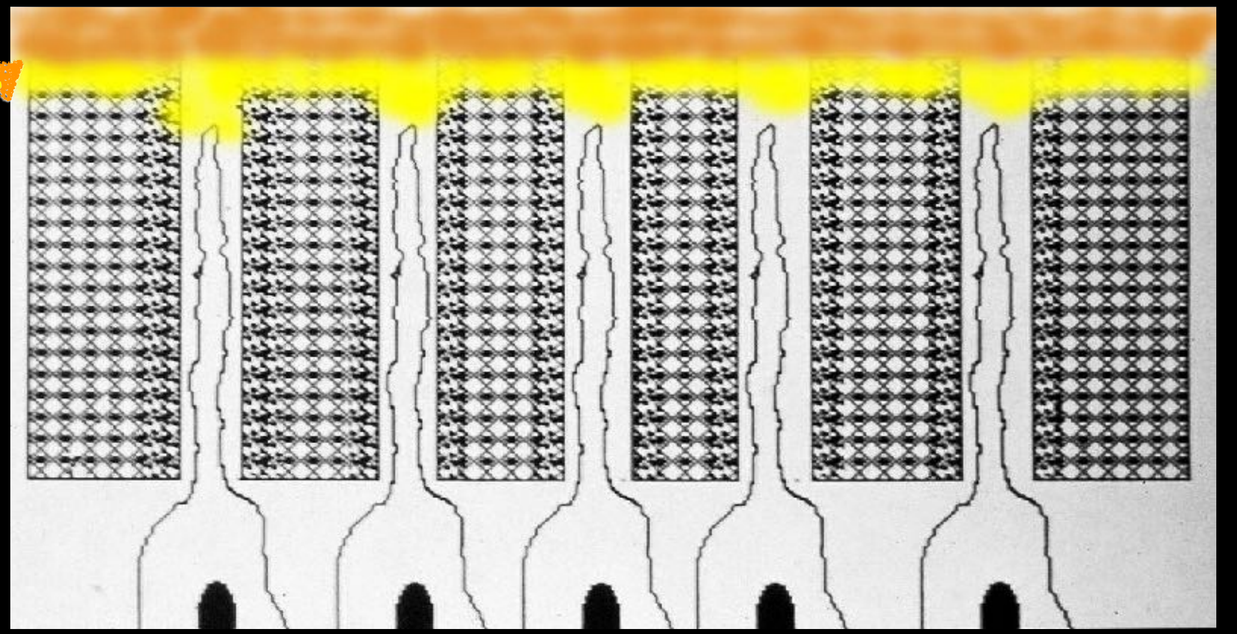
Dentín cross section

Hydrophilic primer

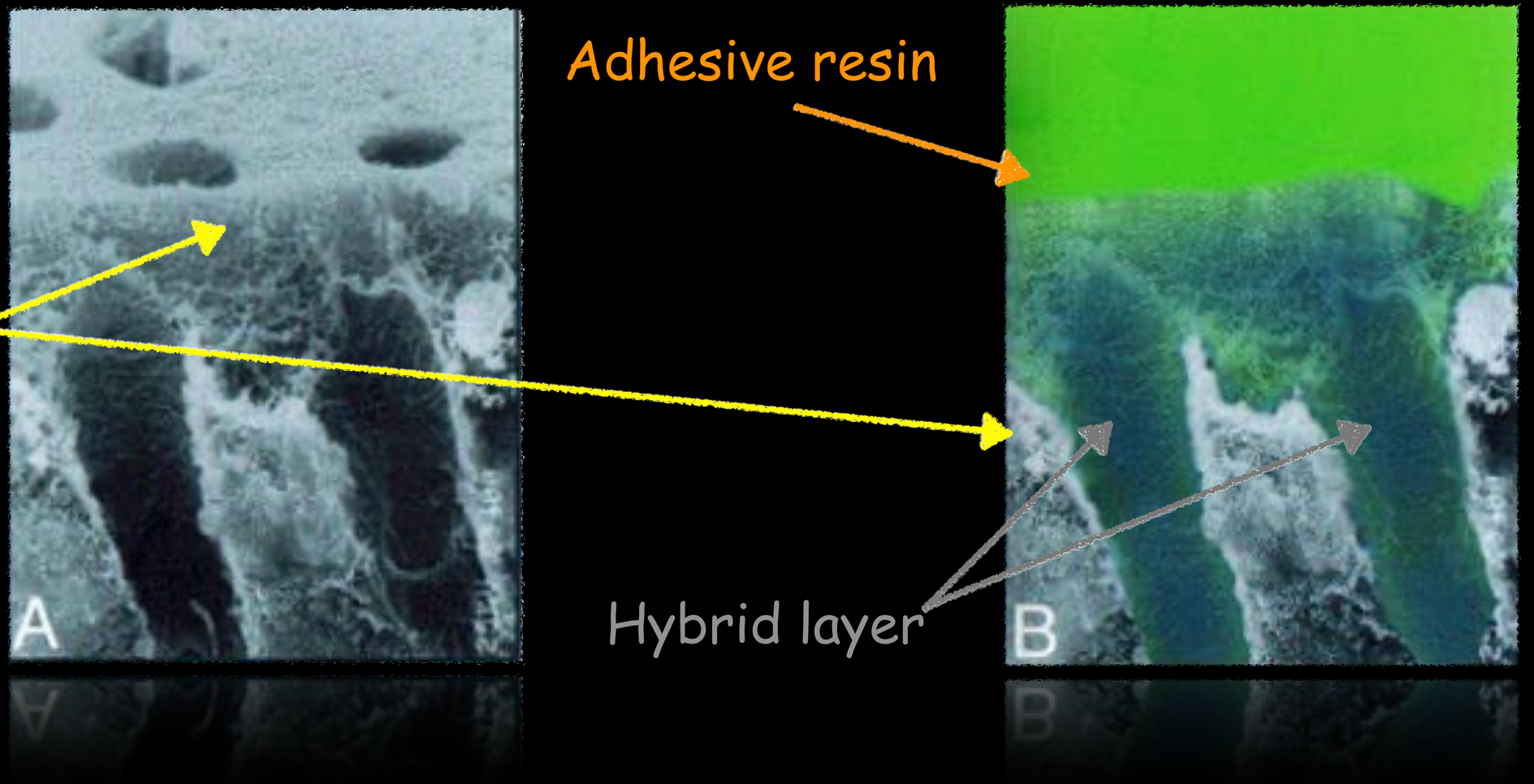
Hybridization & resin tags

Adhesive resin

Stabilization and co-polymerization



JR

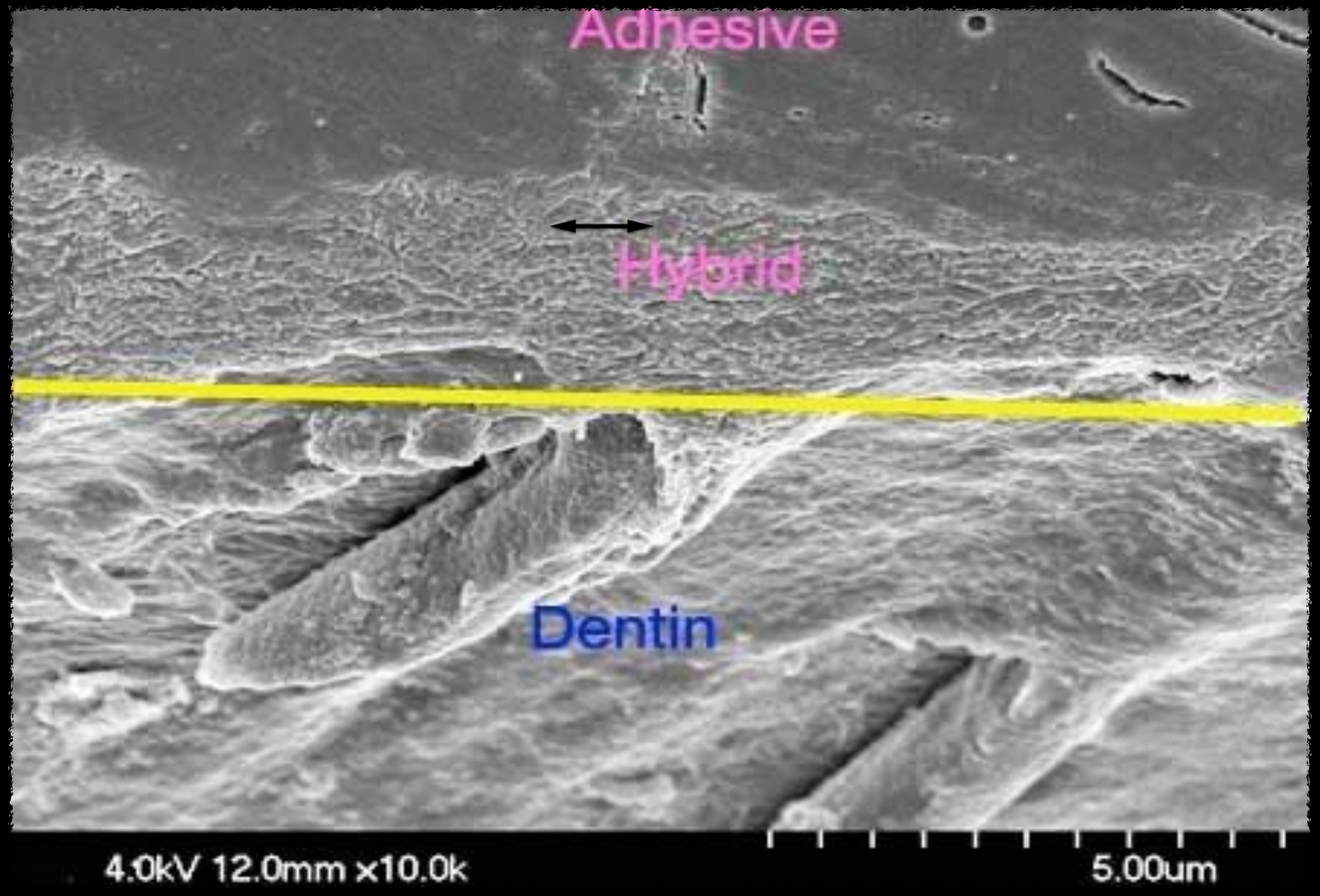

Adhesive resin
Dentin
Hybrid layer
A
B

Tooth-restorative interface

Resin

Hybrid layer

Dentin



JR

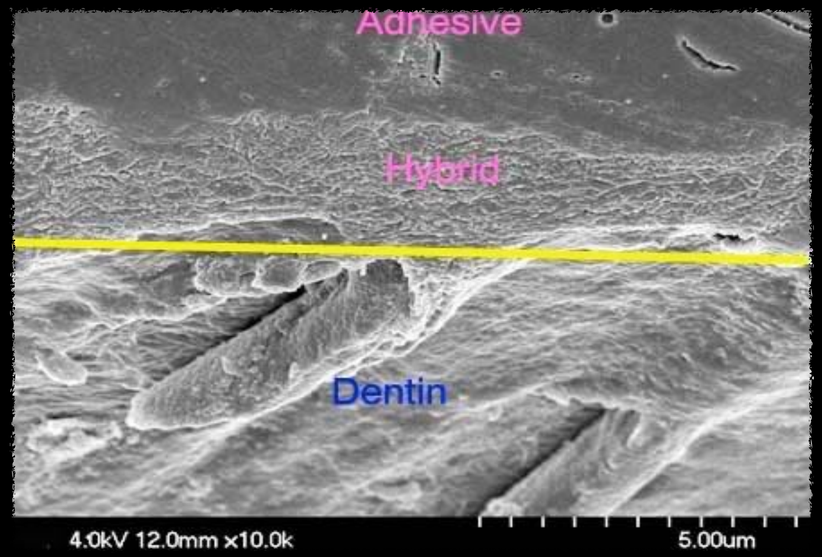
Dentin

Adhesive

(Hybrid layer)

Resin

Hydrophobic end ⟷ Hydrophilic end



JR

Durability of the resin-dentin bond

Incomplete resin infiltration of the demineralized collagen matrix by resin monomers

Hydrolysis of exposed collagen fibrils by host enzymes from the dentin

Hydrolysis of unpolymerized resin by host enzymes from the saliva

Dentin

made with contemporary

me!

Nanoleakage

Dentin bonding made with contemporary hydrophilic adhesives are permeable to water!

Water sorption from dentin during and after bonding
Permeates into hybrid layer
Permeates into adhesive resin layer
"Water Trees"
Hydrolytic breakdown of resin and collagen
Permeability potential is material specific

JR

Conclusion

Dentin bonding is difficult, unpredictable and technique sensitive!

Resin adhesion to tooth structure

The substrates

The products

Clinical considerations

JR

Adhesive systems

Product classification

Descriptive

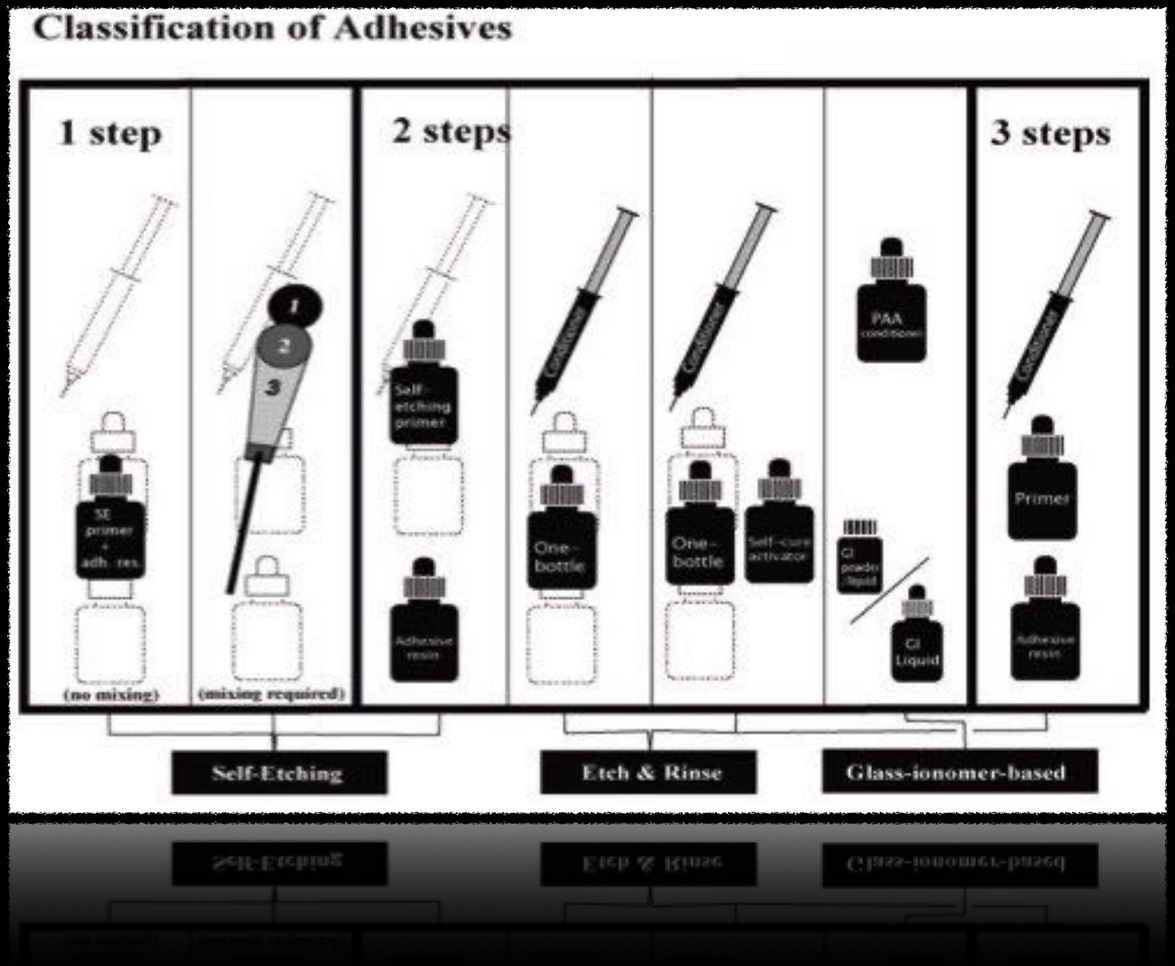
versus

Genealogical

Descriptive:

number of steps (3, 2, or 1)

etch/rinse vs. self etch



Steps - how many?

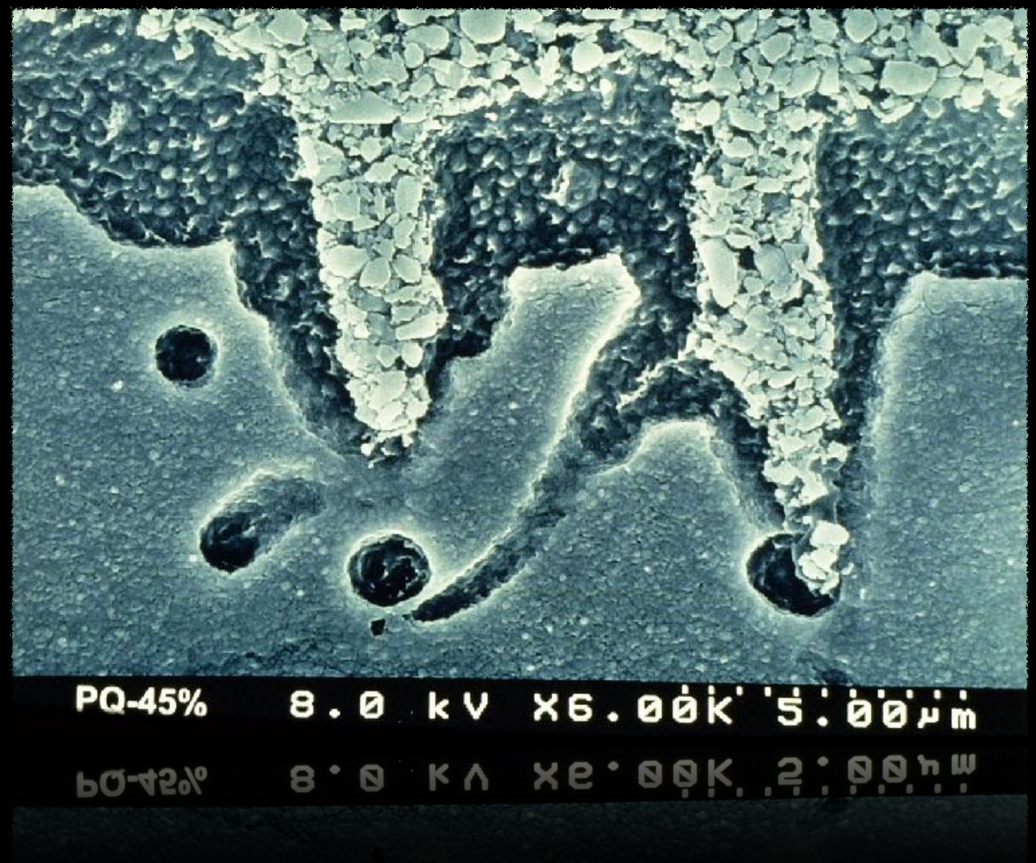
Primer solvent

Total etch or self etch

acetone

ethanol

water



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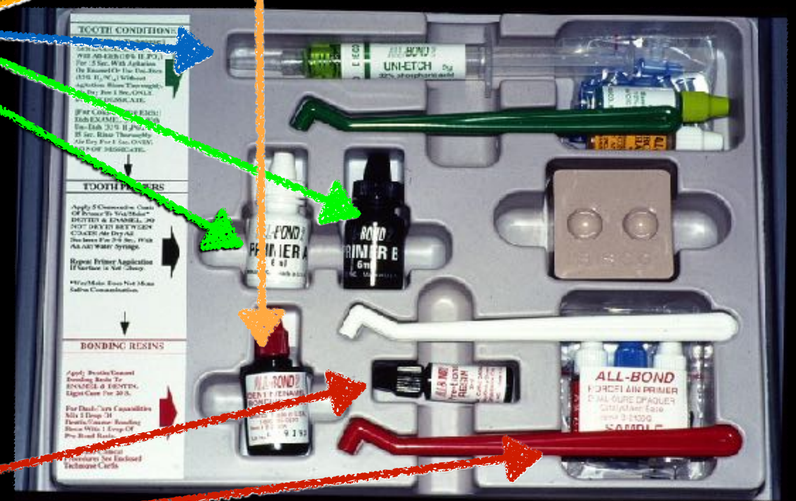
3 - step etch & rinse systems

1992

2006

JR

1. Etch 2. Primer 3. Adhesive resin



Optional components

1. Etch 2. Primer 3. Adhesive resin

Most versatile

Light cure and chemical cure

Direct and indirect restorations

Most predictable

Low technique sensitivity (relatively)

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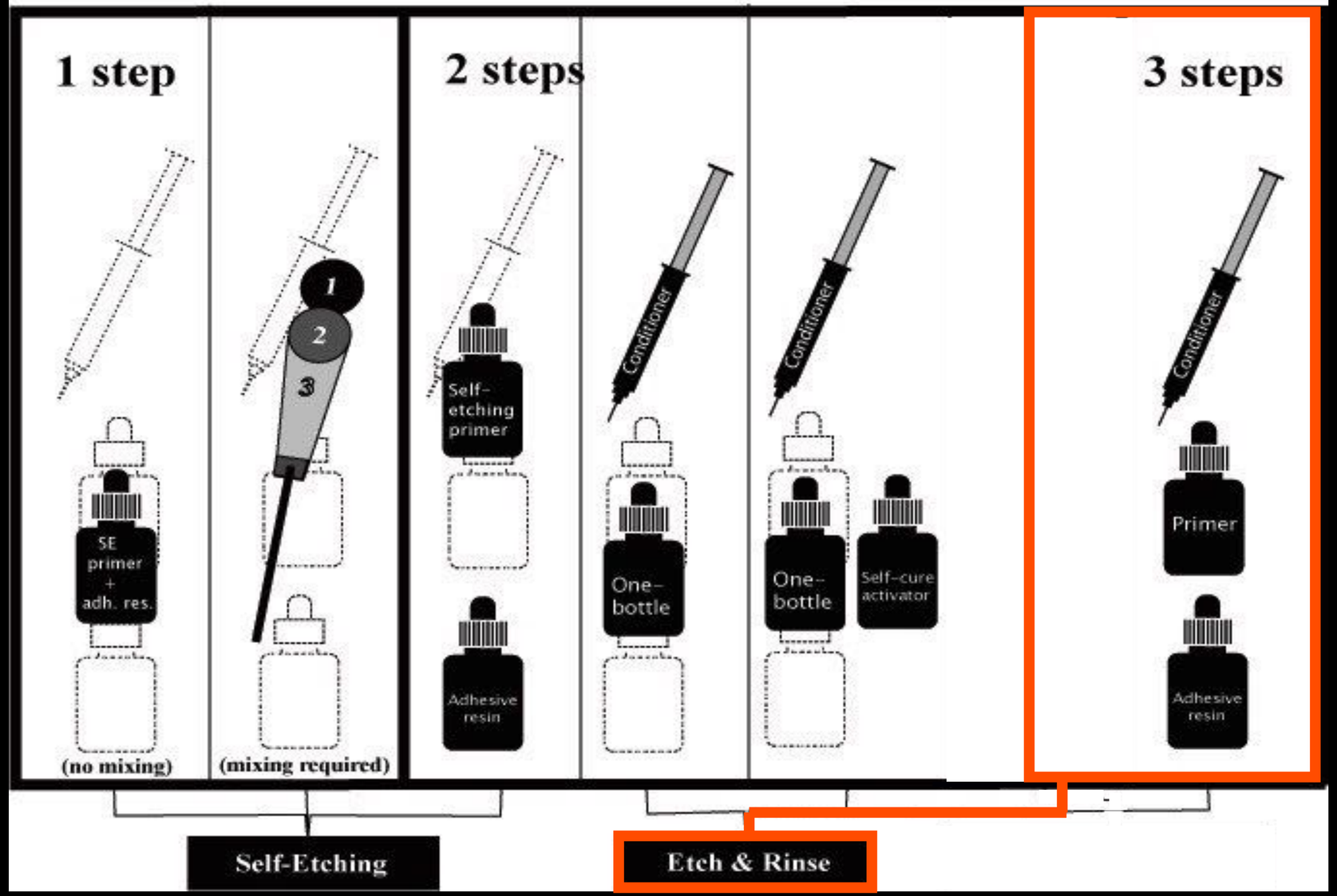
Classification of Adhesives



2 - step etch & rinse systems

1. Etchant 2. Primer/adhesive resin

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1. Etch / primer

2. Adhesive resin

Primer and resin in one container

Simplified inventory and procedure

Convenient for direct restorations

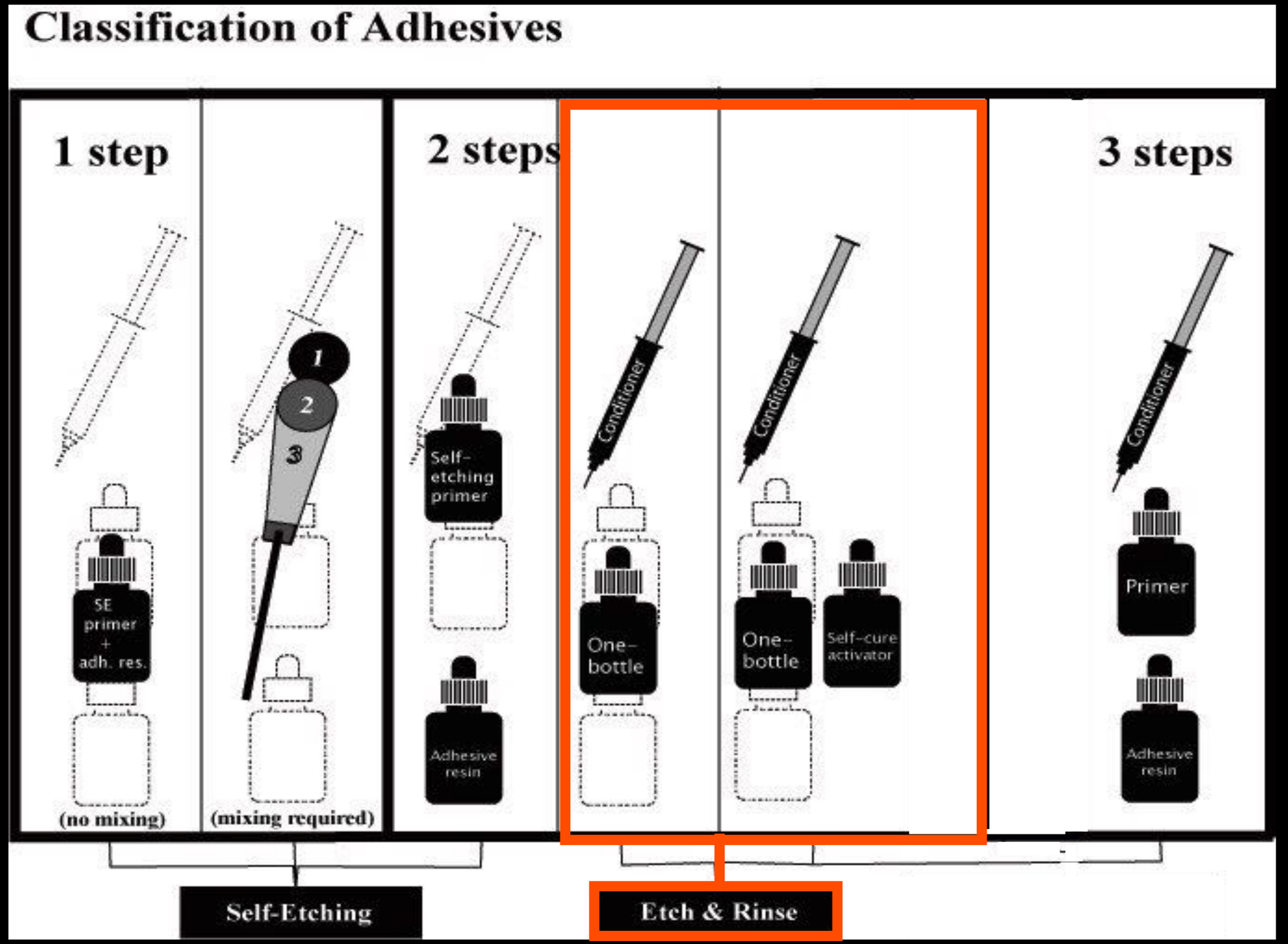
Apply & cure twice for optimal adhesion!

Indirect - use optional dual-cure component

Not reliable with self-cure composites!

1. Etchant. 2. Primer / adhesive resin 2a. "Activator"

JR


Classification of Adhesives
1 step
2 steps
3 steps
SE primer + adh. res.
(no mixing)
1
2
3
(mixing required)
Self-etching primer
Adhesive resin
Conditioner
One-bottle
Conditioner
One-bottle
Self-cure activator
Conditioner
Primer
Adhesive resin
Self-Etching
Etch & Rinse

Self-etching systems

Water-based (for acidity)

Variable acidity

mild:	pH > 2
intermediate:	pH ≈ 1.5
aggressive:	pH ≤ 1

2 - step etching systems

1. Etch / primer 2. Adhesive resin

Acidic primer

- dissolves/suspends smear layer
- primes dentin surface

Less aggressive → ↑ consistency?

↓ post-op sensitivity?

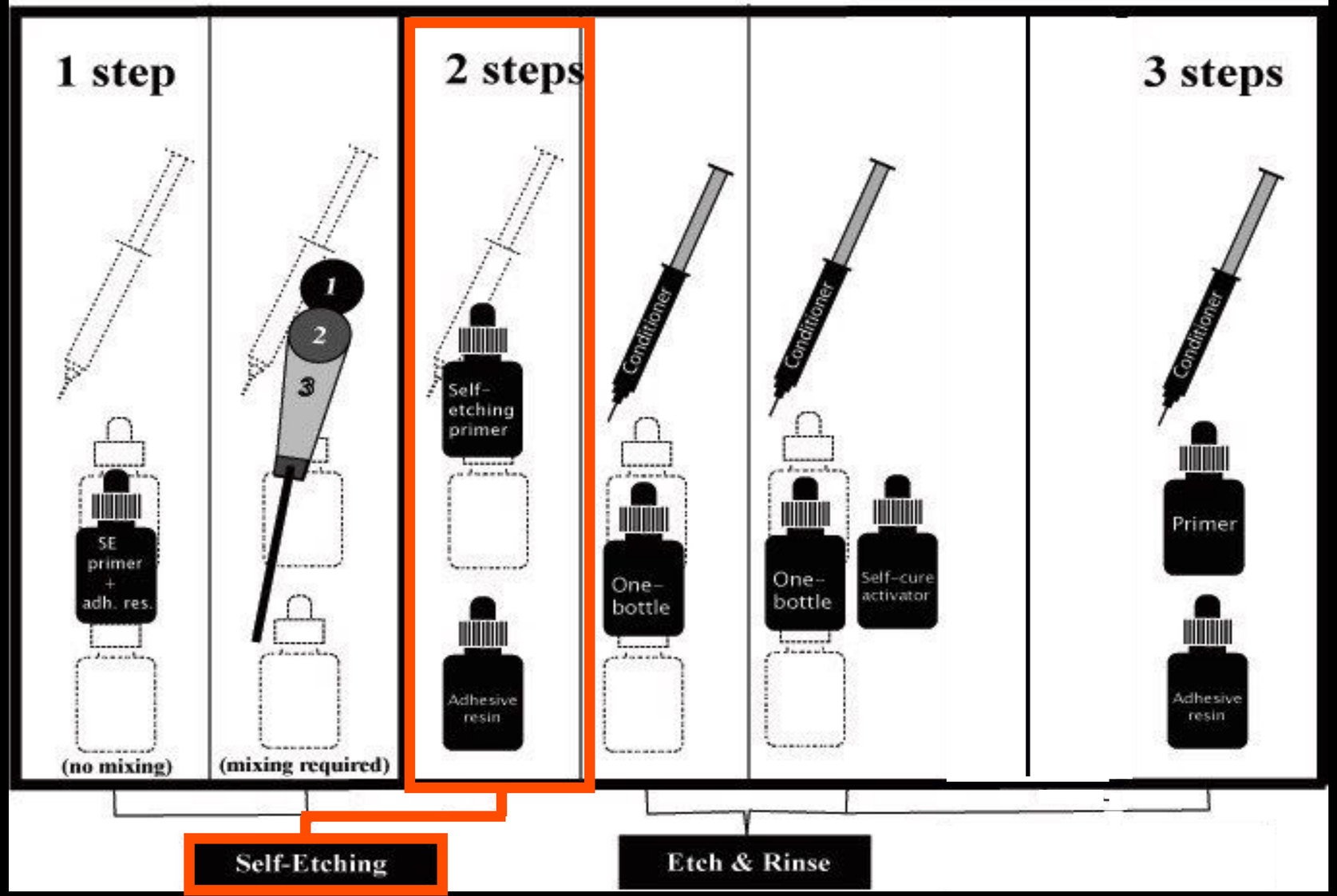
Adequate etch of enamel?

Immediate bond strength?

JR

1. Etch / primer 2. Adhesive resin

Classification of Adhesives



1 - step etching systems

1. Etch / primer / adhesive resin

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1. Etch / primer / adhesive resin

All-in-one

Mixing and no mixing varieties

Adequate etch of enamel?

Immediate bond strength?

No mixing…but shake up!

iBond (Heraeus Kulzer)

G-Bond (GC)

Clearfil S^3 Bond (Kuraray)

Adper Easy (3M/ESPE)

JR

Why must we mix?

Acidic monomers stored in water are subject to hydrolysis during storage

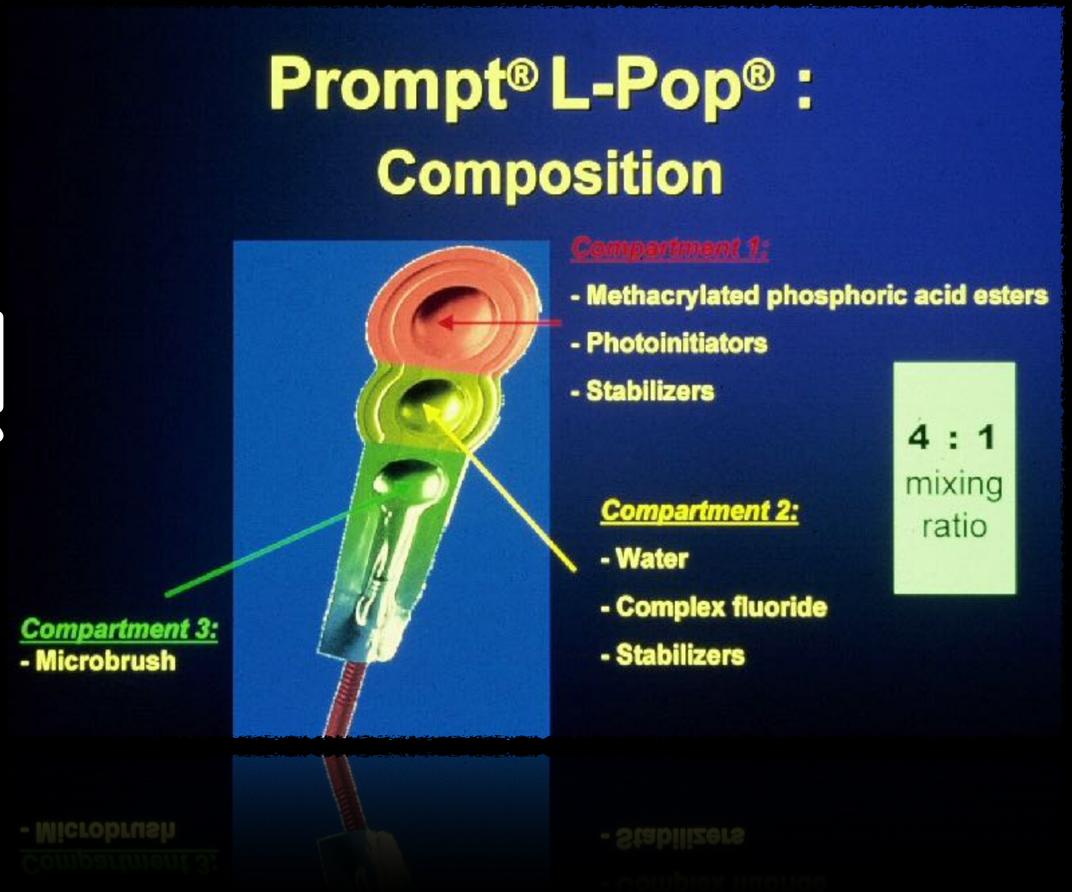
and hydrolized monomers will not polymerize

Earlier self-etching products, therefore, kept resin and water components

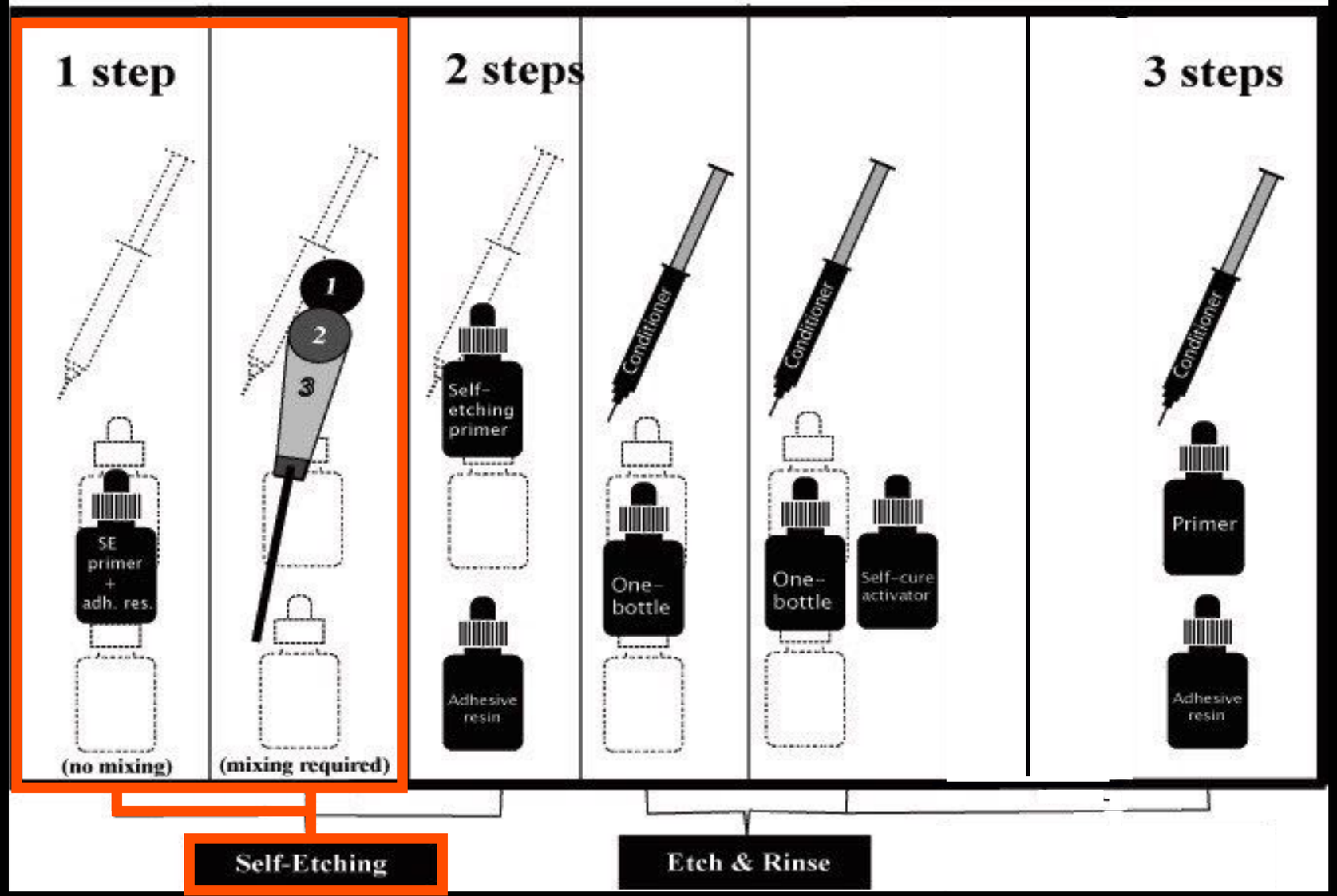
separately packaged and required mixing

1. Etch / primer / adhesive resin

Mixing required!



Classification of Adhesives



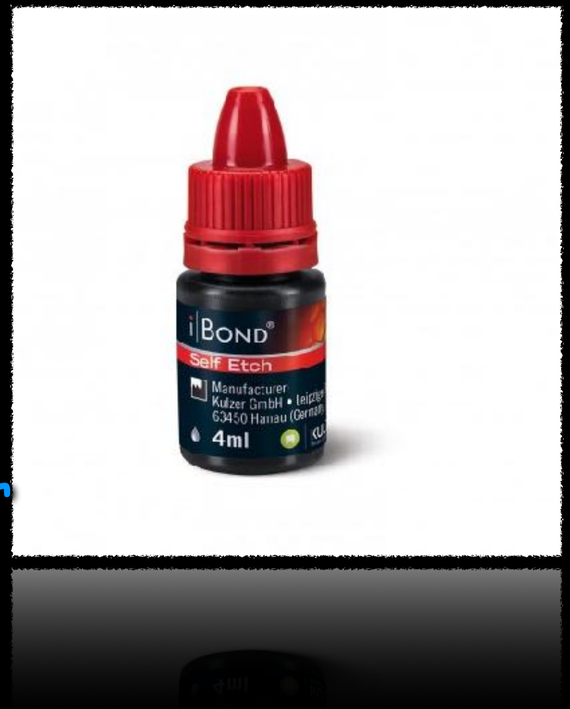
1. Etch / primer / adhesive resin

No mixing

Is bond strength improved by adding a layer of hydrophobic adhesive resin?

YES!

Significant increase in bond strengths



Reduced diffusion of water through hybrid layer

Thicker adhesive layer → less shrinkage stress

" All self-etch adhesives, no matter how they are labeled, are probably most effective as primers."

JR

Considerations for self-etching systems

Milder treatment of dentin

More consistent and predictable hybridization?

Incompatible with self-cure composites

Enzyme degradation → durability?

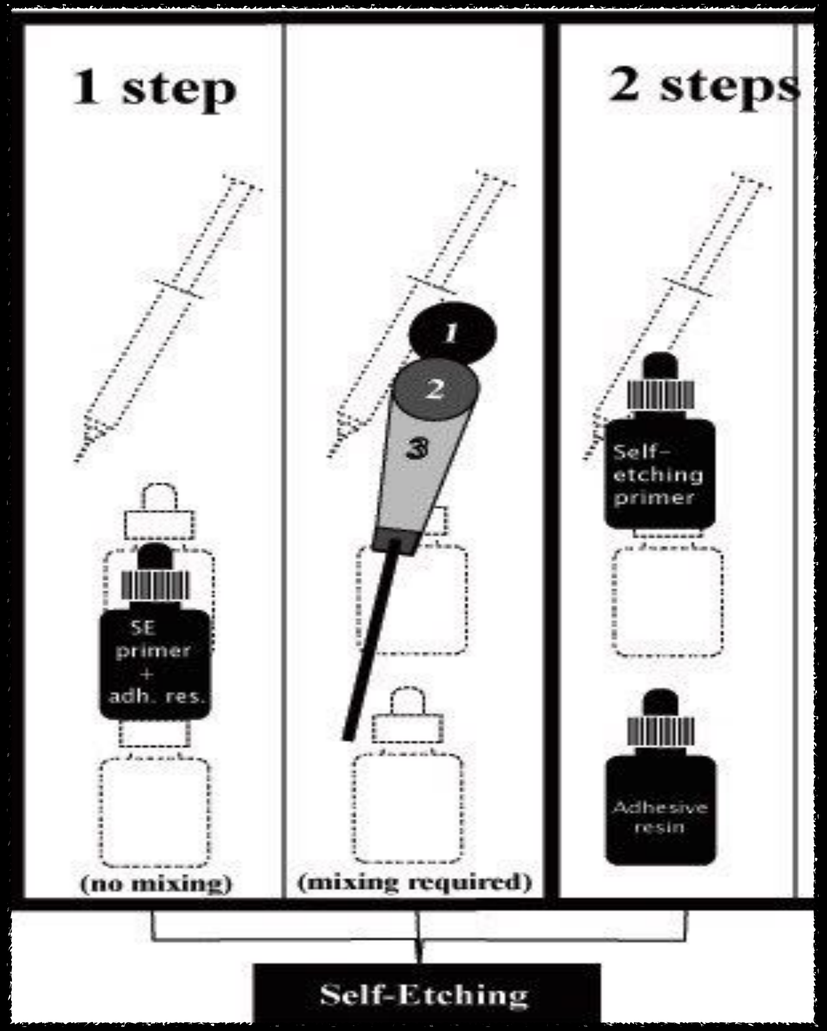
Permeability/water diffusion → durability?

Water "trees" and "blisters" (Tay and Pashley)

Variable acidity among current products

Bond to enamel?

Simplicity ≠ efficacy



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Genealogical

Product classification

Generations 1 through 8

Marketing -based

Implies that newer generations are BETTER

Misleading and confusing

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1st generation dentin bonding agents

(early 1960's)

Designed for ionic or covalent bonding to collagen

Phosphate esters of Bis-GMA

Dentin etching contraindicated

Tended to be hydrophobic

Bond strengths of 2 – 6 Mpa

e.g. Cervident (S.S. White)

2nd generation dentin bonding agents

(early 1980's)

Acid etching of dentin still not indicated

Used organophosphate esters of various monomer

Provided minimal shear bond strengths of 5-6 MPa

Agent placed directly on smear layer

Glutaraldehyde introduced - thought to denature smear layer and collagen

e.g. Scotchbond (3M), Bondlite (Kerr)

3rd generation dentin bonding agents

(late 1980's)

Acid etching dentin still contraindicated
Attempted to remove or penetrate the smear layer
2 component systems introduced
Many different chemical systems
Shear bond strengths 8 – 15 Mpa
Bonded to metals & ceramics as well as tooth structure

e.g. Scotchbond 2 (3M)

Gluma (Heraeus Kulzer)

JR

4th generation dentin bonding agents

(early 1990's)

First systems to recommend "Total Etch"

True universal adhesives

Could produce "gap free" restorations in-vivo

Shear bond strengths 17 – 25 MPa

Bonded well to all dental related substrates

Enamel, dentin, ceramic, metal, amalgam

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4th generation dentin bonding agents

(early 1990's)

Etch

Prime

Bond

Tenure S - Den-Mat
Optibond - Kerr
All-Bond - Bisco
Adper - 3M/ESPE
Gluma Solid - Kulzer

Multi-Component

JR

5th generation dentin bonding agents

(Middle 1990's)

Etch

Gluma Co[illegible]ond - Kulzer

Prime/bond

Solo/Plus - Kerr

SingleBond - 3M/

One Bottle Adhesive Systems

JR

6th generation dentin bonding agents

(2000)

Etch
Prime
Bond

Prompt L-Pop
SE Clear Fil

One component *1 step*

Multi-component *2 steps*

Self etching primer and bond

JR

7th generation dentin bonding agents

(2002)

Etch
Prime
Bond

Self etching primer, bond, desensitizer and disinfectant

JR

8th generation dentin bonding agents

(2011)

JR

8th generation dentin bonding agents

Used with phosphoric acid any time a total-etch approach is desired.

For example, veneers and Class IV restorations

Use as a self-etch adhesive when desired.

For example, posterior restorations, pedo applications

Primes zirconia, alumina, etched ceramics, and alloys

JR