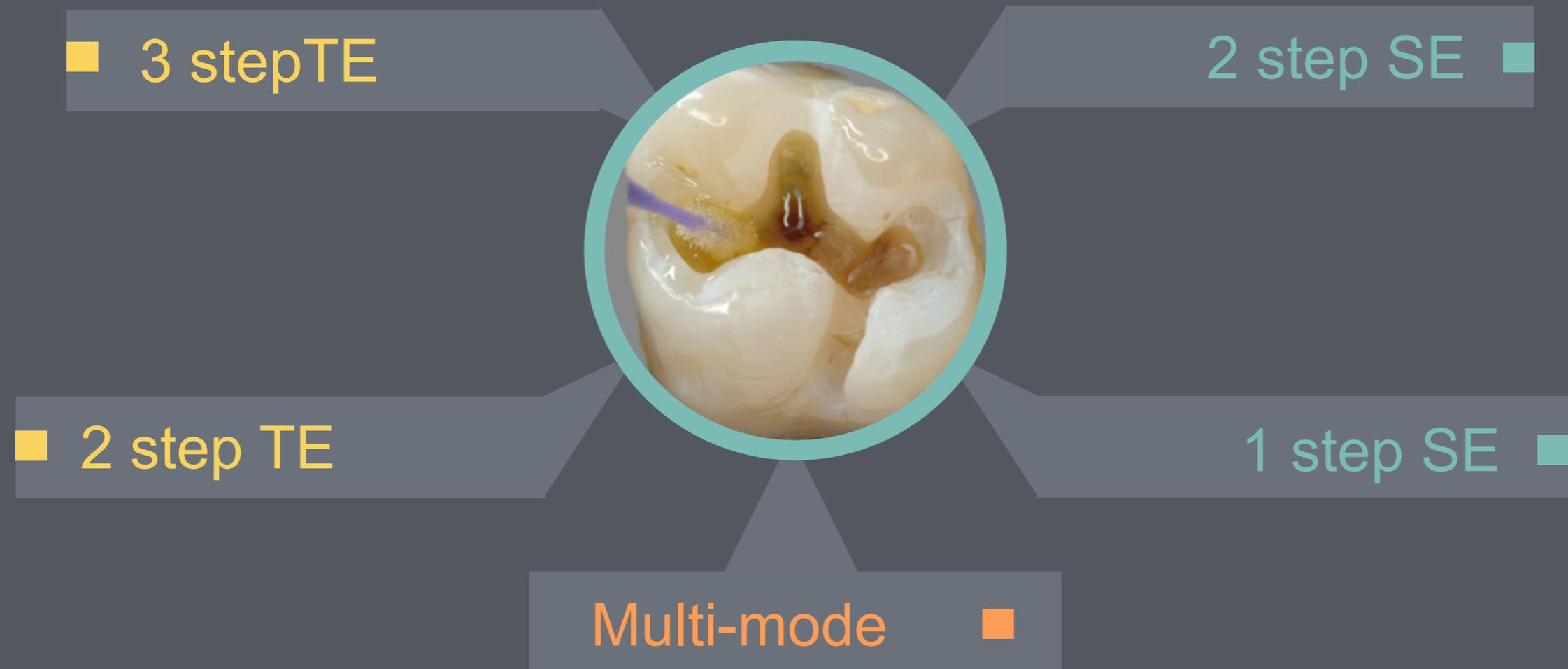
Adhesion decalcification concept



# Classification of dental adhesives by adhesion strategy.

Etch-and-rinse (ER) 	<b>3-step ER</b> Ac + Pr + BR		
	<b>2-step ER</b> Ac + (Pr/BR)		Universal adhesives used as <b>ER</b> adhesives
Self-etch (SE) <i>No separate etchant</i>	<b>2-step SE</b> (Ac/Pr) + BR		
	<b>1-step SE</b> (Ac/Pr/BR)		Universal adhesives used as <b>SE</b> adhesives
Self-adhesive (SA) <i>No separate adhesive</i>	Composite resin	<b>Adhesive and restorative are the same material</b>	
	GICs, including Resin-modified GICs (pre-conditioning with PAA)		

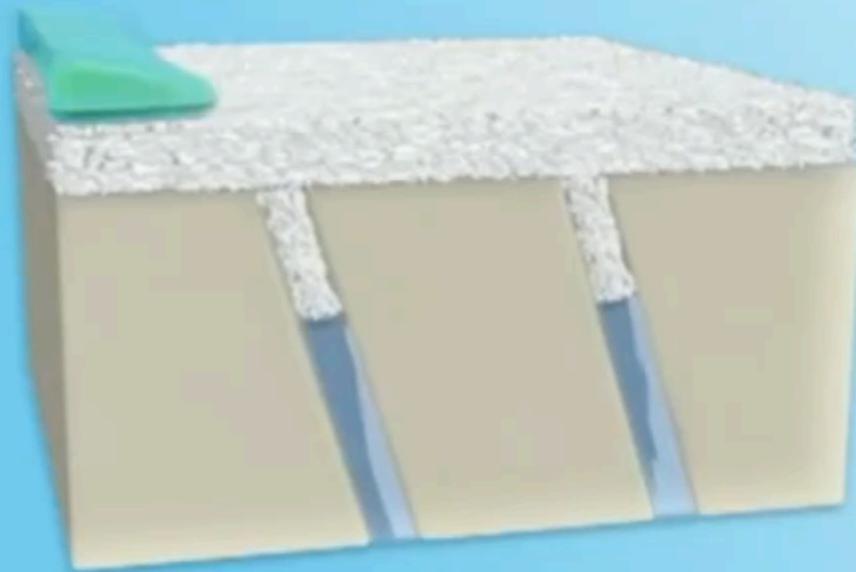
# Classification of dental adhesives by clinical steps



# TOTAL-ETCH (ETCH AND RINSE) ADHESIVES

# TOTAL-ETCH ADHESIVES

Etch&Rinse systems: Strong acid is applied (pH<1)



Etch&Rinse Systems



PHOSPHORIC ACID



PRIMER



ADHESIVE

3 STEP TE



# TOTAL-ETCH ADHESIVES

2 STEP TE

PHOSPHORIC ACID

PRIMER & ADHESIVE

ADHESIVE



# Etchants (Conditioning)

Etchants are relatively strong acids (pH = 1-2) used to remove smear layers and to dissolve the mineral phase to allow formation of micromechanical interlocking in enamel and in dentin.

Phosphoric acid at a concentration 37%, is the preferred etching agent to produce consistent etching patterns while not damaging the pulp.

Concentrations greater than 50% result in the deposition of an adherent layer of **monocalcium phosphate monohydrate** on the etched surface, which inhibits further dissolution.

# Etchants

**Generally, the etchant is supplied as an aqueous gel to allow precise placement over a specific area.**

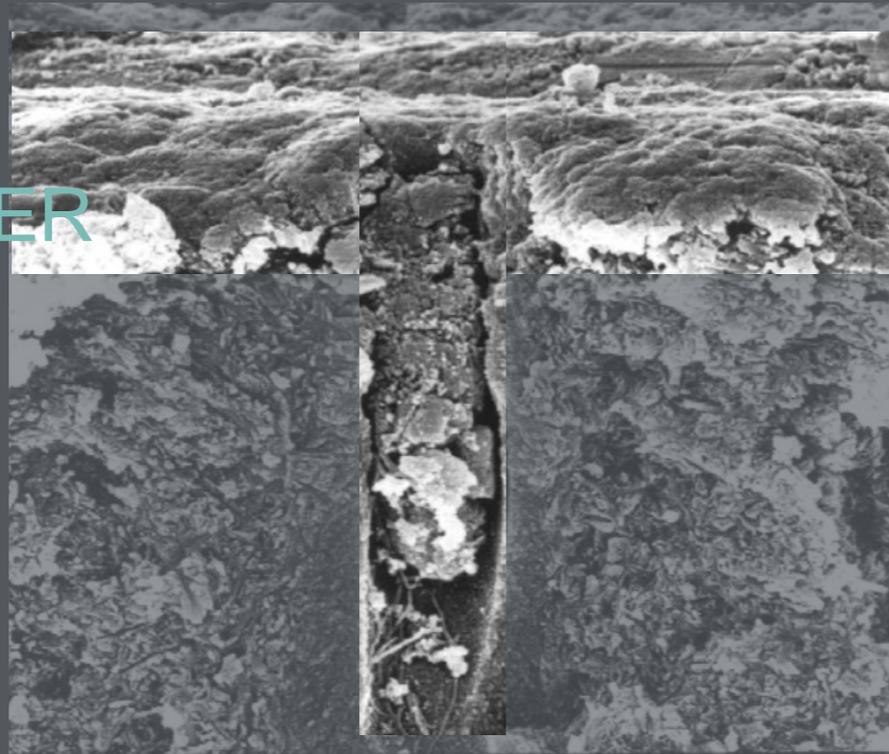
**These gels are often made by adding colloidal silica (the same fine particles used in microfilled composites) or polymer beads to the acid.**

**Brushes are used to place the acidic gel, or the acid may be supplied in a disposable syringe from which it can be expressed onto enamel and dentin.**

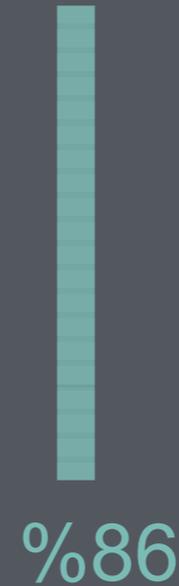
# TOTAL-ETCH ADHESIVES

## SMEAR LAYER

SMEAR LAYER



SMEAR PLUG

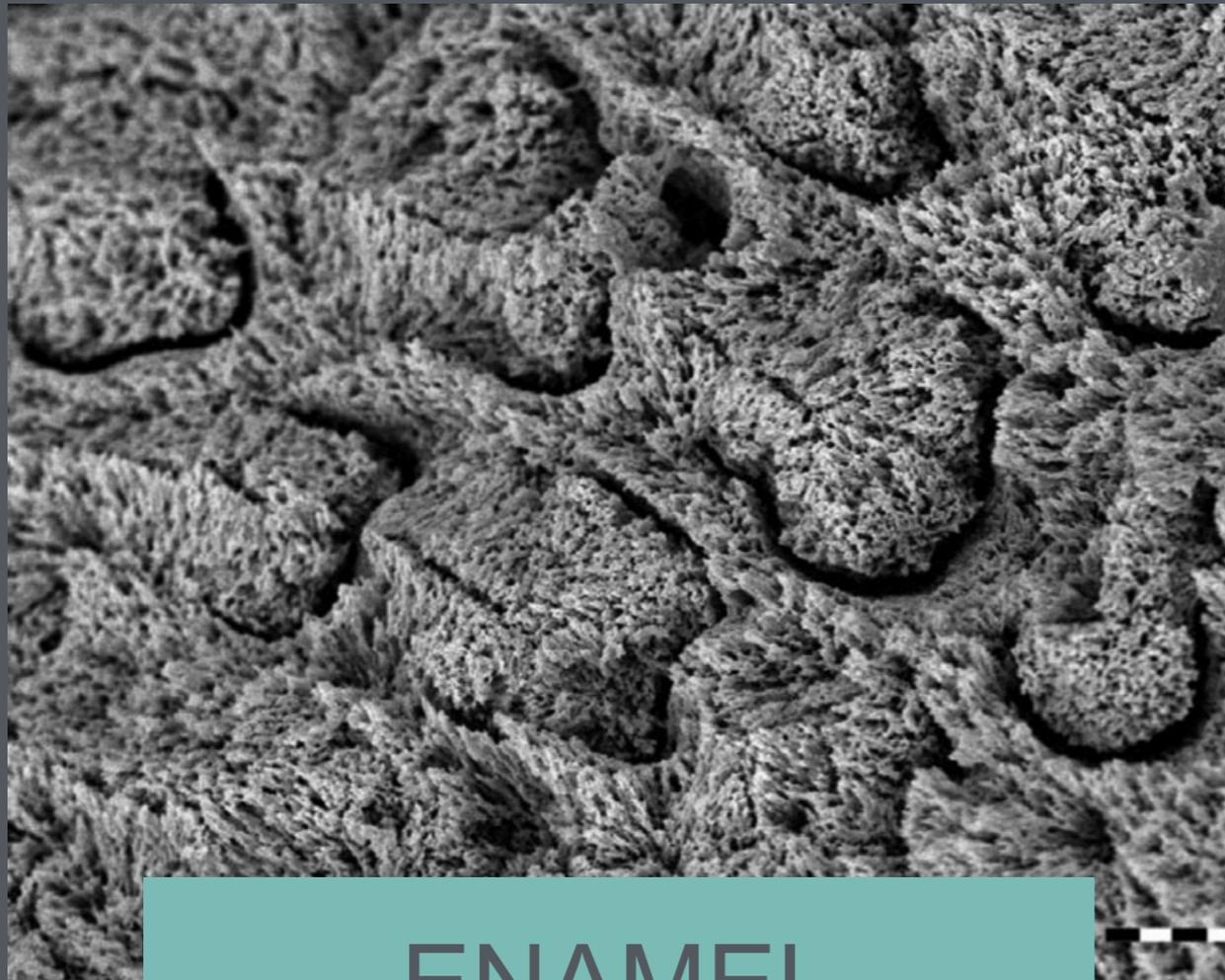


**Reduces fluid  
movement in deep  
dentin**

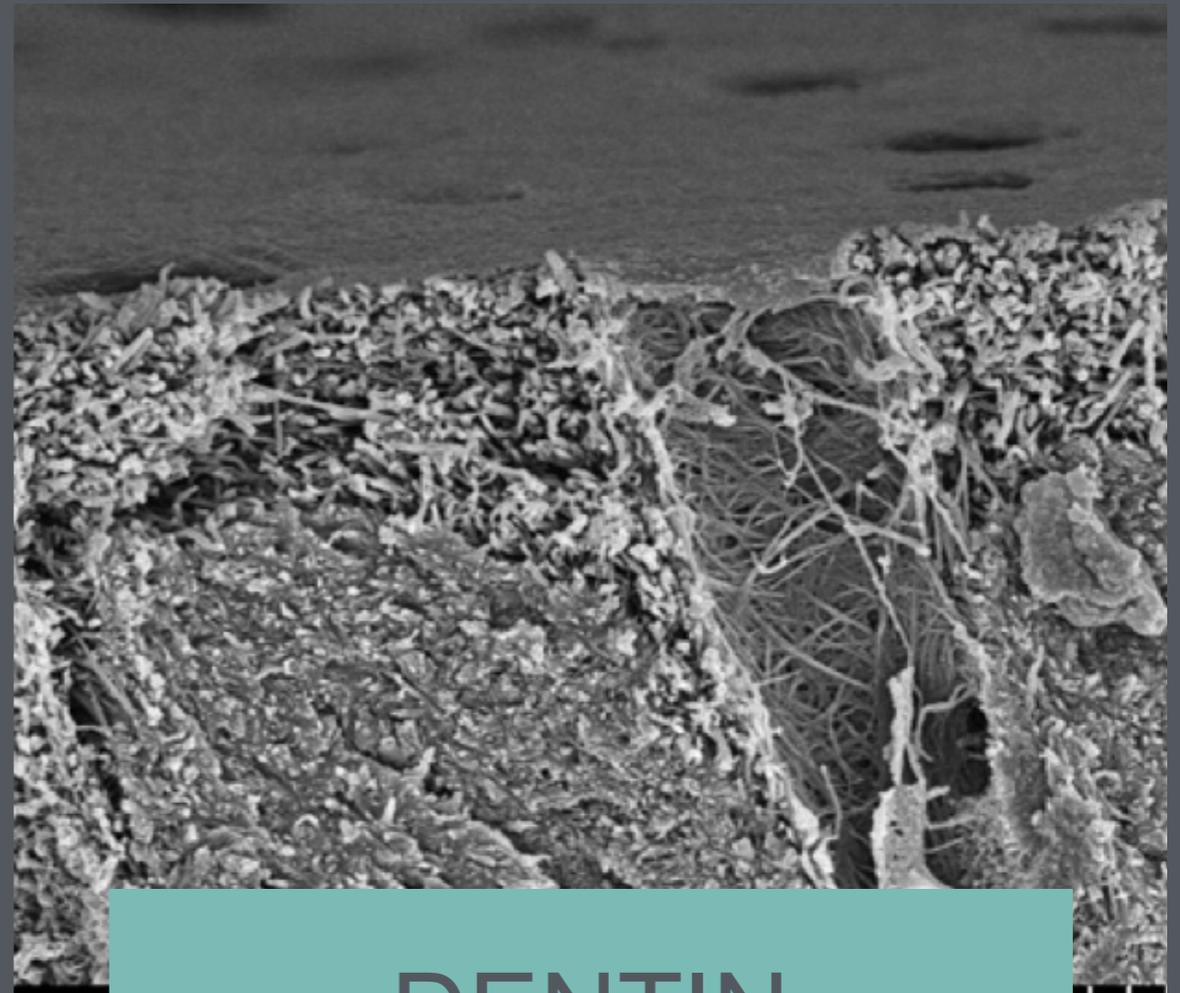
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# TOTAL-ETCH ADHESIVES

## ETCHING STEP



ENAMEL



DENTIN

# Primers

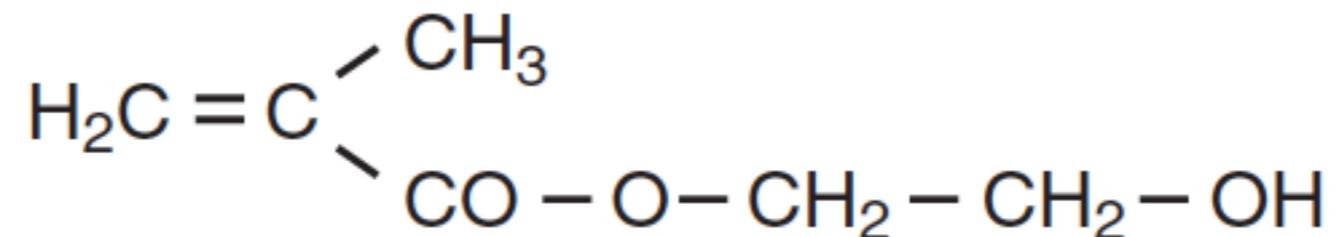
**Dentin etching is highly technique sensitive because the demineralized collagen network readily collapses when dried. Therefore, priming is necessary to maintain an expanded collagen network while removing residual water to allow for the infiltration of the hydrophobic adhesive monomer.**

**Primers are solutions containing hydrophilic monomers dissolved in a solvent such as acetone, ethanol, or water. Such monomers exhibit hydrophilic properties through phosphate, carboxylic acid, alcohol, or ester functional groups.**

# Primers

**HEMA (2-hydroxyethyl methacrylate, is a widely used primer monomer because of its high hydrophilicity and solvent-like nature.**

**HEMA**



# Solvents

Solvents also play important roles in priming systems. The most commonly used solvents are **water, ethanol, and acetone**. In addition to the enhancement of wetting of hydrophilic dentin, each solvent has a specific contribution to improve bond adhesion.

Water can ionize acidic monomers as well as re-expand the collapsed collagen network

Ethanol and acetone have better miscibility with relatively hydrophobic monomers, and their "water-chasing" ability facilitates water removal.

# Adhesives

Generally, adhesive resins are composed mainly of hydrophobic dimethacrylates such as **bis-GMA**, **TEGDMA**, and **urethane dimethacrylates (UDMA)**, and a small amount of a hydrophilic monomer such as **HEMA**.

# Initiators

**Similar initiator systems are used in both adhesives and restorative composites. Polymerization can be initiated either through a photoinitiator system consisting of a photosensitizer (e.g., camphorquinone) and an initiator (e.g., tertiary amine), through a self-cure system that includes a chemical initiator (e.g., benzoyl peroxide [BPO]), or through a dualcure initiator system.**

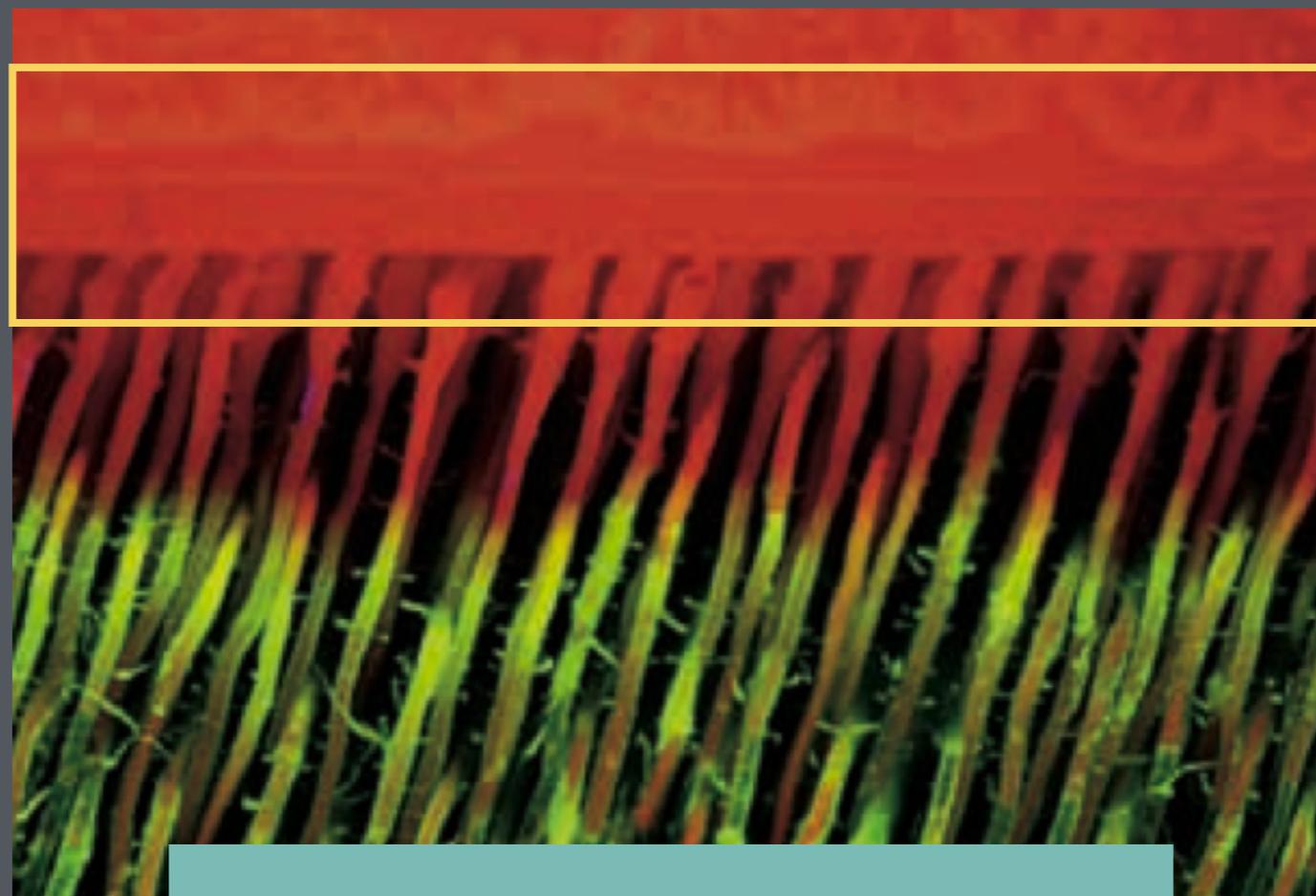
# Filler Particles



**Nanometer-sized silica particles have been added to some adhesives to reinforce the adhesive and thereby produce higher bond strengths.**

# Mechanisms Of Adhesion/ Micromechanical Interlocking

diffusion-based micromechanical interlocking

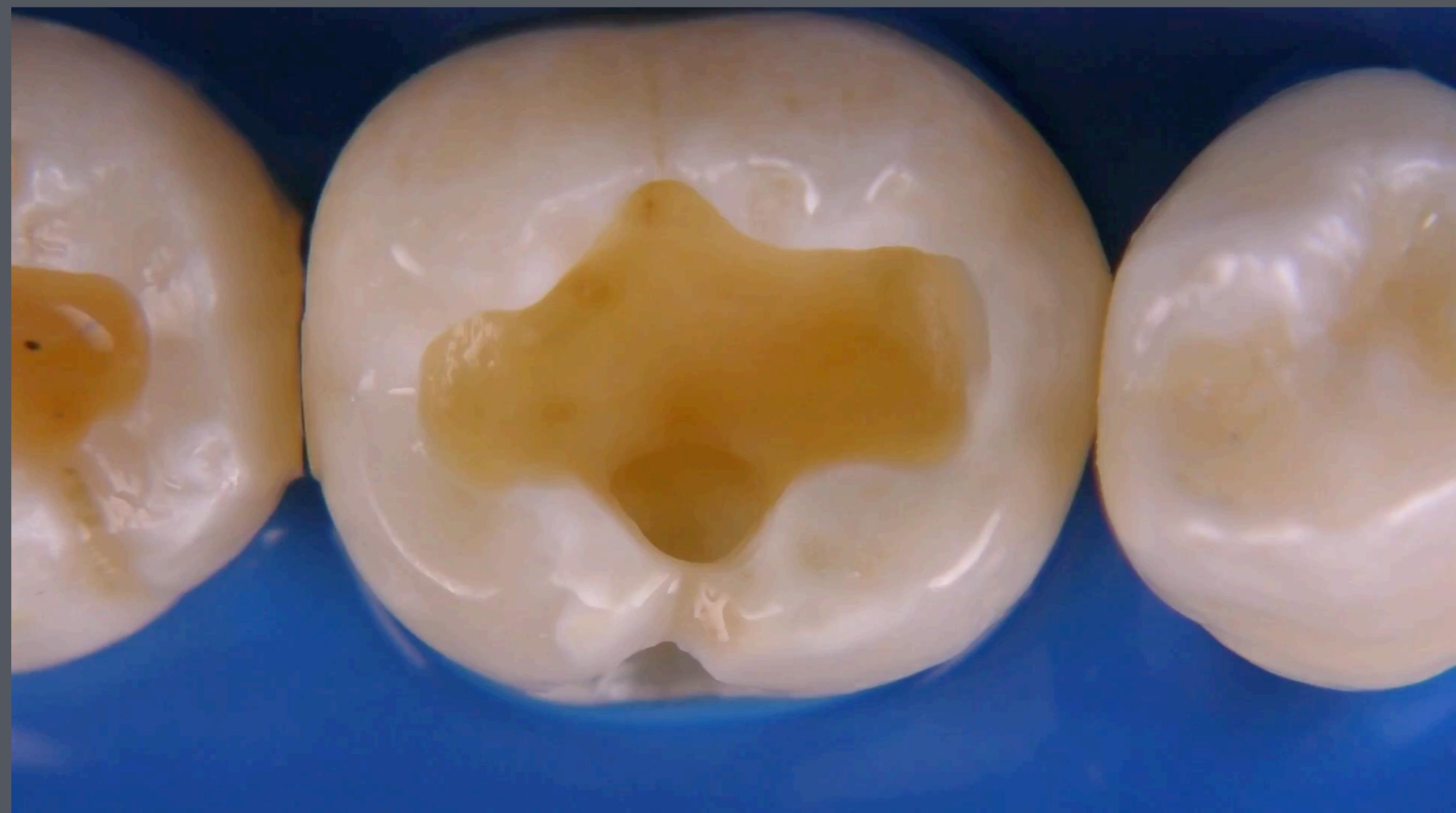


Mineral

Resin

Hybridization



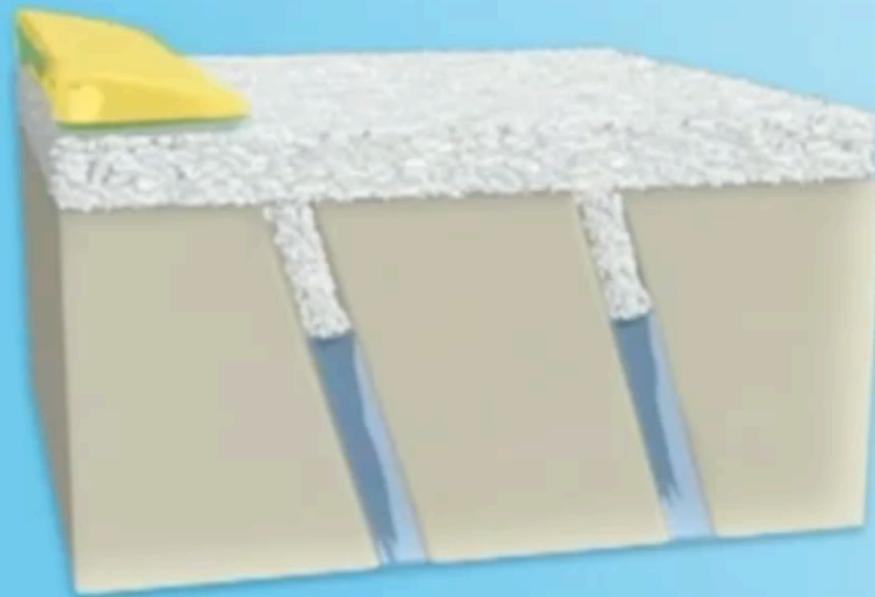




# SELF-ETCH ADHESIVES

# SELF-ETCH ADHESIVES

Smear layer covering the tooth surface



# SELF-ETCH ADHESIVES



Etchant



Primer or



Adhesive

2 stepSE

1 stepSE

AŞASİDİK PRİİ

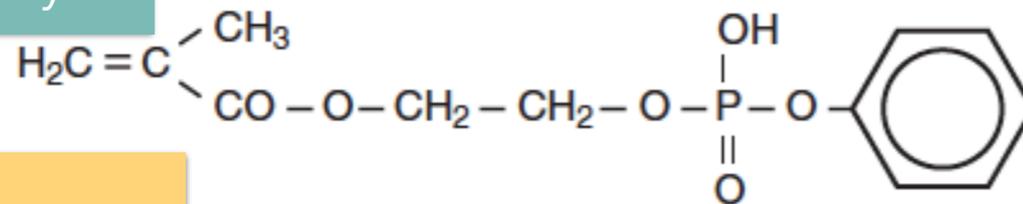
ADEZİV

İV

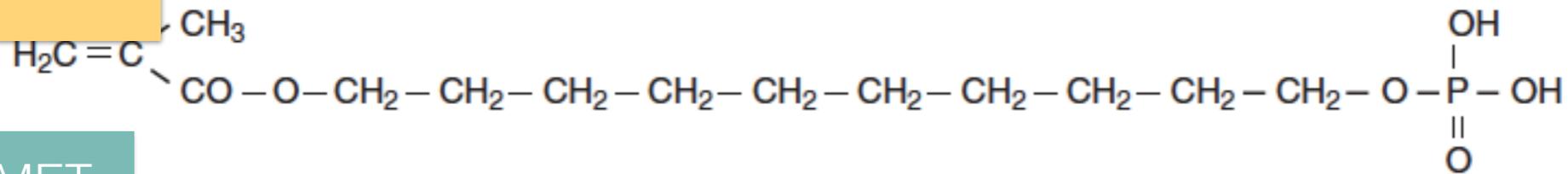


# Asidic Monomers

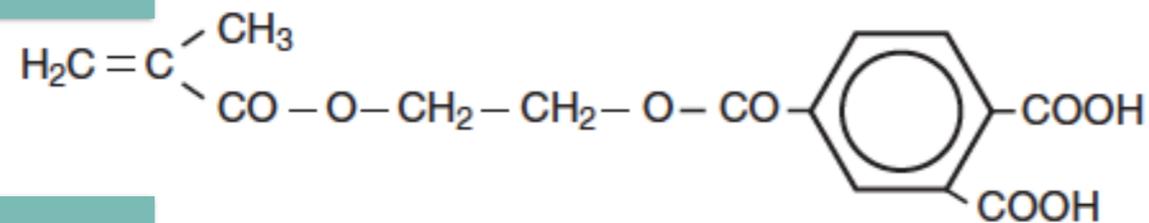
Phenyl-P



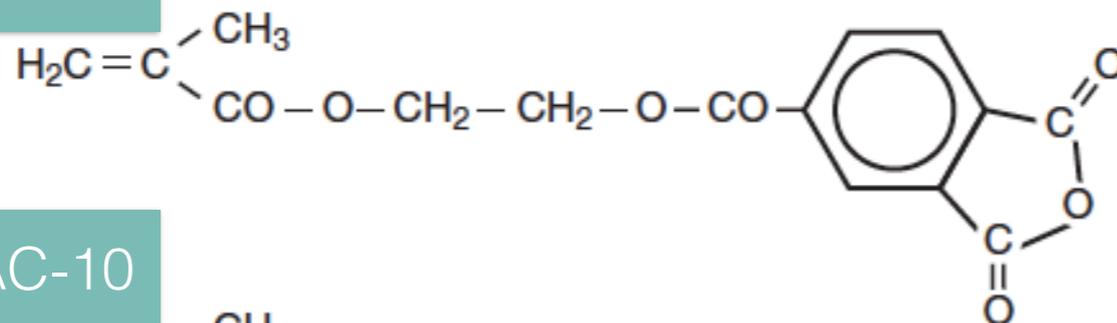
10-MDP



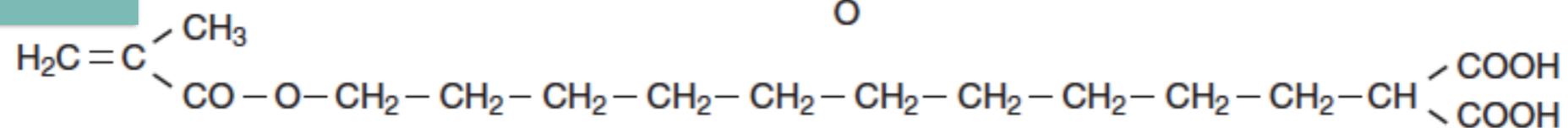
4-MET



4-META

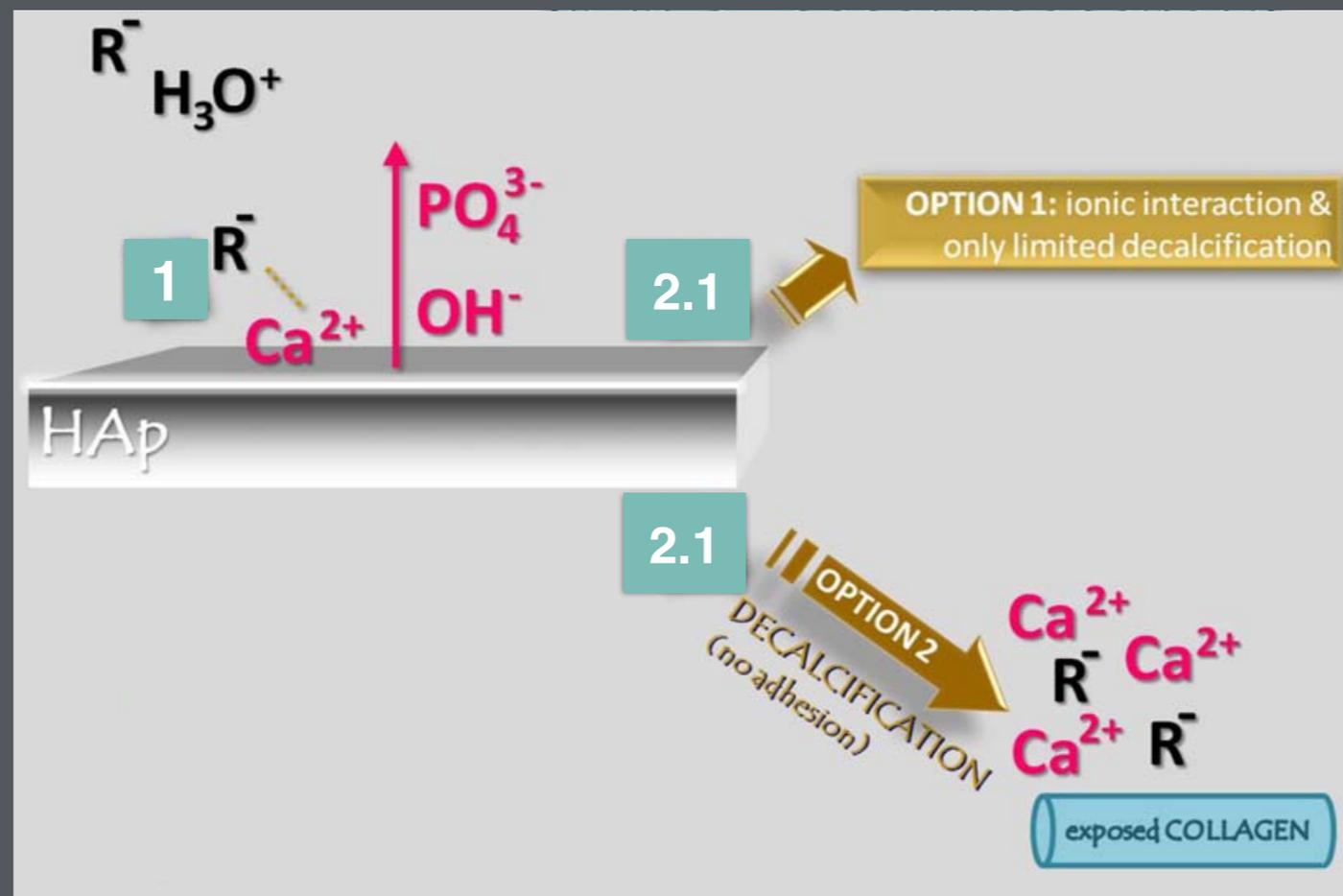


MAC-10



# Mechanisms Of Adhesion/Chemical/Ionic Bonding

Adhesion decalcification concept



# SELF-ETCH SYSTEMS

Adhesive		pH
All-Bond SE	1 Step SE	2.2
Xeno V		1.5
G Bond		1.5
Clearfil S3 Bond Plus		2.7
Futurabond NR		2
Futura Bond M		N.A.
Futura Bond DC		1.4
Adper Prompt L-pop		1.0
iBOND Self Etch		1.6
Clearfil SE Bond		2 Step SE
Clearfil SE Protect	2.0	
Clearfil Liner Bond	1.4	

**Strong - pH ≤ 1**

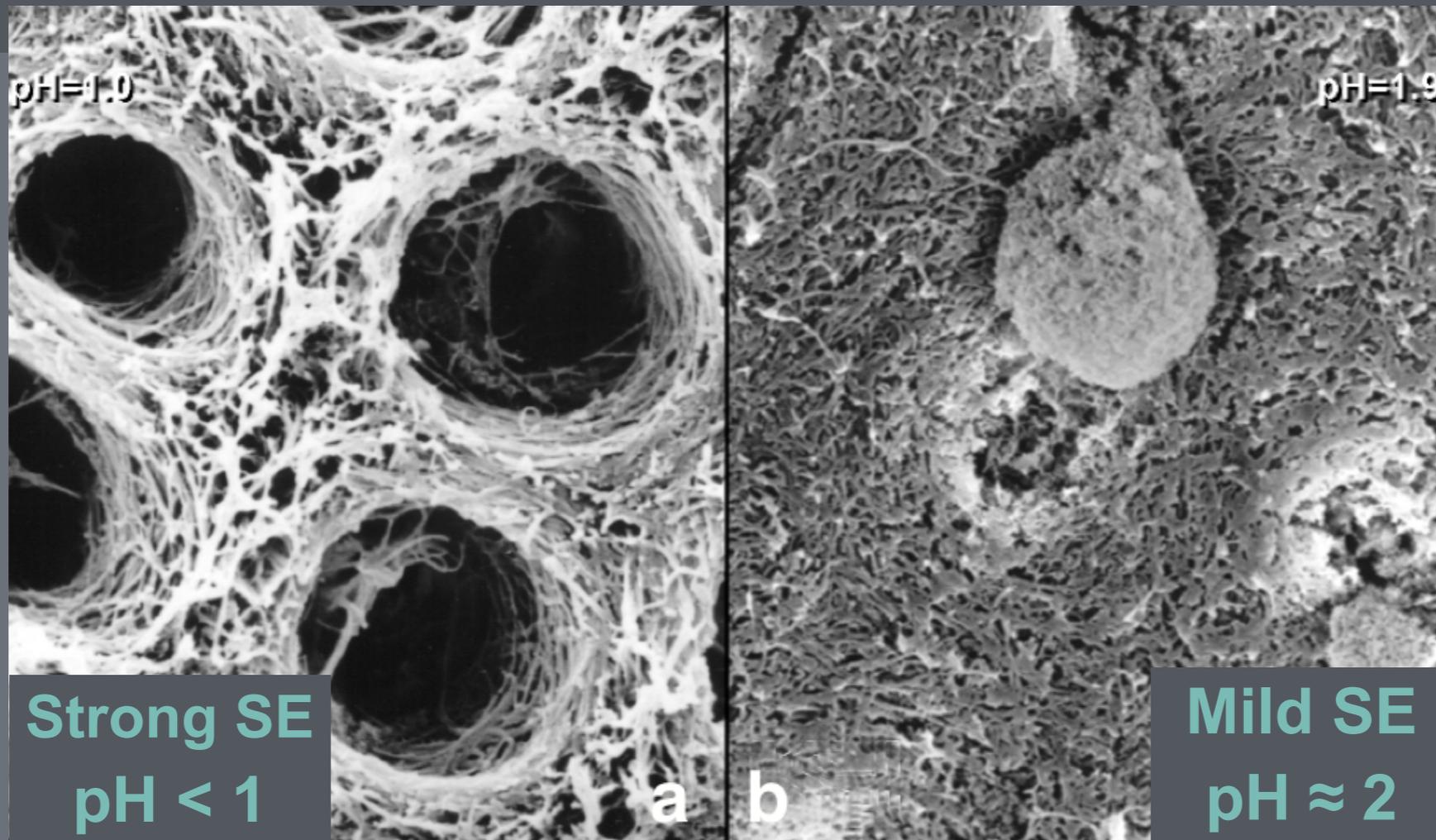
Moderate 1 < pH < 2

**Mild pH ≈ 2**

Ultra-Mild pH=2.5

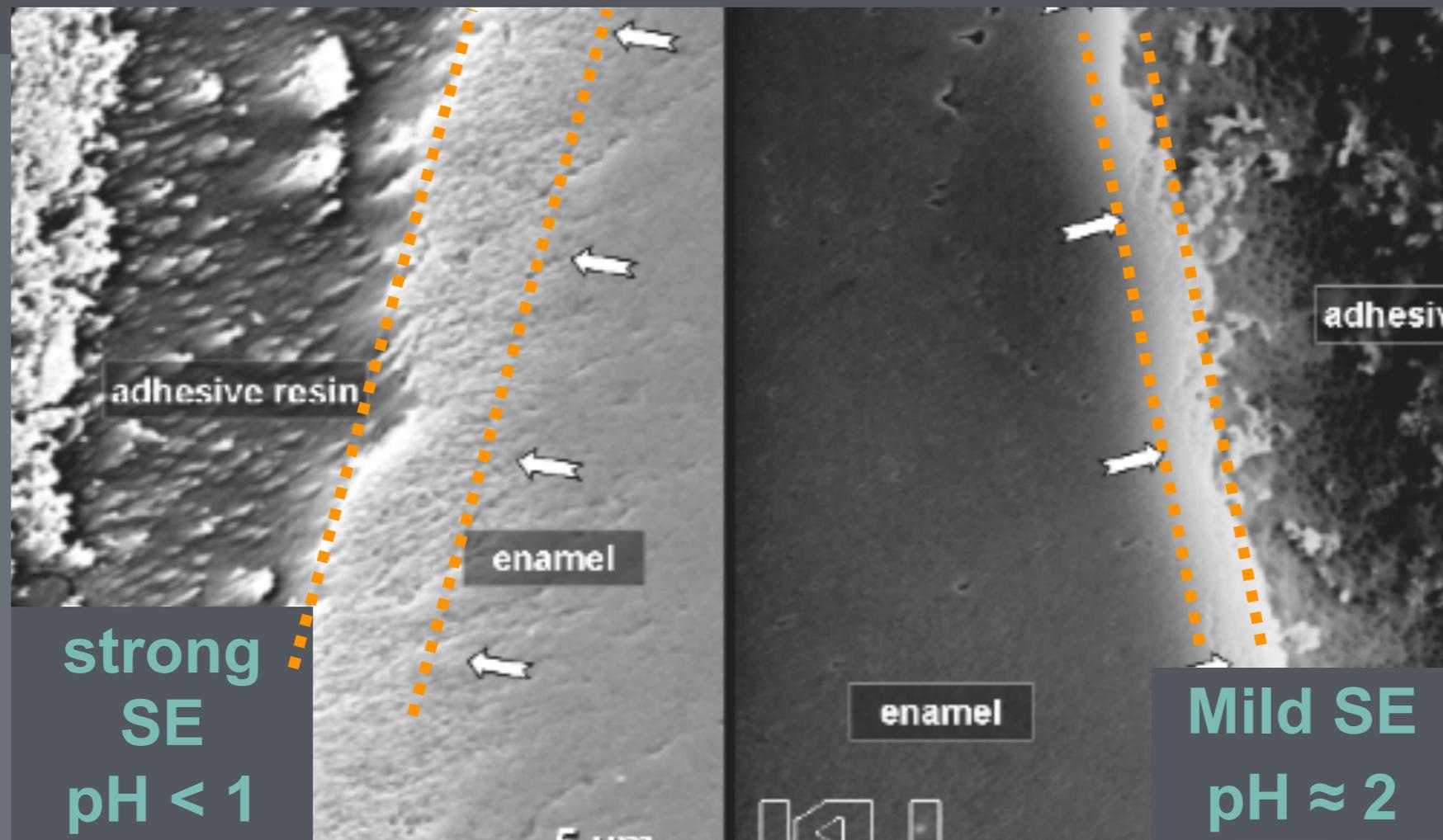
# SELF-ETCH SYSTEMS

## Ph



# SELF-ETCH SYSTEMS

## Effect on enamel



# SELEKTIVE - ETCHING

# SELEKTIVE - ETCHING



Acidic Primer

Adhesive

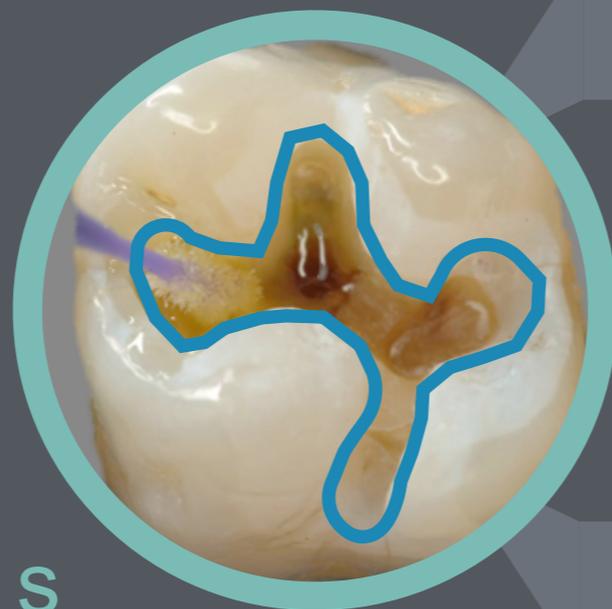


Phosphoric acid

15 s

Rinse

15 s



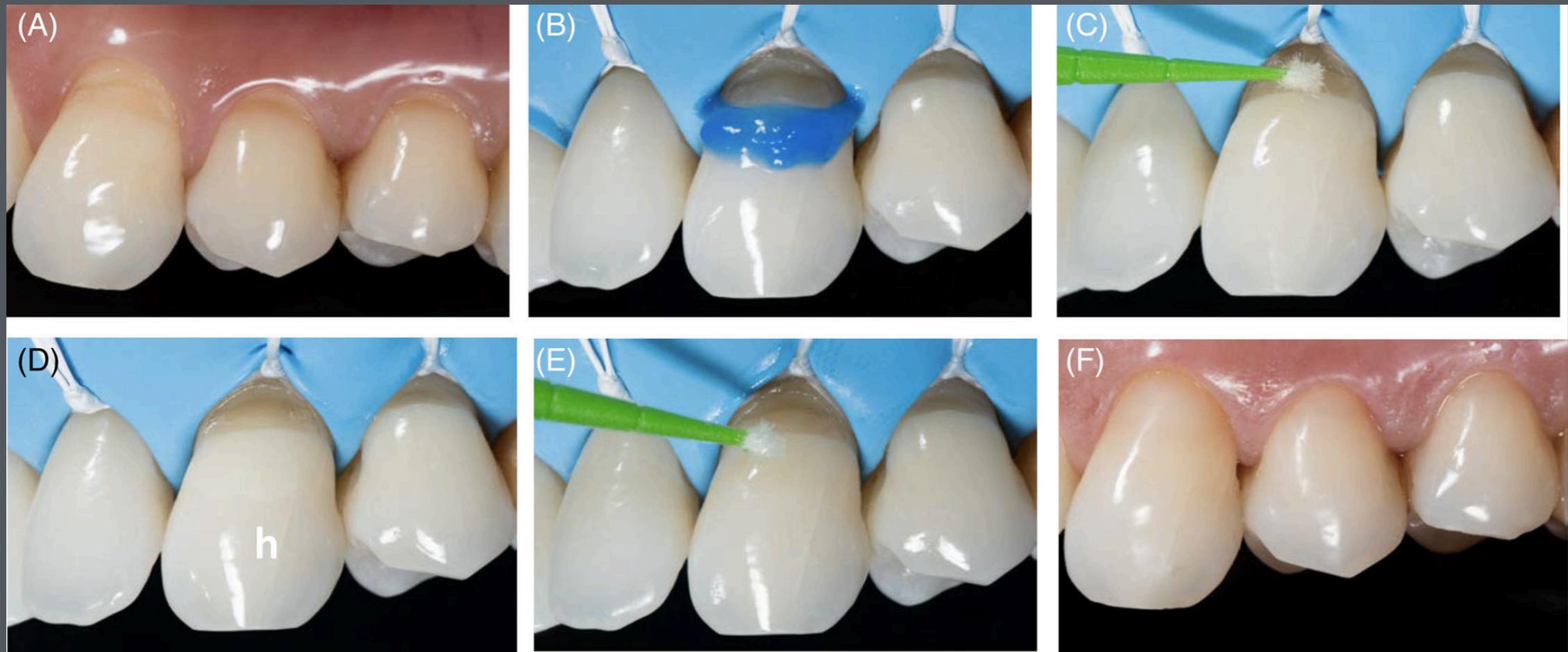
2 step se

1 step se

Ac Acidic Primer Adhesive



# SELEKTIVE - ETCHING



# UNIVERSAL (Multi-mode) ADHESIVES

# UNIVERSAL ADHESIVES



Scotchbond Universal

# UNIVERSAL ADHESIVES

TOTAL - ETCH

SELEKTIVE - ETCH

SELF - ETCH



**Universal Adhesive = 1 step SE**