Orthodontic Adhesive Systems

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Topics to be covered:

- Orthodontic Adhesive Systems
- Enamel Etching
- Cements in Orthodontics
- Bonding to Non-conventional Surfaces
- Elastomeric Ligatures and Chains
- Orthodontic Wires
- Temporary Anchorage Devices (TADs)
- Esthetic Appliances in Orthodontics
- Clear Aligner Therapy


Orthodontic Materials
Scientific and Clinical Aspects
William A. Brantley
Theodore Eliades
Thieme

N. Talic

History

- Buonocore in 1955 improved retention of resin adhesive to enamel by using 85% phosphoric acid
- Newman in 1965 was the first to acid etch and bond brackets using epoxy resin

Newman, G. V. Epoxy adhesives for orthodontic attachments: Progress report. Am J Orthod 51:901, 1965.

Adhesive Systems

- Should not fail during the treatment period
- Failure results in treatment delays
- Failure means unwanted expenses or patient inconvenience
- Should not damage the enamel on debonding at the end of the treatment.

Classification of Adhesive Systems

Based on polymerization they are classified into:

- Chemically Cured
- Light Cured
- Dual Cured

Chemically Cured Adhesives

- Two Phase

  Mixing of the liquid and paste components
- One phase

  No mixing is involved

  Apply the liquid on enamel and bracket
- There is insignificant difference in bond strength between them

  (Bradburn and Pender, 1992)

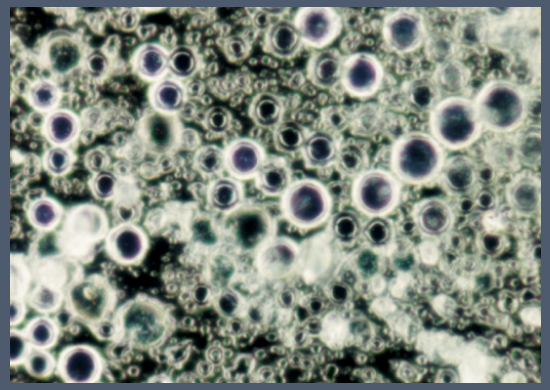
Chemically Cured

- Two phase adhesive systems (Concise, 3M)

☛Manipulation is problematic and time consuming

☛Mixing two components introduces defects

☛The degree of cure did not exceed 55%



Chemically Cured

- One phase Systems (System 1, Ormco) (Unite, 3M)

Advantages:

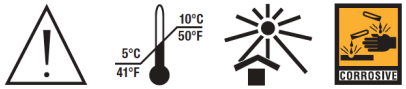
- No-mix of the components
- Reduces the steps needed to place the material
- Application of the liquid component on enamel and bracket base reduces the mixing induced defects

Disadvantages:

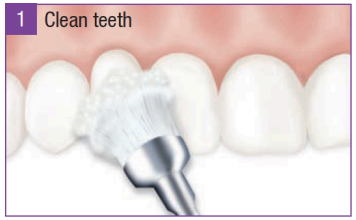
- Polymerization is in-homogenous due to the sandwich technique and diffusion of the liquid

One Phase Systems (System 1, Ormco) (Unite, 3M)

Unite™ Bonding Adhesive with Unite™ Adhesive Primer

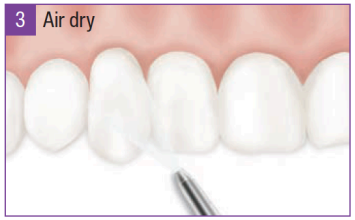


1 Clean teeth

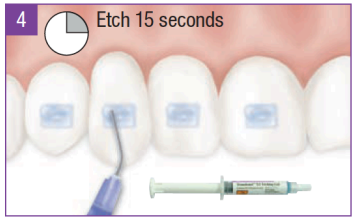


2 H_2O

3 Air dry



4 Etch 15 seconds



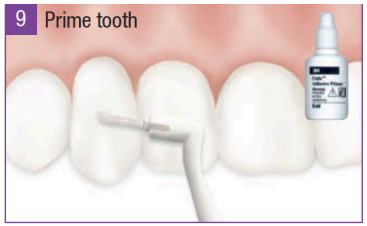
5 Suction and H_2O

6 Air dry

7 Unite™ Adhesive Primer

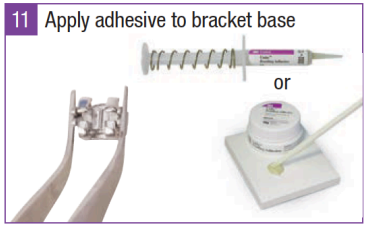
8 Unite™ Adhesive Primer

9 Prime tooth



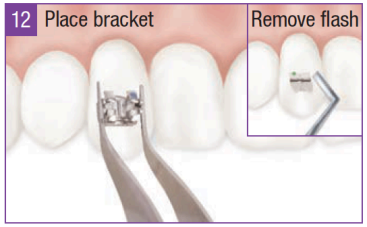
10 Prime bracket

11 Apply adhesive to bracket base



12 Place bracket

Remove flash



13 Hold in final position for 5-10 seconds

14

Table 4. In Vitro Tensile Bond Strengths of Chemically Cured and Paste-Primer Resin Composite Orthodontic Adhesives as a Function of Thickness Between the Bracket and Substrate

	Bond Strength, MPa			
Resin Composite	*0.00 mm*	*0.25 mm*	*0.30 mm*	*0.33 mm*
Chemically cured	4	8	8	8
Paste-primer	9	3	3	0

Adapted and reprinted with permission from Evans LB, Powers JM. *Am J Orthod* 1985;87:508-512.

Light Cured Bonding Systems

- Permits increased working time
- Much easier to clean up around the bracket base
- The ability to cure immediately reduces the chance of contamination
- Degree of cure under stainless steel brackets is comparable to ceramic brackets
- Time consuming

Light Cure Bonding Systems

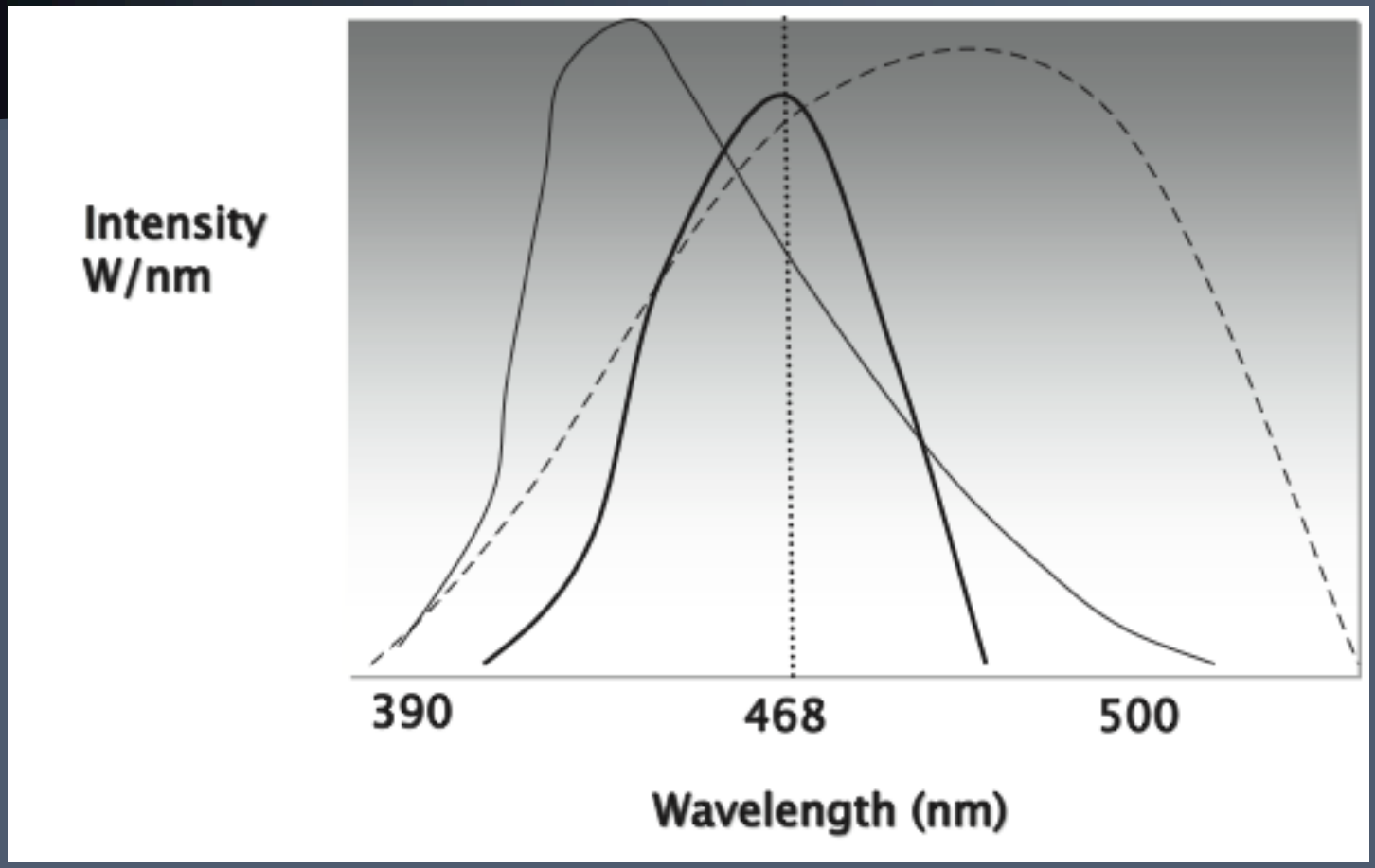
- The extent of polymerization depend on:

1. Exposure time
2. Light intensity
3. Photoinitiator concentration
4. Peak absorbance wavelength by the photoinitiator
5. Filler volume

Photoinitiator

- Camphorquinone (CPQ)
- It's sensitive to light in the blue region of the visible light spectrum
- CPQ absorbs blue light, which has a wavelength between 400 and 500 nanometers
- Peak absorbance is at approximately 468 nm
- It produces free radicals that initiate the polymerization process

Photoinitiator



Theodore Eliades
American Journal of Orthodontics and Dentofacial Orthopedics Volume 130, *Number* 4, 2006

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Light Curing Units

- Tungsten-quartz halogen curing units (TQH)
- Plasma arc curing unit (PAC)
- Light emitting diodes (LED)

Tungsten-quartz halogen Curing Unit (TQH)

- It's a conventional curing unit
- Uses a halogen lamp to generate a white light which is then filtered so that only blue light in the 400 to 500 nanometer range is emitted from the tip
- It generates heat, and therefore the lamp becomes extremely hot
- Halogen bulbs have a limited effective lifetime of around 100 hours and reduced power output overtime

Plasma Arc Curing Units (PAC)

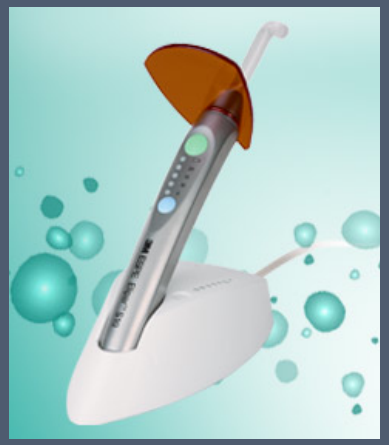
- It was developed in the 1990s
- It uses a high frequency electrical field to generate its plasma energy by transforming xenon gas into a mixture of ions, electrons thereby releasing a significant amount of energy as plasma

Plasma Arc Curing Units (PAC)

- It produces high intensity light delivering more than 1800 mW/cm2 as compared to 400-900 mW/cm2 for halogen conventional curing units
- It cuts down the curing time to 4-9 seconds
- These units have disadvantages as expensive and oversized

Light Emitting Diode (LED)

- It requires no filters to produce blue light
- The lifetime is more than 10,000 hours
- Invariable output energy over time without degradation
- The high-intensity LEDs decreased total light curing time.



Precoated Brackets (APC)

- Increase bonding efficiency
- Standardize the bonding procedure
- Standardize the amount of the adhesive

Precoated Brackets (APC)

- Research showed that APC has lower bond strength, but clinically insignificant
- Kula (2002) showed that there is no difference in bracket failure rates between pre-coated and uncoated brackets (7.5%)
- APC II modified the adhesive with less filler
- APC Plus is a photochromatic adhesive

grēngloo™

TWO-WAY COLOR CHANGE ADHESIVE

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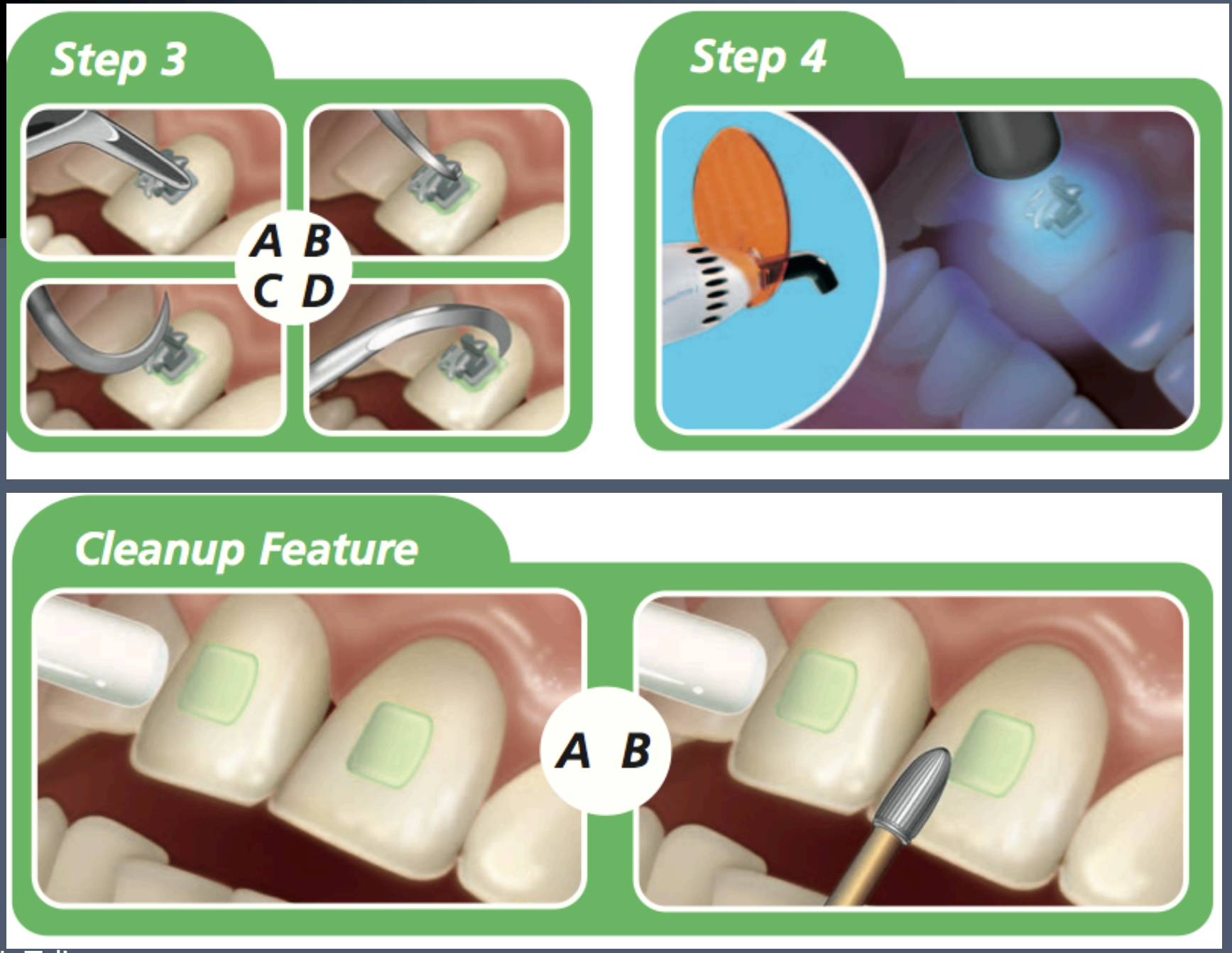
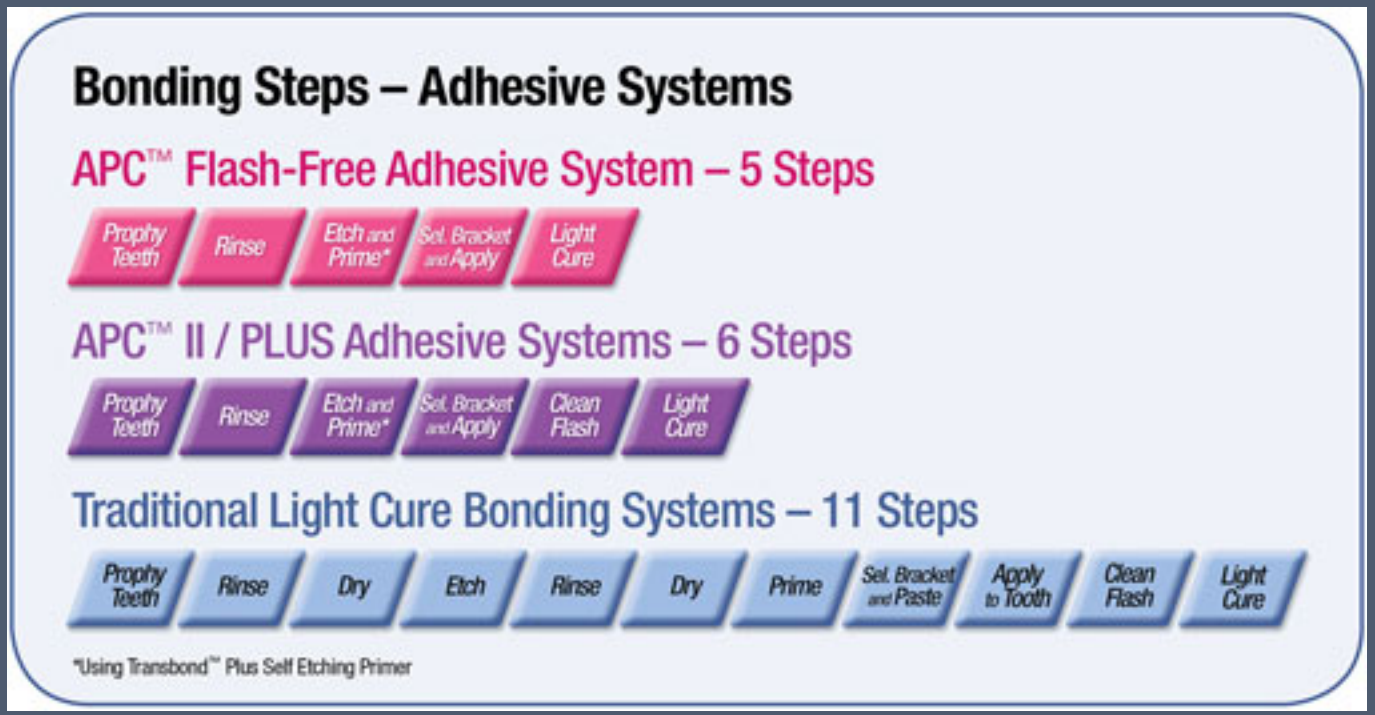

Step 3
A B
C D
Step 4
Cleanup Feature
A B

APC Flash-Free

APC Flash-Free



Original Article

A new flash-free orthodontic adhesive system:

A first clinical and stereomicroscopic study

Moritz Foersch[a]; Christian Schuster[b]; Roman K. Rahimi[c]; Heinrich Wehrbein[d]; Collin Jacobs[e]

Conclusion: The flash-free adhesive significantly reduced the time needed for the bonding process. The excess resin expanded 0.16 to 0.08 mm over the bracket margin. The new technology seems to facilitate a smooth and sufficient marginal surface of the adhesive, which clinically might improve reduction of plaque accumulation. (*Angle Orthod.* 2016;86:260–264.)

Dual Cure Adhesives

- Reliance phase II Dual cure
- It combines the benefits of chemical cure and light cure in a single system
- Polymerization is initiated by light and proceed by a chemical reaction
- The most time consuming

Classification of Adhesive Systems

- Conventional composites
- Conventional glass ionomer cement
- Resin-modified glass ionomer (Hybrid ionomer)
- Polyacid-modified composites (compomer)

Resin Composites

- Dimethacrylate monomers and glass particles
- Highly filled resins contain 60-80% glass filler
- Lightly filled resin contain 28% silica

Resin Composites

- Chemical cure requiring hand mixing (Concise)
- Light cure is supplied as a single paste (Transbond)
- Paste-primer formulation do not require mixing, it depends on the intimate contact between the paste and primer (System 1 +)

Conventional Glass Ionomer

- The powder is fluoroaluminosilicate glass
- The liquid is polyacrylic acid in water
- Chemically cured
- Supplied as powder and liquid
- Mixed by hand or encapsulated

Conventional Glass Ionomer

Advantages

- Self adhesion to enamel and dentin
- Fluoride release
- Biocompatible
- Thermal expansion similar to dentin
- No setting exotherm
- The possibility of eliminating etching
- The possibility to bond in a wet environment

Conventional Glass Ionomer

Disadvantages

- Short working time
- Long setting time
- Slow development of strength
- Low abrasion resistance
- Lack physical properties to retain brackets
- Low bond strength
- Failure rates can reach 50%

Resin-Modified Glass Ionomer (Hybrid)

- It combines the properties of GI and the strength of resin composites
- Powder is Fluoroaluminosilicate
- Liquid is a complex monomer of carboxylic acid groups and vinyl groups
- Can be chemically cured: Fuji Ortho (GC America)
- Can be light cured: Fuji Ortho LC (GC America)


GC Fuji ORTHO LC CAPSULE
50 CAPSULES
ORTHO


GC Fuji ORTHO LC
INTRODUCTORY PACKAGE
ORTHO
GC Fuji ORTHO LC POWDER 15g


New Products
GC Fuji ORTHO LC PASTE PAK Automix
Available in
Bracket Adhesive & Band Cement


GC Fuji ORTHO BAND LC PASTE PAK
BLUE
Automix compatible
PASTE PAK

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Table 2. Typical In Vitro Tensile Bond Strengths of Direct-Bonding Orthodontic Adhesives to Ceramic, Metal, and Plastic Brackets

Adhesive	*Bond Strength, MPa*		
	Ceramic	*Metal*	*Plastic*
Hybrid ionomer	6-7	3-4	1-4
Resin composite, slightly filled	5	9	8
Resin composite, highly filled	5	13	8

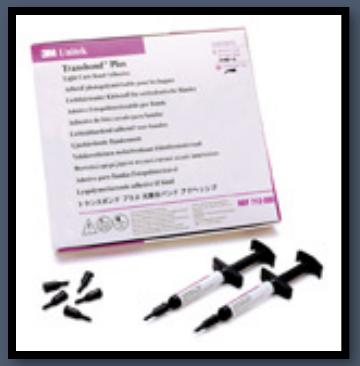
Adapted and reprinted with permission from Blalock KA, Powers JM. *Am J Orthod Dentofac Orthop* 1995; 107:596-603; Buzzitta VAJ, Hallgren SE, Powers JM. *Am J Orthod* 1982;81:87-92; de Pulido LG, Powers JM. *Am J Orthod* 1983;83:124-130.

Compomers (Polyacid-modified Composite Resins)

- Is a single paste with major ingredients of resin composites and glass ionomer except for water
- Initial setting occur by polymerization
- Acid-base can occur later as the material absorbs water
- Example is 3M/Unitek, Transbond Plus

Compomers (Polyacid-modified Composite Resins)

- Acid etching is required
- Bonding surface must be dry
- Release of small amounts of fluoride
- Chemical adhesion has not been shown
- Strength is superior to resin-modified GI but less to resin composites



Bracket Failure Rates

- Chemical cure composites vs. light cure composites

  No significant difference
- Chemical cure composites vs. glass ionomer

  Glass ionomer had higher bracket failure rates
- Chemical cure composites vs. compomer

  No significant difference,

  Compomer had better protection against deminerlization
- Resin-modified glass ionomer

  Has clinical failure rate of 3%

Journal of Orthodontics 2002; 29: 205-210

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Rogers S et al. Orthodontic fluoride-containing adhesives and decalcification in patients with fixed appliances: a systematic review.

Am J Orthod Dentofacial Orthop. 2010 Oct;138(4):390.e1-8

- It is impossible to make recommendations on the use of fluoride-containing orthodontic adhesives during fixed orthodontic treatment
- Glass ionomer cement is more effective than composite resin in preventing white spot formation, but the evidence is weak;
- Further research is required to determine the effectiveness of the various fluoride-containing orthodontic adhesives

Bonded molar tubes: a survey of their use by specialist orthodontists
Murray et al. J Orthod. 2012; 39:129-135

A 74% response rate was obtained

In more than 80% of cases, BMTs were used on first and second permanent molars by 52% and 33% of orthodontists respectively

Direct bonding was used by all for BMT placement.

Etch times for molars, compared to other teeth, increased from 15 to 30 seconds by 51% of orthodontists.

Adhesives for bonded molar tubes during fixed braces treatment.

Millett D. et. al. Cochrane Database Syst Rev. 2011 Jun 15;(6)

- The failure of molar tubes bonded with either a chemically-cured or light-cured adhesive was considerably higher than that of molar bands cemented with glass ionomer cement.
- There was less decalcification with molar bands cemented with glass ionomer cement than with bonded molar tubes cemented with a light-cured adhesive.