

Adhesive systems - actual overview and handling properties

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Adhesive systems - actual overview and handling properties

Basic principles of bonding to enamel and dentin

Challenges for effective bonding

Overview Adhesive systems

Etch&rinse technique or self-etching adhesives?

Luting of indirect restorations

Treatment of the deep cavity floor

Handling of adhesive systems

Summary

Bonding to enamel

- phosphoric acid etching enamel
⇒ optimal wettability and most effective bonding
- 35-40% phosphoric acid for 30 s at prepared enamel for 60 s for fissure sealing
- thorough rinsing with water
- contamination control

Summary

Bonding to dentin

- phosphoric acid etching of dentin:
 - application time: ca. 15 – 20 s
 - prolonged etching time ⇒ deeper exposed collagen network
 - avoid excessive drying ⇒ option: re-wetten
 - short-chained hydrophilic monomers need to penetrate down to the ground of the collagen network
⇒ prolonged and active application = effective penetration

Summary

Bonding to dentin

- self-etching primer in dentin:
 - dissolving the smear layer, etching and penetrating the dentin simultaneously
 - no rinsing
 - evaporating the solvent

Universal adhesives


Summary

- Do not confuse with „universal primer“
- Advantage: application in etch&rinse technique and as a self-etching adhesive
- Effective bonding to zirkonia
- Critical effectiveness as silan
- Application of universal primers or universal adhesives to zirkonia:
no phosphoric acid application!

Etch & rinse-technique	Self-etching systems
<ul style="list-style-type: none"> + Most effective bonding to enamel - More technique sensitive on acid-etched dentin - Lower long-term stability against degradation - More time consuming due to separate etching + More effective on sclerotic dentin 	<ul style="list-style-type: none"> - Lower bond strength to enamel + Simultaneous etching and penetration into dentin - Inefficient penetration into thick smear layers - Not compatible with chemically initiated curing composites + Less harmful etching adjacent to the pulp

Self-etching adhesives


Caution: Compatibility with chemically initiated curing composites




acidic primer-adhesives can inhibit initiator systems of composite resins

Sanares A.M.E. et al. Dent Mater 17: 542-556 (2001)
 Tay FR et al. J Adhes Dent 5: 27-40 (2003)
 Suh B.I. et al. J Adhes Dent 5: 267-282 (2003)
 Malaquias P. et al. J Appl Oral Sci 28: e20200121 (2020)

Adhesives and indirect restorations



Light-curing before application of dual-curing luting composites



Does the restoration still fit after light-curing of the adhesive?

Light-curing of the adhesive before the application of luting composites

Thickness of the cured adhesives

Thin Film Thickness

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Purpose: Universal adhesives (UBAs) are applied to 2-mm etched resin (ESB) or 3-mm self-etch (ESE) resin. This study investigated whether these UBAs could benefit from a highly filled zinc bonding layer (ZBL) curing them into ZBLB and ZBLSE, respectively, thus also compensating for the constant thin film thickness of UBA.

Materials and Methods: Microtensile bond strength (μBTBS) to buccal dentin of Clearfil Universal Bond Quick (CUBQ) (ZBLB), Clearfil Universal Bond Quick (CUBQ) and Prime&Bond Active Plus (PBAP) (ZBLSE), applied to ESB and ESE resin, were compared with the adhesive resin (ER) of Optibond FL (OFL) resin, which was compared to that of the ZBLB and ZBLSE. From which was also compared to ZBLB and ZBLSE. The μBTBS were measured after 1 month of water storage (1W) and additional 20,000 and 50,000 microcycles (20, 50, 100) were statistically compared using three different linear mixed-effects models with specific contrasts (p < 0.05).

Results: Overall, the top generation adhesives, bonding mode, APPE, ERB, slightly inferior μBTBS, μBBS and ZBLB (ZBLB) resin (ZBL) were applied to both ESB and ESE bonding modes. In ZBLB mode, ZBLB generally provided the highest μBTBS. CUBQ presented an intermediate and lowest μBTBS. No significant differences were found between of ZBLB and ZBLSE. CUBQ (ZBLB) presented a higher μBTBS than ZBLSE (ZBLSE) in 1W, 20,000 and 50,000 microcycles. The overall benefits of ZBL on the 1-month and 100-cycled bonding efficacy differed for the different UBA brands.

Keywords: bond strength, durability, hydrophobic, linear mixed model (LME), adhesive-dentin interface.

Journal Pre-proof

Adhesive	Adhesive layer thickness (μm)
Clearfil Universal Bond Quick	8-10
G-Premio Bond	2-3
Prime&Bond active	8-10
OptiBond FL	50-100
Clearfil SE Bond	12-15

* Unpublished TEM observations.

Universal adhesives

Dual-curing by mixing with initiators

Product examples:

Adhese Universal DC	(Vivadent)
Clearfil Universal Bond Quick	(Kuraray)
Futurabond U	(Voco)
Futurabond M+	(Voco)
G-Premio Bond	(GC)
Prime&Bond Active	(Dentsply)
Scotchbond Universal Plus	(3M)
Universal Bond	(Tokuyama)

Curing of the adhesive before the application of luting composites

Curing of universal adhesives by contamination with luting composites in a company's product line

Product examples:

Adhese Universal DC	Variolink Esthetic DC	(Vivadent)
G-Premio Bond + DCA	G-CEM LinkForce	(GC)
G-Premio Bond	G-CEM One	(GC)
OptiBond Universal	Nexus Universal	(Kerr)
OptiBond FL Primer	Nexus Universal	(Kerr)
Prime&Bond active	Callibra Ceram	(Dentsply)
Scotchbond Universal	RelyX Ultimate	(3M)
Scotchbond Universal Plus	RelyX Universal	(3M)

Effective dark curing even in a company's product line?

Adhesives on pulpal cavity floors

Summary

- **Distribution of tubules:**
the closer to the pulp
the more open tubules + larger diameters
- **Amount of monomer diffusion into the pulp dependent on:**
 - dentin permeability
 - residual dentin thickness
> 200 µm: increased permeability
 - sclerotic dentin
 - aggressiveness of dentin conditioning
avoid phosphoric acid etching adjacent to the pulp

Recommendations for effective application of adhesive systems

Important steps:

- **Enamel:** phosphoric acid etching for 15 s to 60 s
rinse thoroughly
- **Dentin:** phosphoric acid etching for ca. 15 s
don't dry too long (optional: re-wetting)
- Contamination control
- Active primer application
- Extended primer application time
- Effective solvent evaporation
- Light-curing
- For direct restorations:
apply adhesive 2x or a flowable composite

Recommendations for effective application of adhesive systems

Reaction on contamination with saliva during the application of adhesives



after phosphoric acid etching

additional etching for shorter time

Sillas Duarte, Jr. et al. SEM Analysis of Internal Adaptation of Adhesive Restorations After Contamination with Saliva
J Adhes Dent 1: 51-56 (2005)

Recommendations for effective application of adhesive systems

Reaction on contamination with saliva during the application of adhesives



after application of primers or primer/adhesives

drying or rinsing and drying

additional application of primer or primer/adhesive

Yoo HM et al.: Oper Dent 31(1):127-134 (2006)
Sattabanasuk V et al.
J Adhes Dent 8:311-318 (2006)

Recommendations for effective application of adhesive systems

Reaction on contamination with saliva during the application of adhesives



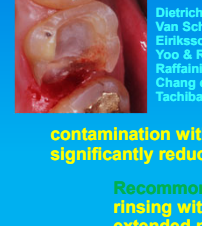
after application of the adhesive (multi-bottle system)

drying or rinsing and drying

additional application of primer and adhesive

Recommendations for effective application of adhesive systems

Reaction on contamination with blood during the application of adhesives



Dietrich et al. (2002) Dent Mater 18: 159-162
Van Schalkwyk et al. (2003) South African Dent J 58: 143-147
Eiriksson et al. (2004) Dent Mater 20: 184-190
Yoo & Rereira (2006) Oper Dent 31: 660-665
Raffaini et al. (2006) Am J Dent 21: 159-162
Chang et al. (2010) Oper Dent 35: 330-336
Tachibana et al. (2011) J Adhes Dent 13: 349-358

contamination with blood: significantly reduced effectiveness of adhesive systems

Recommendation: rinsing with water, extended primer application time, and sandblasting

Recommendations for effective application of adhesive systems

Reaction on contamination with **astringents** during the application of adhesives



Powers et al.	(2003)	Odontology 91: 1-6	
O'Keefe	(2005)	Am J Dent 18: 168-172	
Kimmes et al.	(2007)	J Adhes Dent 8: 363-66	no effect on etch&rinse
Kuphasuk et al.	(2007)	Oper Dent 32: 399-405	less effect on etch&rinse
Hamirattasai et al.	(2009)	Oper Dent 34: 415-422	
Chayabutr & Koils	(2011)	Oper Dent 36: 18-26	
Tauböck TT	(2017)	J Adhes Dent 19: 249-52	no effect on etch&rinse

Contamination with astringents:
decreased effectiveness of adhesive systems

Recommendations for effective application of adhesive systems

Reaction on contamination with **astringents** during the application of adhesives

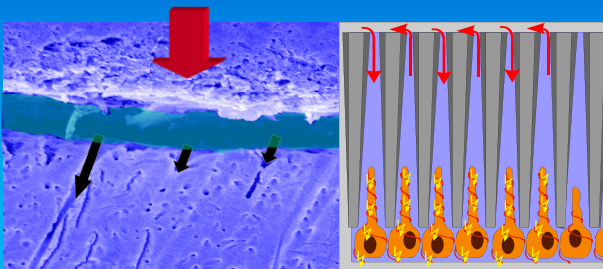
- avoid application of astringents

- contamination with
 - aluminium sulphate (Orbat®)
 - aluminium chloride (Racegel®)
 - iron sulphate (Viacostar®)

	H ₃ PO ₄	E&R CHX	SE CHX
- aluminium sulphate (Orbat®)	+	+	+
- aluminium chloride (Racegel®)	+	+	+
- iron sulphate (Viacostar®)	+	+	-

Pucci CR, Araújo RM, Lacerda AJ, Souza MA, Huhtala MF, Feitosa FA. Effects of Contamination by Hemostatic Agents and Use of Cleaning Agent on Etch-and-Rinse Dentin Bond Strength. Braz Dent J. 2016; 27:688-692

Postoperative hypersensitivity



Postoperative hypersensitivity

Reasons for insufficient adhesive dentin seal:

Handling

Etch & rinse systems

- extended etching time without extended times for primer application
- wet bonding disregarded
- saliva contamination
- multi-function syringe insufficient separation of water and air
- insufficient light-curing

Postoperative hypersensitivity

Reasons for insufficient adhesive dentin seal:

Handling

Self-etching adhesives

- too short primer application time
- not actively applied
- insufficient solvent evaporation
- multi-function syringe insufficient separation of water and air
- insufficient light-curing

Workshop adhesive techniques a hands-on course



Further information on www.ublunck.de