ORTHODONTIC BONDING MATERIALS (AN UPDATE)

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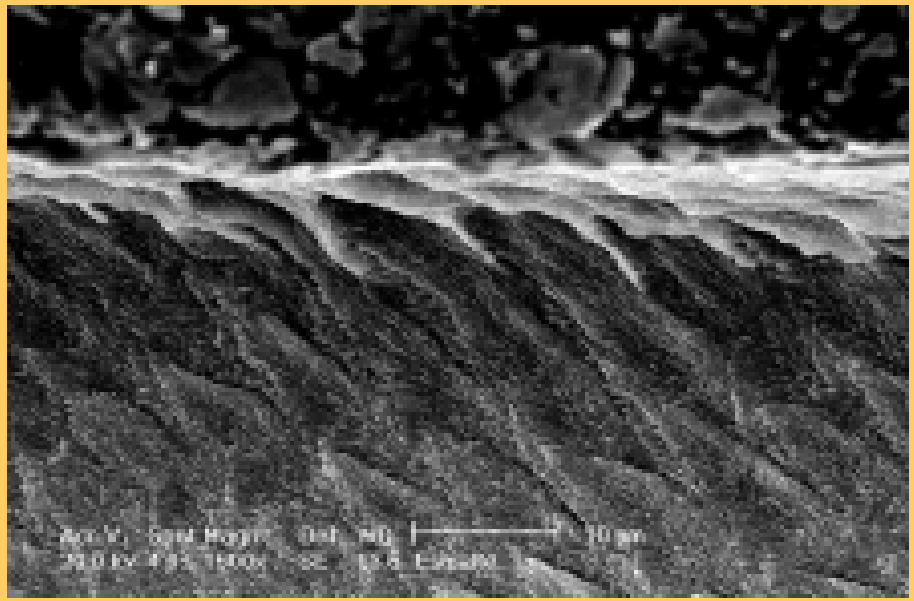
Introduction to dental adhesion

Adhesion or bonding entails molecular interactions at the junction between dissimilar materials. Any process termed as adhesion is really an assembly that is defined as an “adhesive joint” (Marshall et al., 2010).

“adhesive”

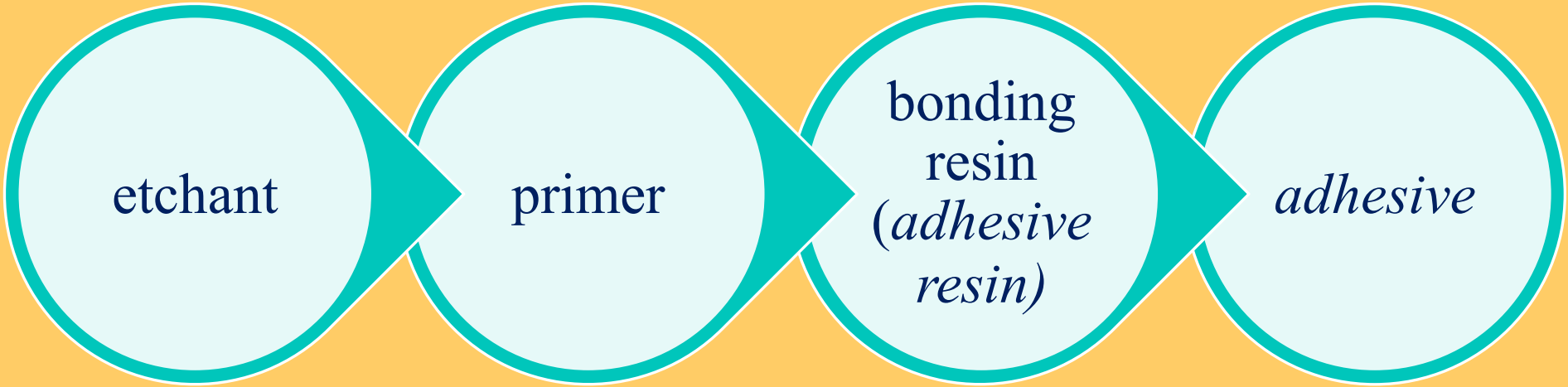
“interface”

“adherend” or “surface”



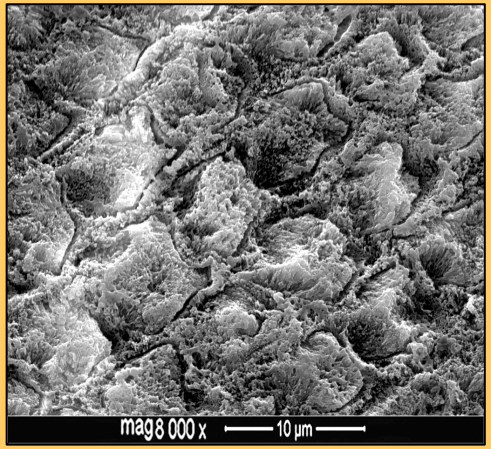
Introduction to dental adhesion

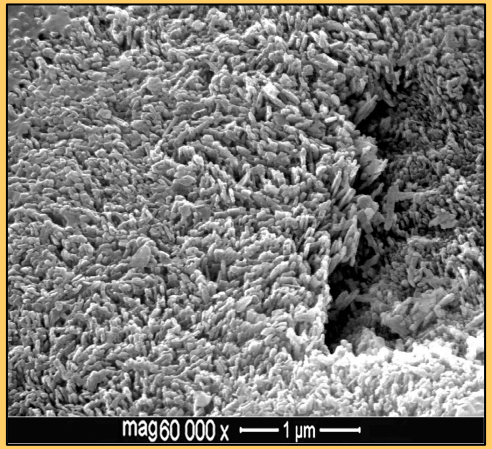
- Dental adhesives consist of three main components:

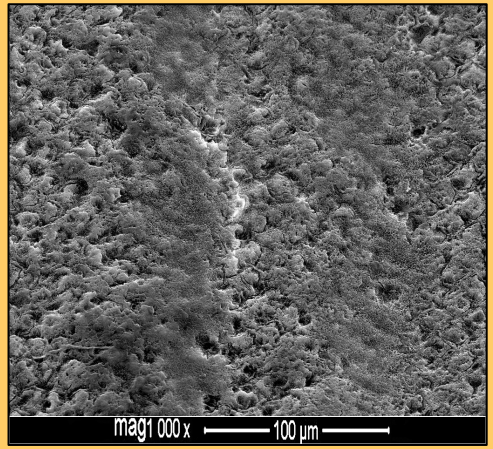


Etchant

low, hydrophobic surface to a hydrophilic high-energy surface which almost "sucks" the resin material into the rough surface







Primer

The primer serves as a type of molecule that helps make the treated surface, which is very hydrophilic, become more hydrophobic in order to accept the very hydrophobic bonding resin.

Bonding resin

The bonding resin then becomes incorporated into the primed surface and, once cured, forms the structural support of the bonded interface between the tooth and the subsequently placed composite material.

Bonding resin

- A hydrophobic polymeric layer is more insoluble and resistant to erosion and degradation by acids and other components of oral fluids than a more hydrophilic one.
- The ideal adhesive would have a hydrophilic nature during placement and would become much more hydrophobic after curing. Such materials are not readily available to dentistry—instead, a combination of hydrophilic and hydrophobic molecules are used in modern adhesives to effect durable bonding.

Bonding resin

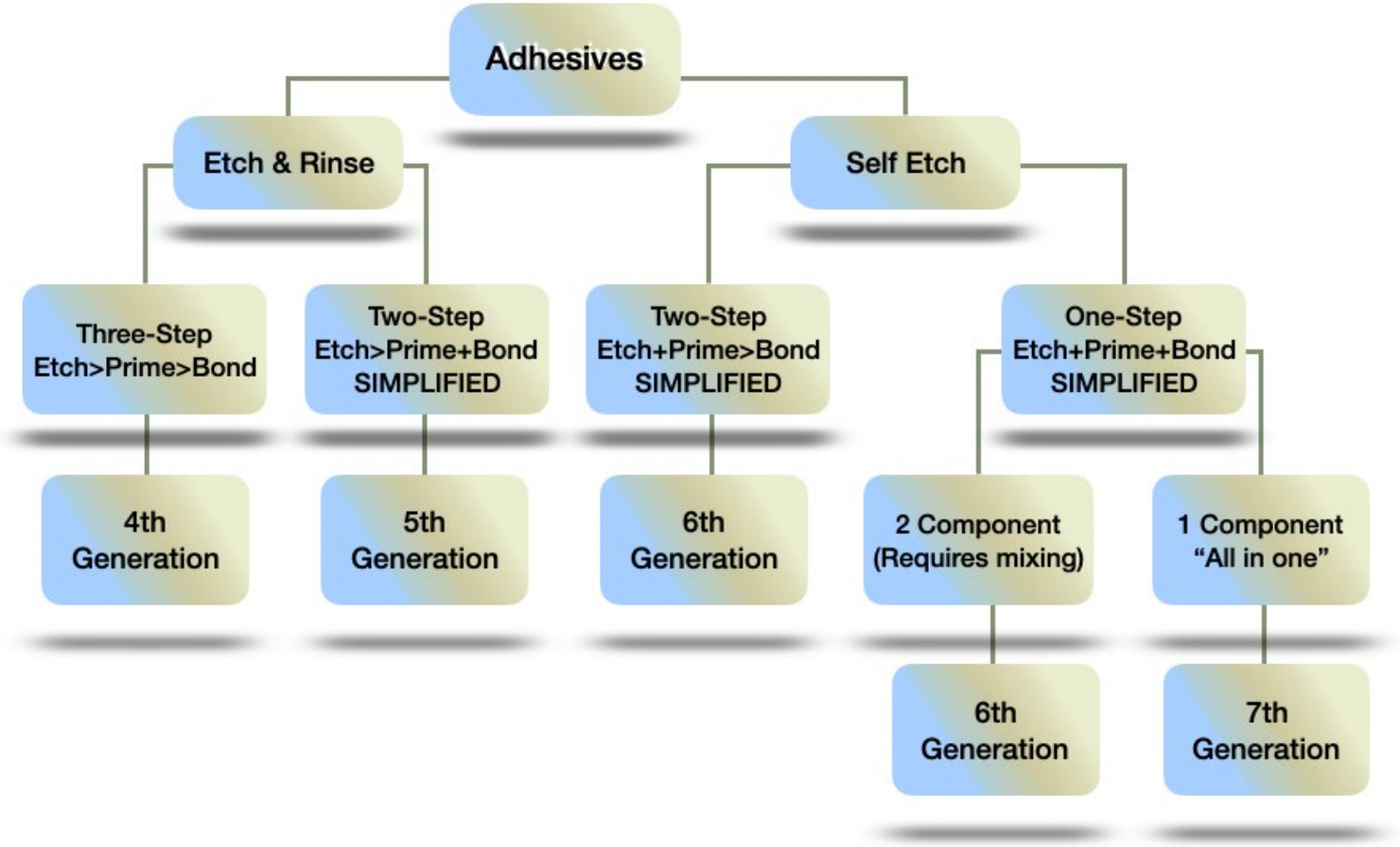
- Bisphenol glycidyl methacrylate (bis-GMA), the main monomer used in most bonding materials.
- A monomer like hydroxylethyl methacrylate (HEMA) is totally miscible in water and serves as an excellent polymerizable wetting agent for dental adhesives.

Adhesion systems classification

Adhesives have two main categories in the classification system related to their mechanism of adhesion, namely the Etch-and-rinse system (EAR) and the self-etch system (Corrado Profeta, 2013 ; Manolea et al., 2016 ; Cerone, 2017).

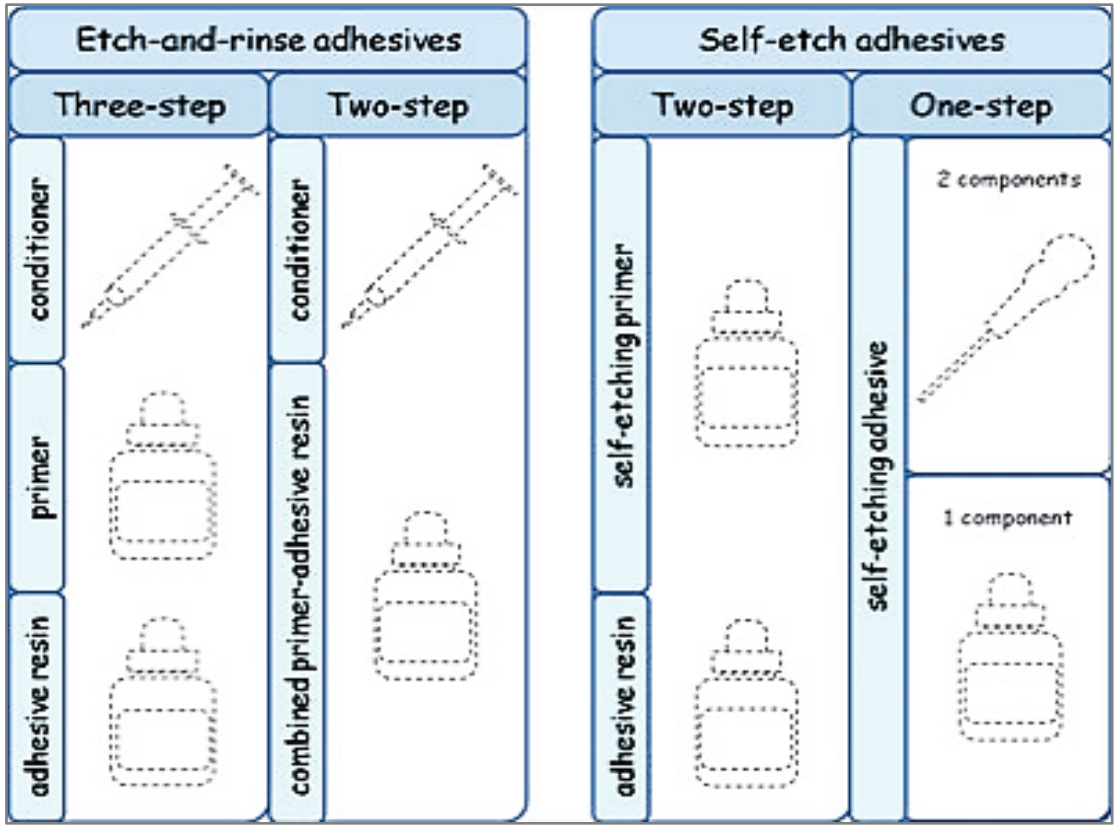
Adhesion systems classification

These systems are hierarchy systems, which can be furtherly classified according to the number of clinical steps into four subcategories: three-step EAR, two-step EAR, two-step self-etch, and one-step self-etch. In addition, the adhesives can be classified according to their order in industrial introduction into eight generations, reflecting substantial variations in product characteristics in each class. Currently, adhesives from the fourth to eighth generation are presented in dental markets (Alkadhimi and Motamedi, 2019).



Adhesion systems classification

Classification of contemporary adhesives. Two-step etch and rinse adhesives are also referred to as ‘one-bottle’ systems, while one-step self-etch adhesives are often referred to as ‘all-in-one’ systems. Each component, either primer or bonding or even self-etching adhesive can be presented in two separate bottles that need to be mixed prior to application. Therefore, one-step self-etch adhesives may be subdivided into one- and two-component systems (Cardoso et al., 2011).



Primer

Two-step etch and rinse adhesives are also referred to as ‘one-bottle’
Transbond XT primer (3M Unitek)

Primer

Self-etching primers such as Transbond Plus (3M Unitek) and SEP (Reliance Orthodontic Products) now are part of the orthodontic armamentarium

Primer

Self-etching systems offer simplified bonding strategy,

- ✓ lower contamination risk.
- ✓ less technique sensitive.
- ✓ more user-friendly.
- ✓ Time-saving bonding.
- ✓ beneficial in a moist environment (Hellak et al., 2016 ; Shaik et al., 2018).

Primer

Self-etching primers
Transbond Plus (3M Unitek)

Primer

Transbond Plus Self Etching Primer system consists of three bubble reservoirs (Pashley and Tay, 2001):

- The first one contains methacrylated phosphoric acid esters, bis-GMA, photoinitiators (camphor quinone), and stabilizers.
- The second one contains water, HEMA, polyalkene acid, complex fluoride and stabilizers. The bubble is activated by squeezing the first reservoir, thereby discharging its content into the second.
- The freshly mixed fluid is discharged into the third bubble section, which accommodate a small applicator tip.

Primer

Self-etching primers versus EAR adhesives

systematic reviews (Fleming et al., 2012, Hu et al., 2013 , Bharathi and Jain, 2019).

NS

In view of an absence of conclusive evidence, the choice of enamel bonding technique in orthodontics is governed by orthodontist preference (Alkadhimi and Motamedi, 2019)

Primer

SEP (Reliance Orthodontic Products): Assure Plus is the latest generation of universal bonding resins used as self etch or total etch primer

- Eliminates additional conditioners with:

– Stainless
– Composite
– Amalgam
– Acrylic
– Gold
– Pontics

- Porcelain with Porcelain Conditioner (silane)
- Zirconia
- Lithium Disilicate

Primer

None of the mild and ultra-mild universal adhesive types (pH 2.3–3.2) used in self-etch mode attained satisfactory bond strength, suggesting the use of more aggressive SEA (Cerone et al., 2019).

Orthodontic Adhesives Composite

Transbond XT composite (3M Unitek)

Orthodontic bonding materials, What are the updates?

Orthodontic bonding materials

- SBS.
- DEMINERALIZATION (WSL).
- ENAMEL DAMAGE (CRACKS, FRACTURES).
- ADHESIVE REMNANTS.

Primers update in orthodontic

nCaP were incorporated into the composite adhesives (Zhang et al., 2016a ; Xie et al., 2019 ; Hasan, 2021, Noor and Ibrahim, 2022) or other antimicrobial agents combined with the primers such as silver oxide (Akhavan et al., 2013 ; Sodagar et al., 2016) or calcium fluoride nanoparticle (Tuma and Yassir, 2021) depending on the ion-release concept.

Adhesives Composite update in orthodontic

In vitro studies

Orthodontic composite resin Aegis Ortho (The Bosworth Co. Illinois) incorporating nACP as bioactive filler showed superior performance against demineralization as compared with conventional Transbond XT composite and comparable performance to the RMGIC (Fuji Ortho LC).
(Uysal et al., 2009).
Likewise, when orthodontic brackets bonded with Aegis Ortho, the enamel around the brackets could be significantly harder than the enamel around brackets bonded conventional Transbond XT (Uysal et al., 2010a).
Furthermore, Aegis Ortho adhesive material exhibited reduction in lesion depth and bacterial adhesion to the control adhesive Transbond XT (3M Unitek), but were comparable to fluoride releasing orthodontic adhesive Quick Cure (Reliance Orthodontic Products, Itasca, IL).
However, they showed significantly lower SBS (mean: 24.2 ± 5.4 MPa) as compared to conventional composite resin (mean: 36.7 ± 6.8 Mpa. However, 90% of the teeth bonded with Aegis Ortho showed more than half of adhesive left after brackets debonding (Uysal et al., 2010b).

Adhesives Composite update in orthodontic

In vivo studies

- Aegis Ortho (The Bosworth Co. Illinois) compared to the conventional Transbond XT composite (3 M Unitek, USA), the nACP-containing adhesive significantly reduced the demineralization of enamel adjacent to brackets after 30-day or 45 day experimental period (Agarwal et al., 2013).

- A more recent clinical study compared Aegis Ort. Illinois) with Transbond™ Plus Color Change Adhesive (3M Unitek), the latter contains fluorosilicate glass as the fluoride releasing orthodontic adhesive. Both orthodontic adhesive showed efficient bonding and WSL prevention which were assessed after 3 and 6 months of orthodontic treatment (Naidu and Suresh, 2019).

Adhesives Composite update in orthodontic

However, the anti-demineralizing effect of Aegis Ortho was not always significant.

In two in vitro studies, it showed a lower remineralizing effect when compared to

- **Transbond XT (3M Unitek)**

or other preventive measures such as,

- **Vanish fluoride varnish (3M),**
- **Pro-seal resin sealer (Reliance),**
- **casein phosphopeptide-ACP paste (MI Paste) (Behnan et al., 2010)**
- **RMGI (Fuji Ortho), sealant ProSeal (Reliance),**
- **Clinpro XT Varnish (3MEspe) (Paschos et al., 2016).**

Conclusion

Orthodontic bonding materials showed effective performance, however, research is ongoing on the development of an orthodontic bonding system that combines the positive effect of remineralizing, antibacterial protective agents with commercially available materials.


Thank
You