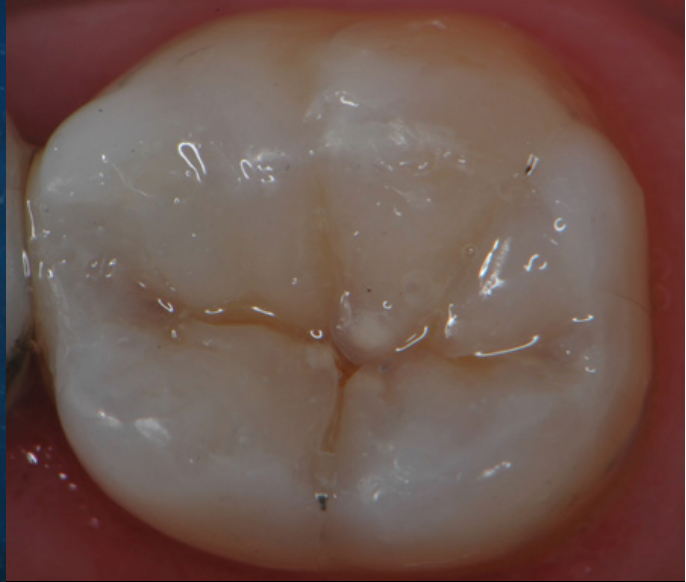
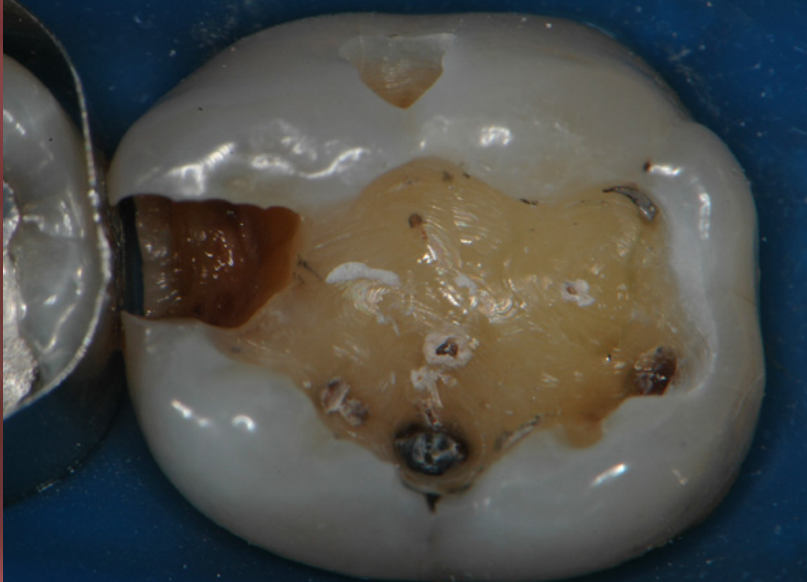


Adesão e Sistemas adesivos





O INÍCIO DA ODONTOLOGIA ADESIVA



Buonocore MG. J Dent Res, 34: 849-53, 1955.

Procedimento eficaz, tecnicamente simples e de baixo custo

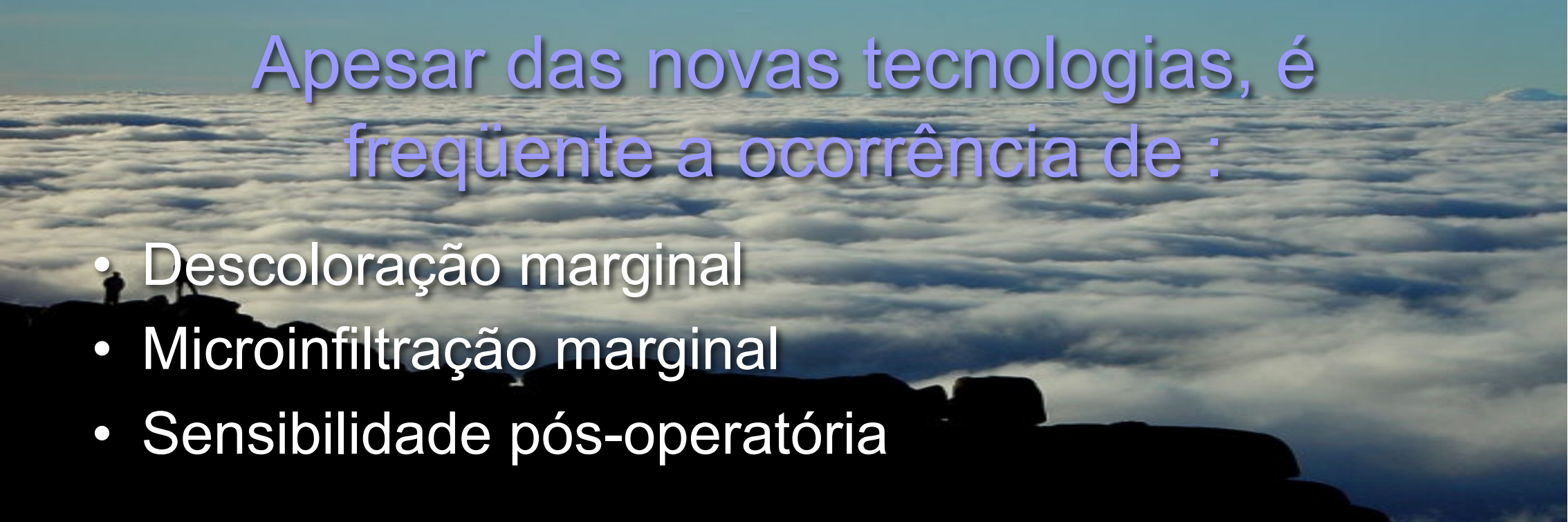


Ataque Ácido Total: esmalte e
dentina

Fusayama, 1979

Camada Híbrida

Nakabayashi, 1982



Apesar das novas tecnologias, é
freqüente a ocorrência de :

- Descoloração marginal
- Microinfiltração marginal
- Sensibilidade pós-operatória

University of Mogi das Cruzes Clinical Research Center
6 month recall



Total-etch (One-Step Plus, Bisco)



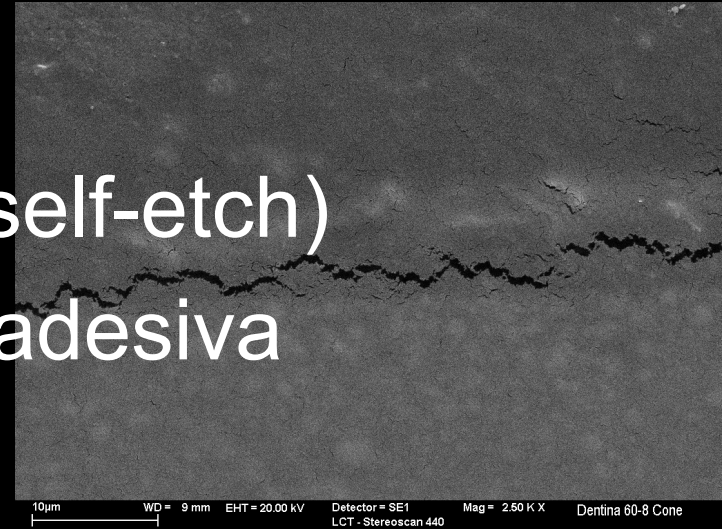
Self-etch (iBond, Heraeus Kulzer)

Restorations inserted by the same operator, same day, same patient

Isso ocorre sobretudo, devido a:

- Erros técnicos
- Falta de estabilidade do produto (self-etch)
- Falta de estabilidade da interface adesiva

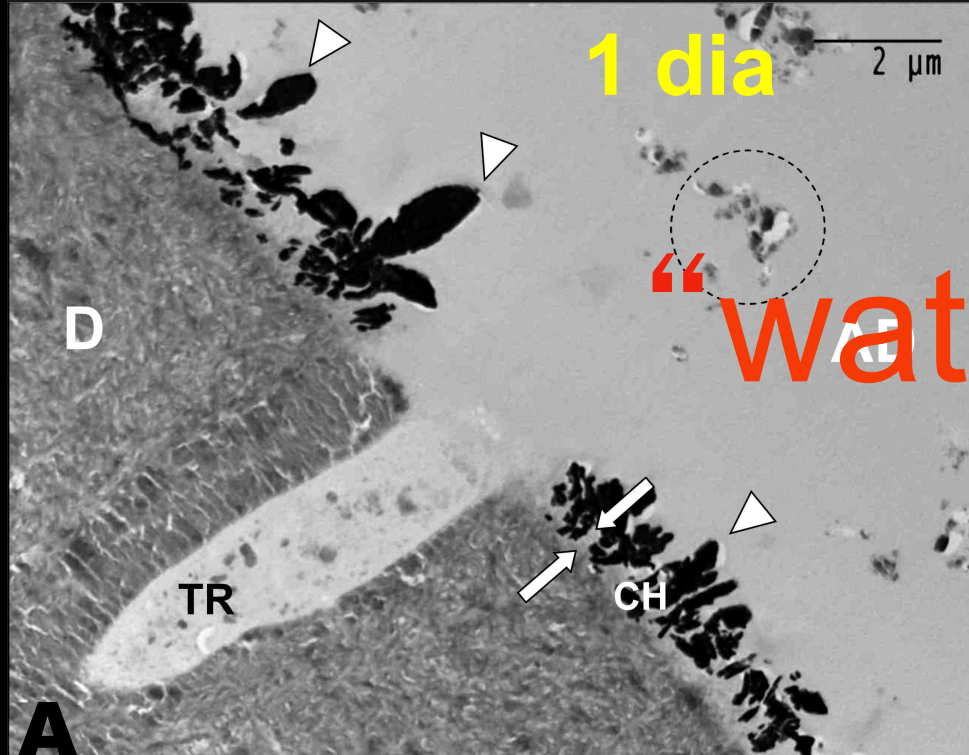
DENTINA!!!



Instabilidade da interface adesiva

- A degradação da interface adesiva parece ocorrer muito rapidamente, sobretudo nos sistemas simplificados.

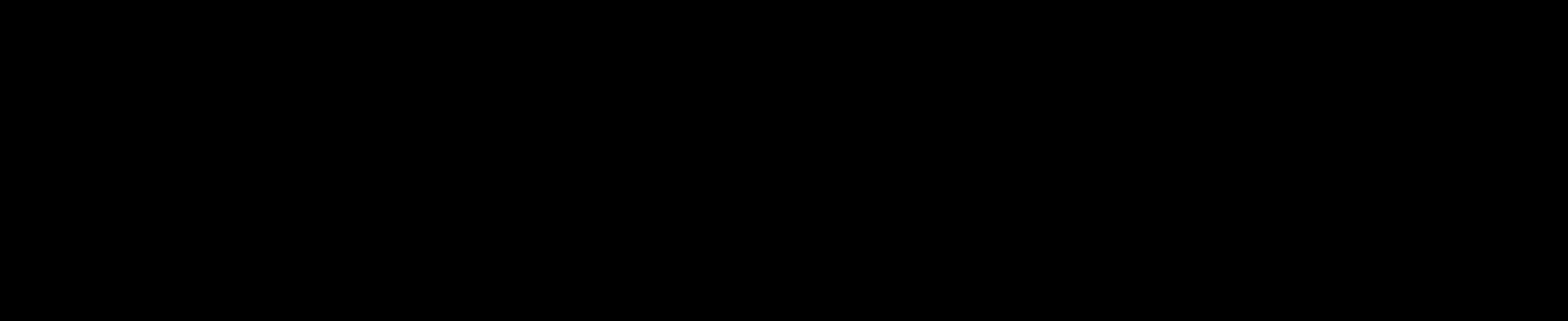
ADM, 2006



1 dia “O desafio é o de se desenvolver um material
hidrófilo o suficiente para permear a dentina,
hidrófobo o suficiente para formar um “filme”
impermeável, e estável o suficiente para proteger o
complexo dentino-pulpar, ao longo dos anos, dos
fluidos e bactérias orais da atuação hidrolítica e
enzimática do fluido tubular .” **2 meses**

Lodovici E, 2004 e 2007

Funções básicas dos sistemas adesivos



1. Proteção do complexo dentino-pulpar

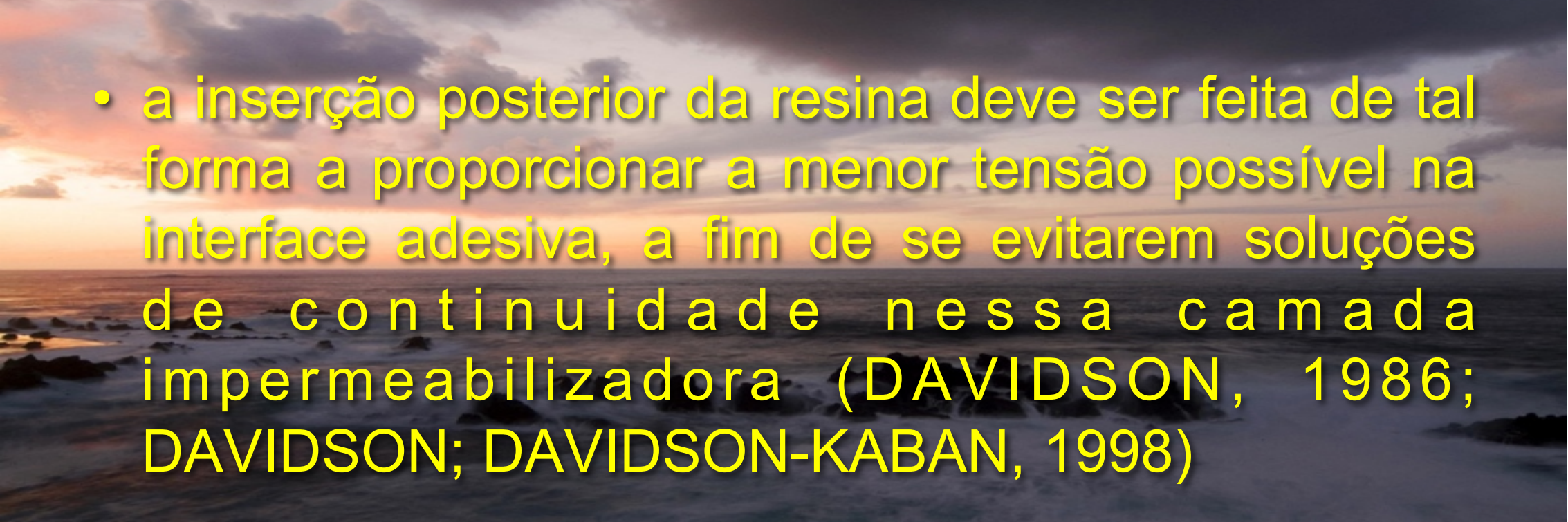
- Os sistemas adesivos, através da penetração tubular dentinária (*tags* resinosos) e da formação de uma película resinosa sobre a dentina, devem isolar a mesma, dificultando a ocorrência de estímulos gerados por agressores externos.

Entretanto...

- o remanescente dentinário da parede pulpar deve ser superior a 0,5 mm a fim de que os próprios componentes do sistema adesivo não se tornem irritantes pulpares (ACCORINTE et al., 2005; MERYON; TOBIAS; JAKEMAN, 1987)

2. Retenção de materiais restauradores ao dente



- 
- a inserção posterior da resina deve ser feita de tal forma a proporcionar a menor tensão possível na interface adesiva, a fim de se evitarem soluções de continuidade nessa camada impermeabilizadora (DAVIDSON, 1986; DAVIDSON; DAVIDSON-KABAN, 1998)

3. Manutenção da integridade da interface adesiva

- Fluidos orais
- Esforços mastigatórios
- Variações de temperatura
- Bactérias/Ácidos



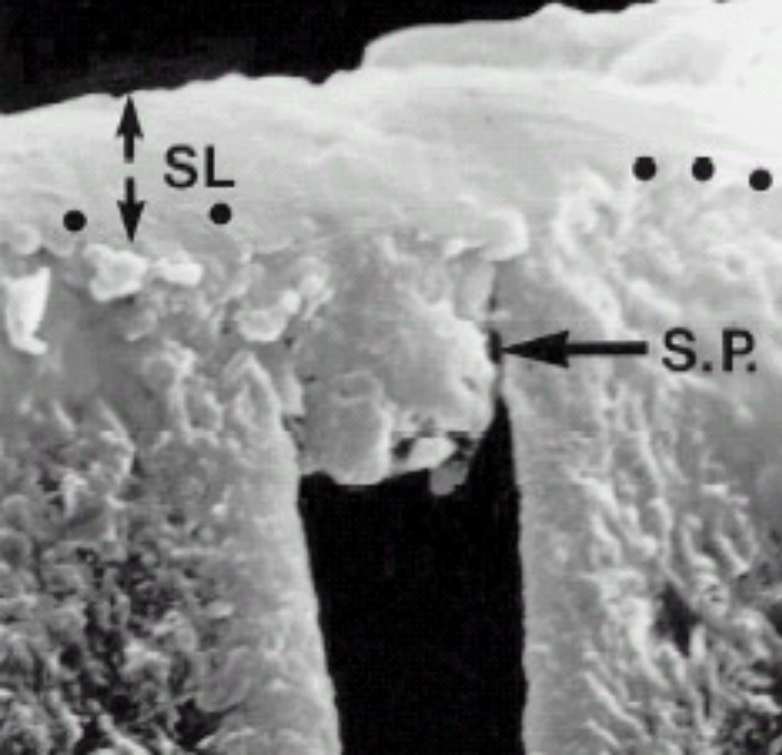
Desenvolvimento dos sistemas adesivos

The background of the slide is a photograph of a forest. The trees are mostly bare, suggesting an autumn or winter setting. The ground is covered in fallen leaves and some low-lying vegetation. The overall atmosphere is misty and somewhat somber, with a muted color palette of greens, browns, and greys.

ALL GENERATIONS

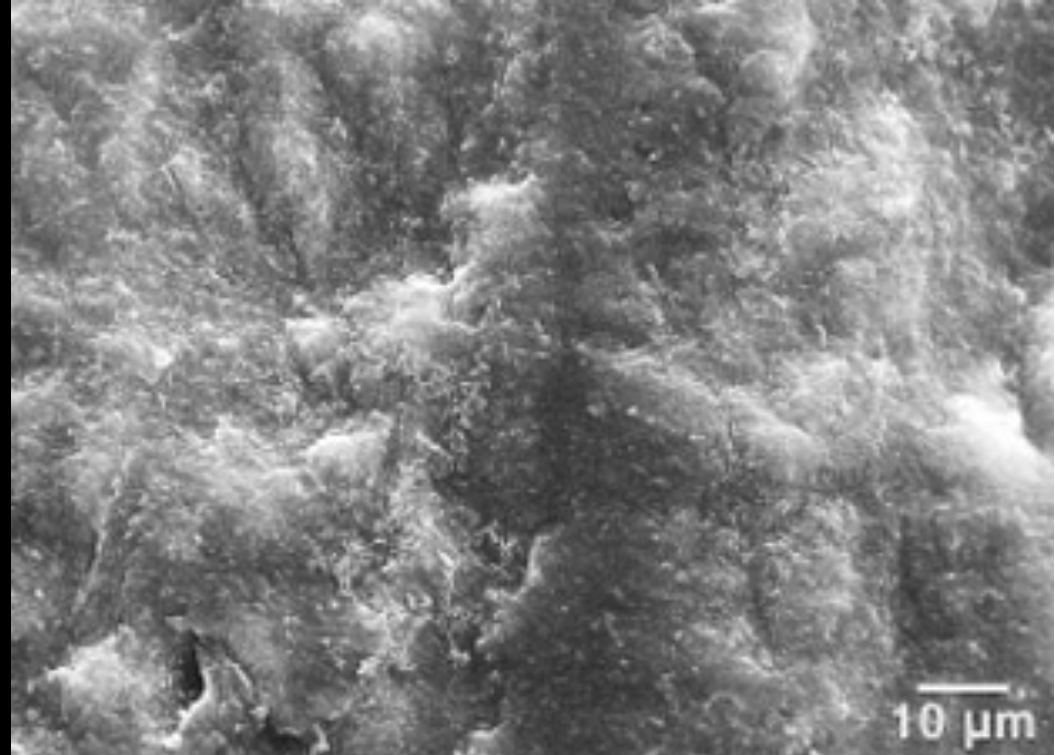






S
M
E

L
A
Y
E
R



Smear layer

Fragments de dentina, óleo do micromotor, saliva, sangue, bactérias etc que obstruem parcialmente os túbulos dentinários e podem interferir negativamente na adaptação do material restaurador, favorecendo a infiltração marginal

RETIEF (1974); BRÄNNSTRÖM & NYBORG (1974); JOHNSON & BRANNSTROM (1976).

Por que remover a smear layer?

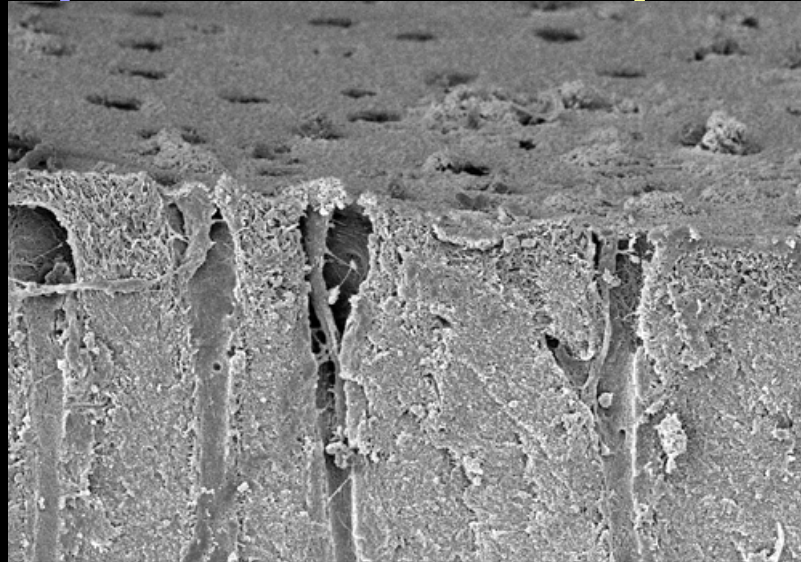
Por que ela interfere na adesão de alguns materiais odontológicos com a dentina, se o princípio de adesão for a hibridização.

Por que não remover a smear layer?

PASHLEY (1984): porque ela constitui um forrador cavitário que reduz a permeabilidade dentinária mais eficientemente que qualquer selante cavitário.

WATANABE (1994): fundamento utilizado para sugerir a integração do material restaurador com a lama dentinária.

Sistemas etch & rinse para remover smear layer

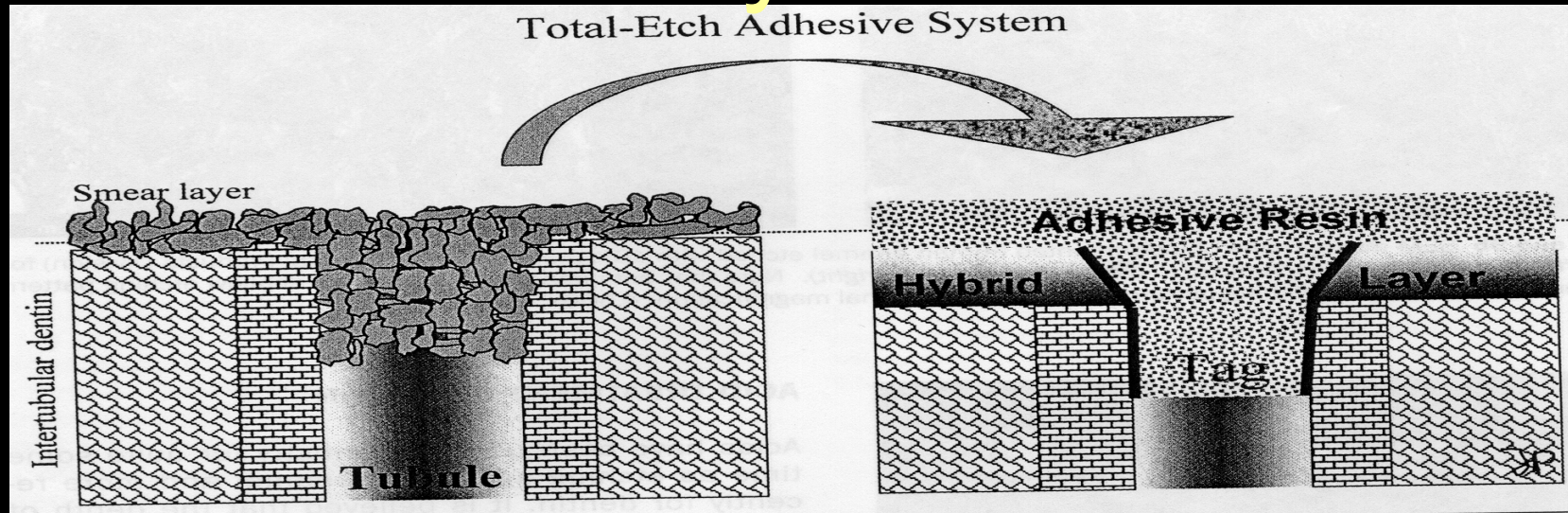


S4700-11 4.5kV 12.0mm x2.50k SE(M)

20.0um

gentilmente cedida pelos
Profs. Geraldeli e Perdigão

Etch-&-rinse systems



Perdigão & Lopes 1999

Sistemas Self-etching systems



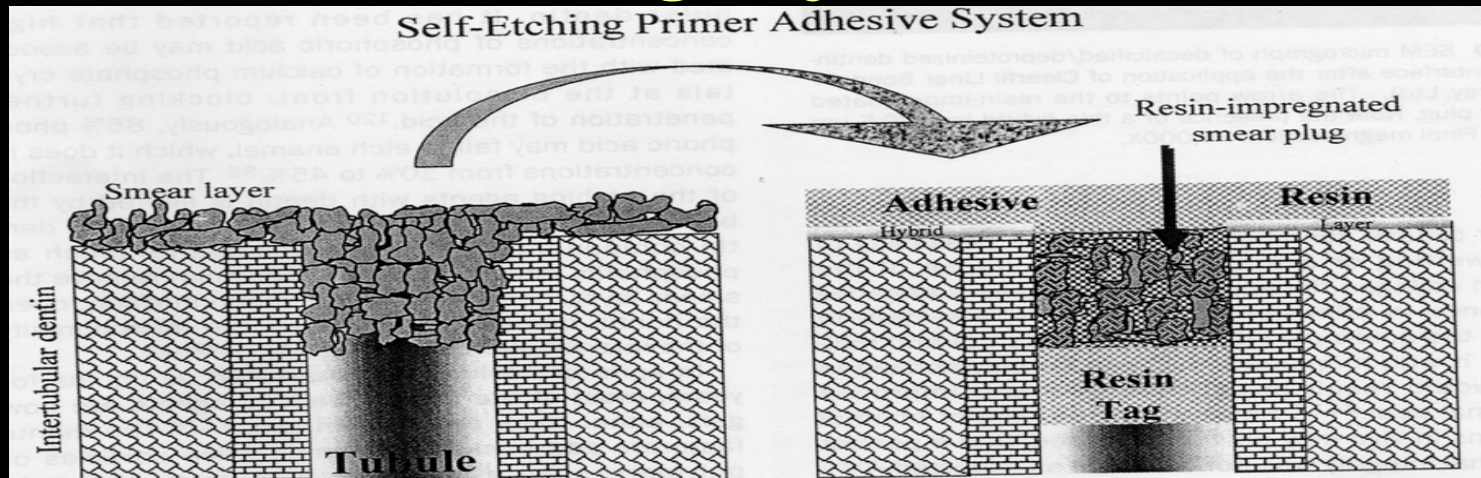
Dr. Ana Quinelato

Miniresid 3.5kV 12.5mm x60.0k SE(M) 7/25/02

500nm

www.jorgeperdigao.net

Self-etching systems



Perdigão & Lopes, 1999

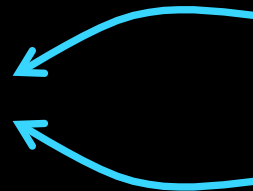
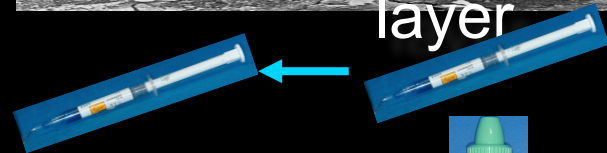
Manutenção da smear
layer

Remoção da smear
layer

Ácido

Primer

Bond



1 passo

2 passos

3 passos

Manutenção da smear
layer

Remoção da smear
layer

Ácido
Primer
Bond



1 passo

2 passos

3 passos

Manutenção da smear
layer

Remoção da smear
layer

Ácido
Primer
Bond



1 passo

2 passos

3 passos

Manutenção da smear layer

Remoção da smear layer

Ácido
Primer
Bond



1 passo

2 passos

3 passos

Manutenção da smear
layer

Remoção da smear
layer

Ácido

Primer

Bond

ONE BOTTLE TWO BOTTLE E BOTTLE MULTIPLE BOTTLES

1 passo

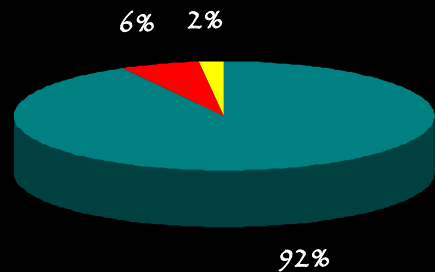
2 passos

3 passos

Relembrando...



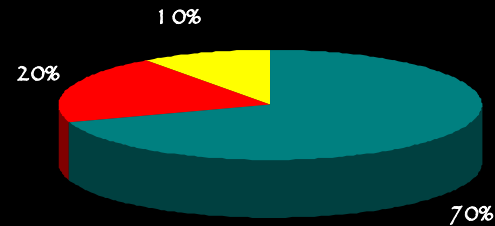
Esmalte



Substratos



Dentína



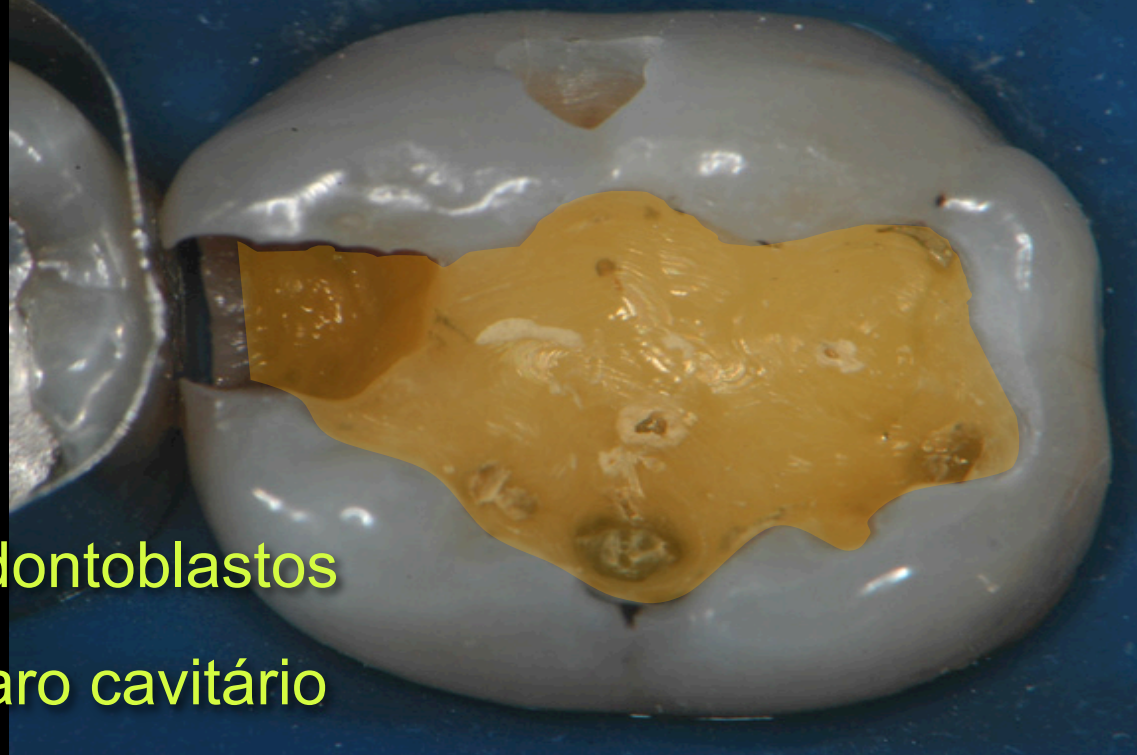
Esmalte

- Tecido homogêneo
- Constituído por cristais
- Ausência de umidade



Dentina

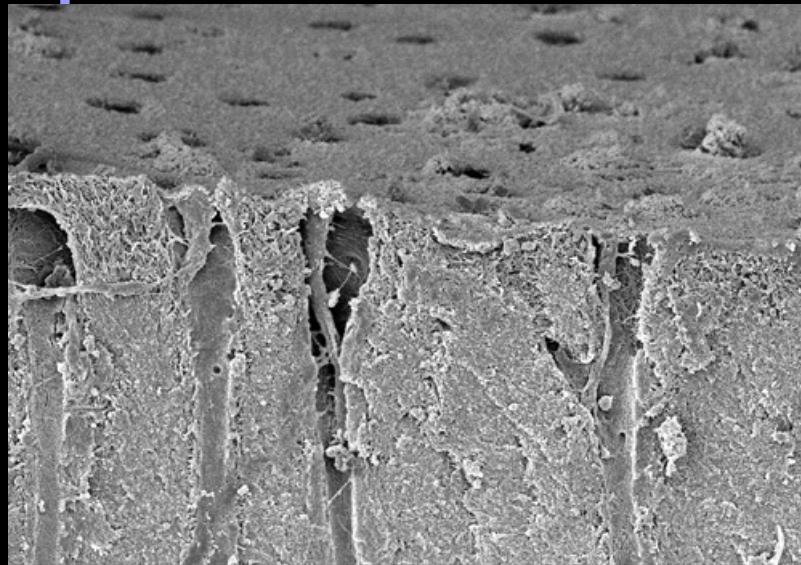
- Tecido vivo, heterogêneo
- Constituído por túbulos
- Presença de fluido tubular
- Presença de prolongamentos de odontoblastos
- Presença de smear layer pós-preparo cavitário



Diferentes substratos...

...diferentes abordagens durante o
protocolo adesivo

Sistemas que removem a smear layer

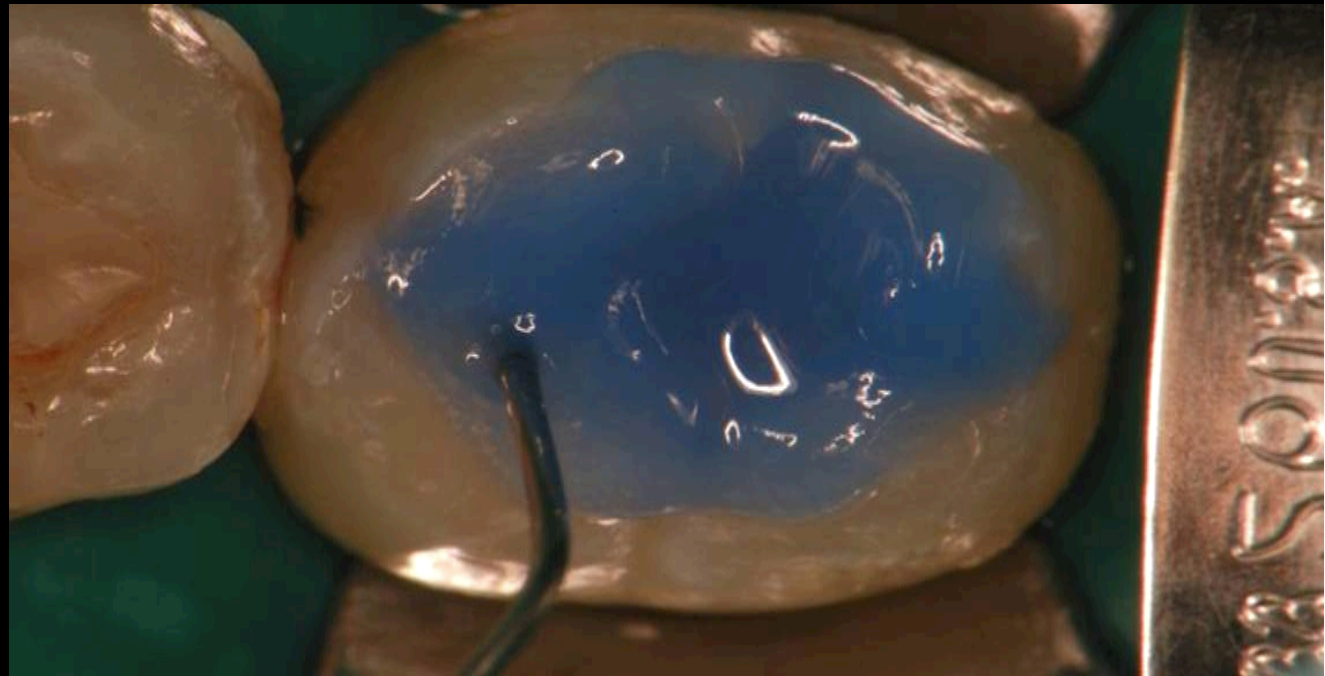


S4700-11 4.5kV 12.0mm x2.50k SE(M)

20.0um

**gentilmente cedida pelos
Profs. Geraldeli e Perdigão**





~~Condicionamiento ácido total~~

~~Total etch~~

Etch & rinse

Condicionamento ácido do esmalte

Reação química na qual através de um ácido se faz a desmineralização seletiva do esmalte criando retenções micromecânicas que serão preenchidas por um agente de união

Does the Acidity of Self-etching Primers Affect Bond Strength and Surface Morphology of Enamel?

Sandra Kiss Moura^a/Arlete Pelizzaro^b/Karen Dal Bianco^b/Mario Fernando de Goes^c/
Alessandro Dourado Loguercio^d/Alessandra Reis^d/Rosa Helena Miranda Grande^e

Purpose: This study examined the ultrastructure and microtensile bond strengths (TBS) of self-etching (with different acidity) and conventional adhesive systems bonded to unground enamel.

Materials and Methods: Resin composite (Filtek Z250) buildups were bonded to unground enamel surfaces of third molars after adhesive application with the following materials: Clearfil SE Bond (CSE); Optibond Solo Plus Self-Etch (OP); Tyrian Self Priming Etching (TY), and the controls Scotchbond Multi-Purpose Plus (SBMP) and Single Bond (SB). Six teeth were assigned to each material. After storage in water for 24 h at 37°C, the bonded specimens were sectioned into beams of approximately 0.8 mm² and subsequently subjected to μ TBS testing at a crosshead speed of 0.5 mm/min. The average values were subjected to one-way ANOVA ($\alpha = 0.05$). The effect of surface conditioning of each material was observed under scanning electron microscopy (SEM).

Results: The highest resin-enamel bond strength was observed for SBMP (22.7 ± 5.2) and SB (26.7 ± 5.2 MPa). The lowest mean bond strengths were 10.9 ± 3.2 and 7.8 ± 1.5 MPa for TY and OP, respectively. CSE showed an intermediate performance (18.7 ± 4.6 MPa). An overall increase in porosity was evident along the entire enamel surface treated with the self-etching primers; however, no selective demineralization similar to that with 35% phosphoric acid was observed.

Conclusion: The highest bond strength means and the more retentive etching pattern were observed for the two-step etch-and-rinse adhesives. Among the self-etching systems studied, Clearfil SE Bond should be preferred.

Keywords: adhesive system, bonding, enamel morphology.

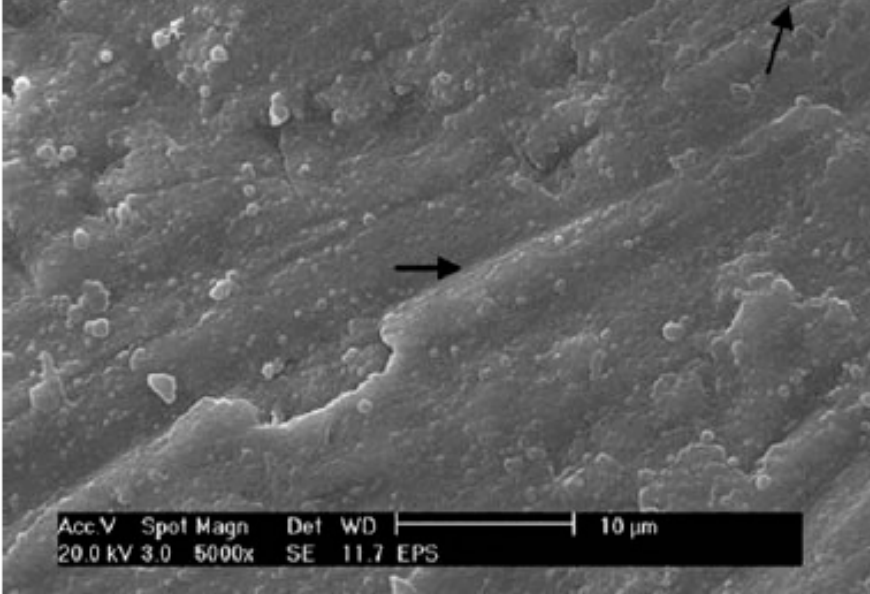


Fig 1a SEM micrograph of unground enamel following cleaning with slurry of pumice and water. The surface is very smooth. Surface view (5000X): grooves (black arrow) from the cleaning procedure.

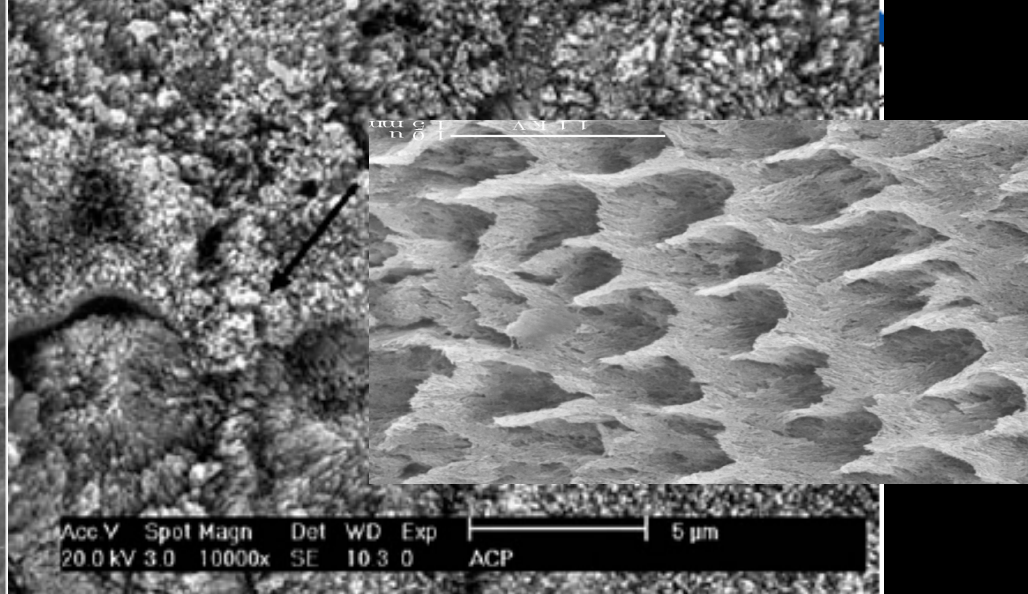


Fig 2a SEM micrograph of unground enamel following treatment with 35% phosphoric acid. Surface view (5000X): note interprismatic demineralization (black arrow – type 1 pattern; white arrow – type 2 pattern) and no uniform (white *) pattern.

MOURA SK et al., 2006

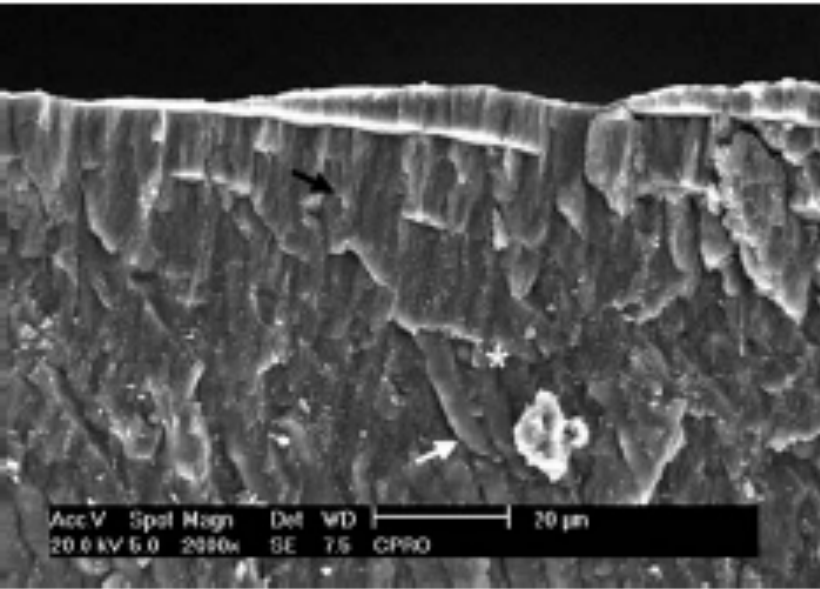


Fig 1c SEM micrograph of unground enamel following cleaning with slurry of pumice and water. Sagittal view (3000X); note aprismatic enamel layer (black arrow); prismatic enamel (white arrow) and transition between prismatic and aprismatic enamel (white *).

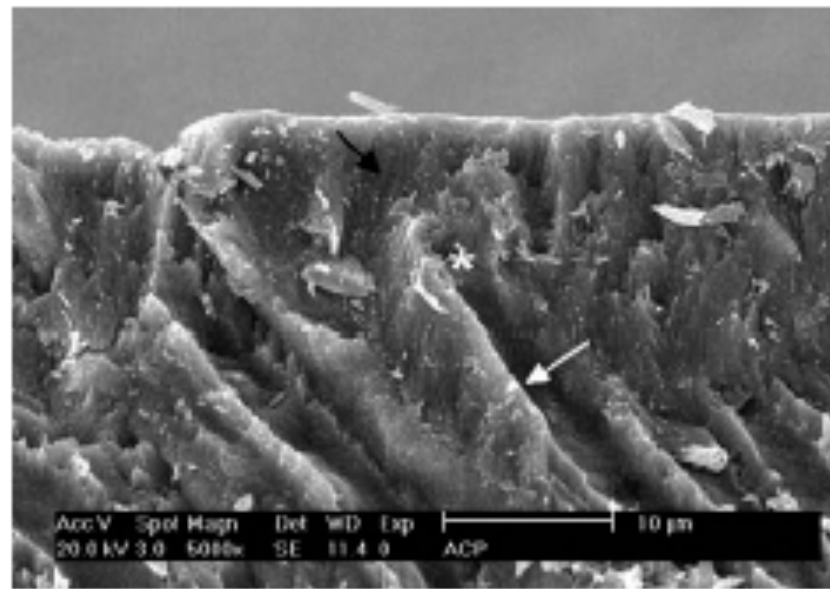
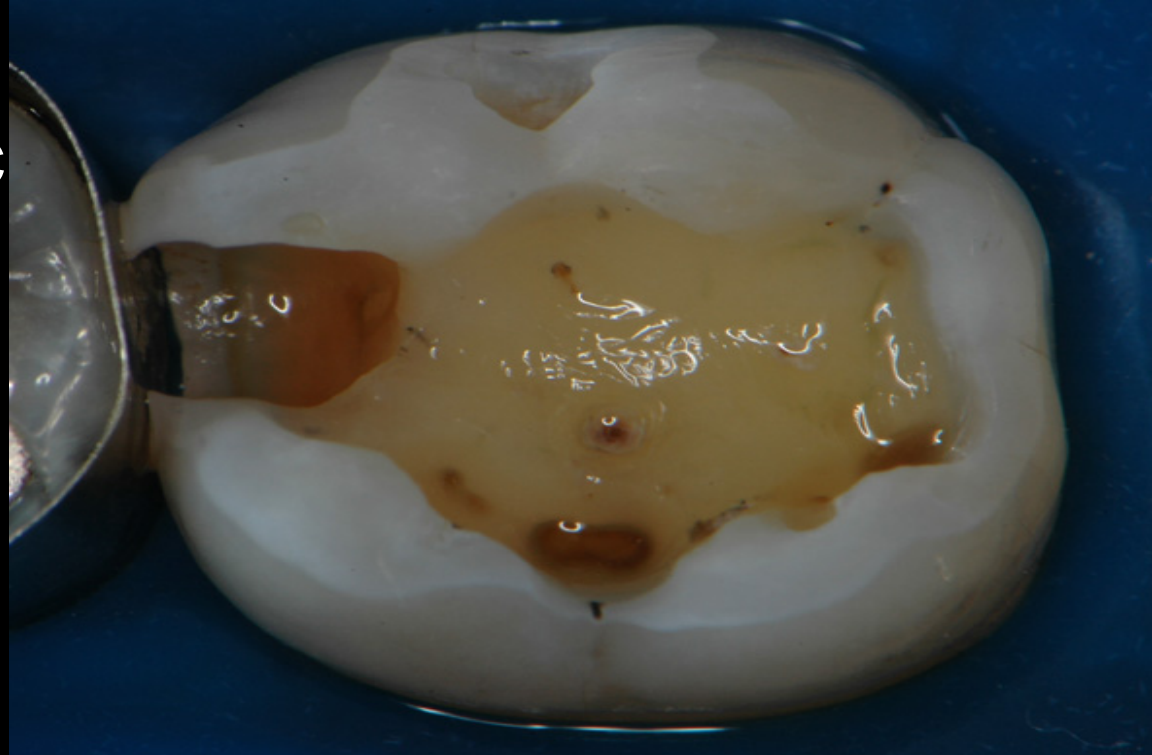


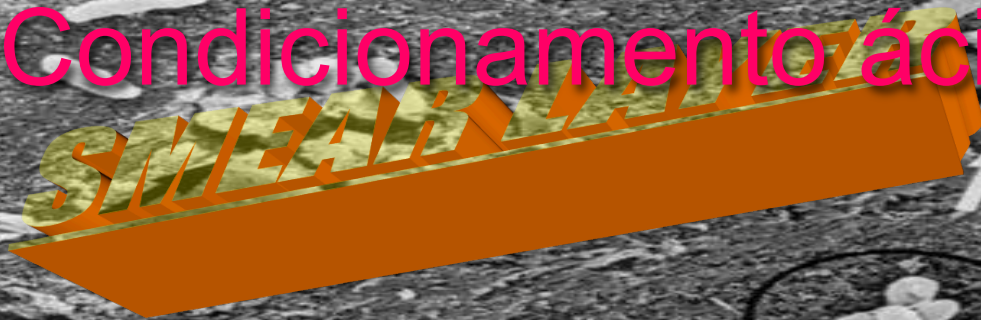
Fig 2c SEM micrograph of unground enamel following treatment with 35% phosphoric acid. Sagittal view (5000X); note aprismatic enamel layer (black arrow); prismatic enamel (white arrow) and transition between prismatic and aprismatic enamel (white *).

Aumenta a área de superfíc

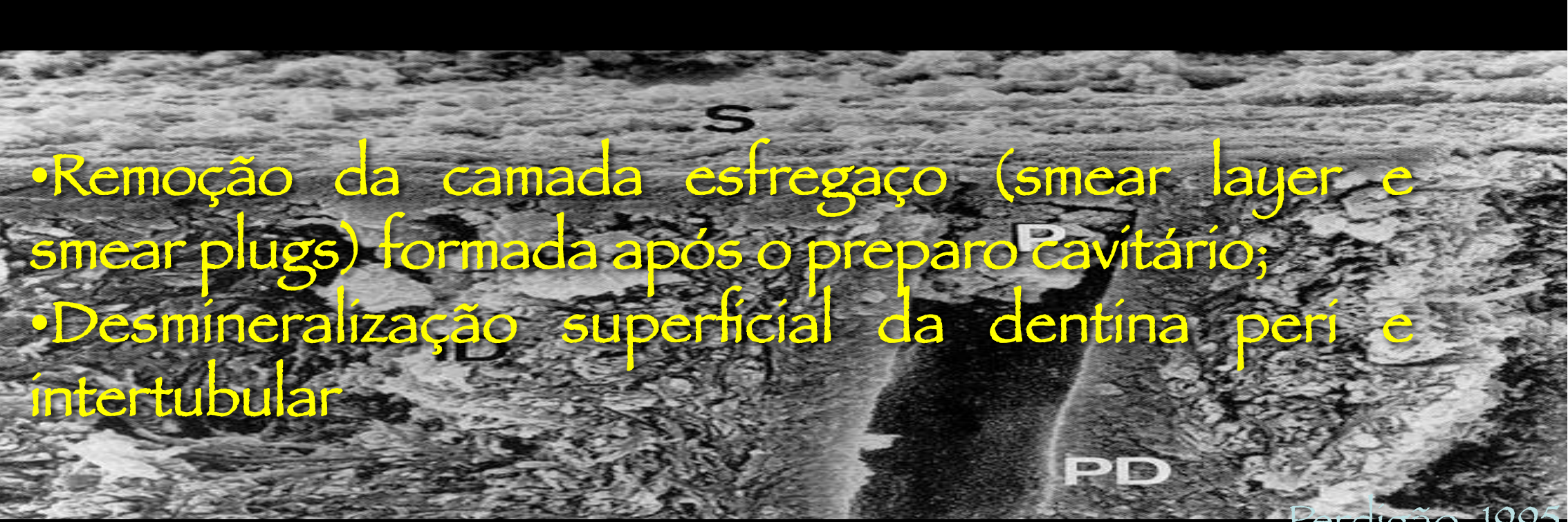
*** Aumenta a energia de supe**



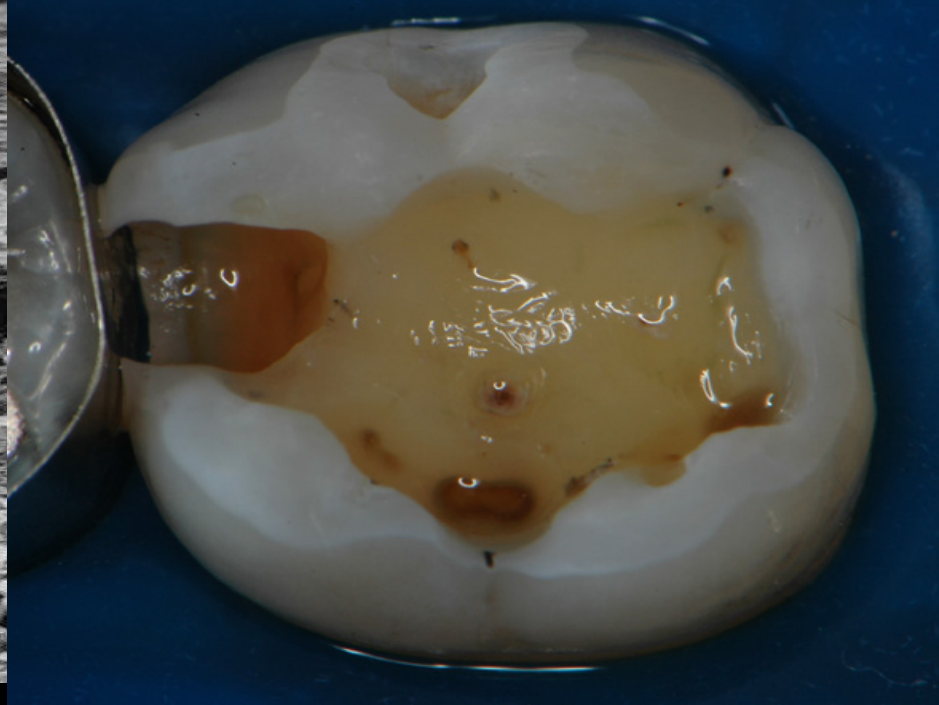
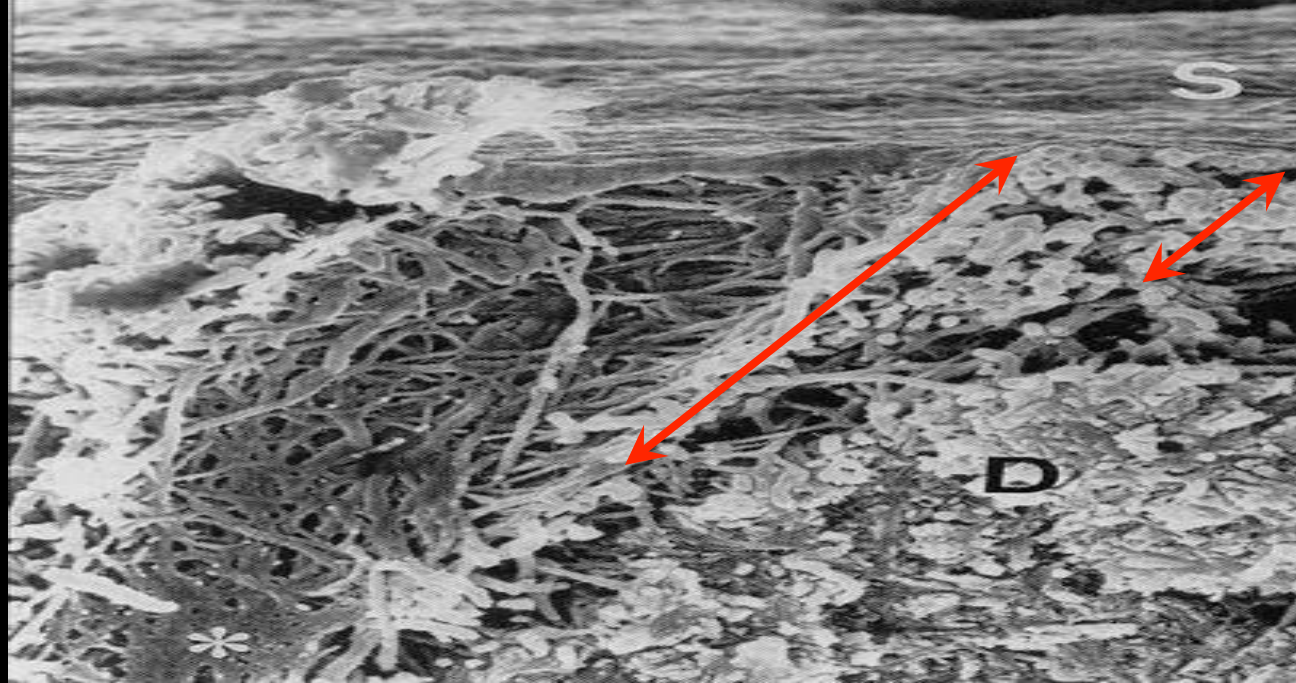
Condicionamento ácido da dentina



BACTÉRIAS



- Remoção da camada esfregação (smear layer e smear plugs) formada após o preparo cavitário;
- Desmineralização superficial da dentina peri e intertubular

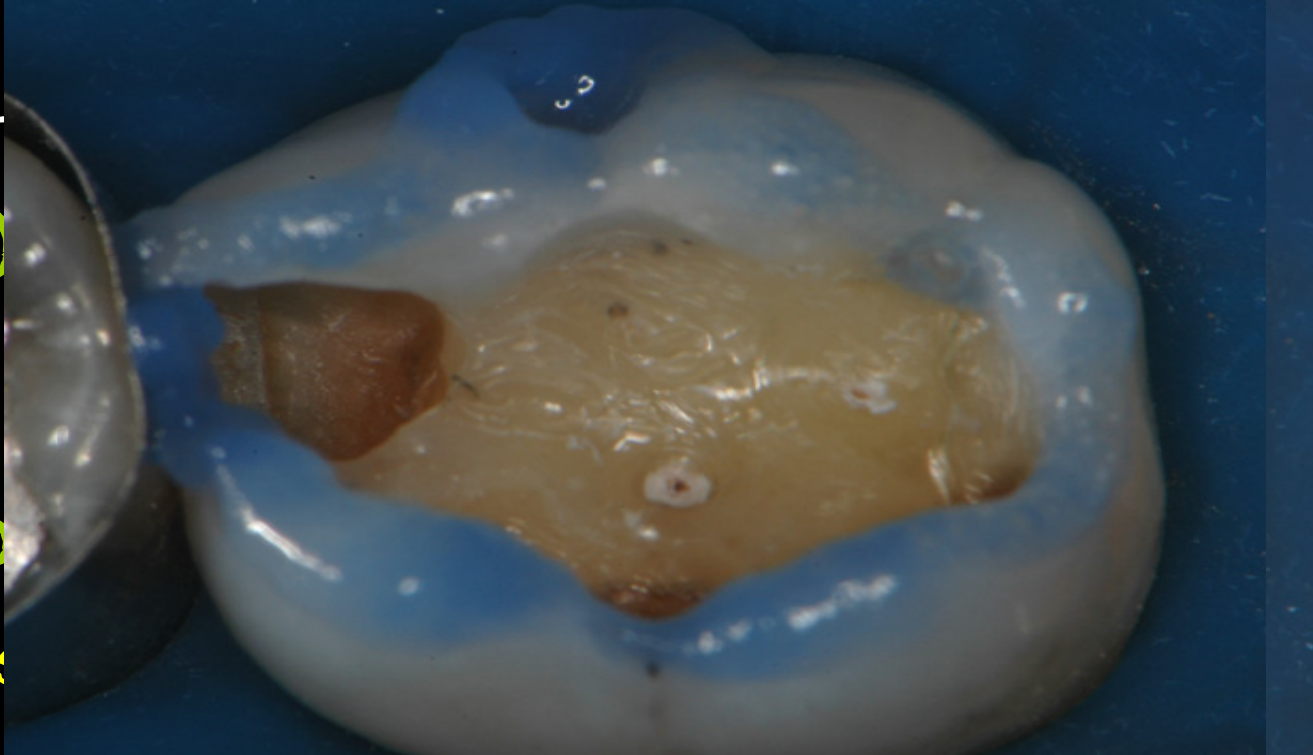


Pardigão 1995

Tempo de condicionamento
15s na dentina - 30s
Tempo de enxágue

No mínimo, o mesmo

* Remoção de produtos



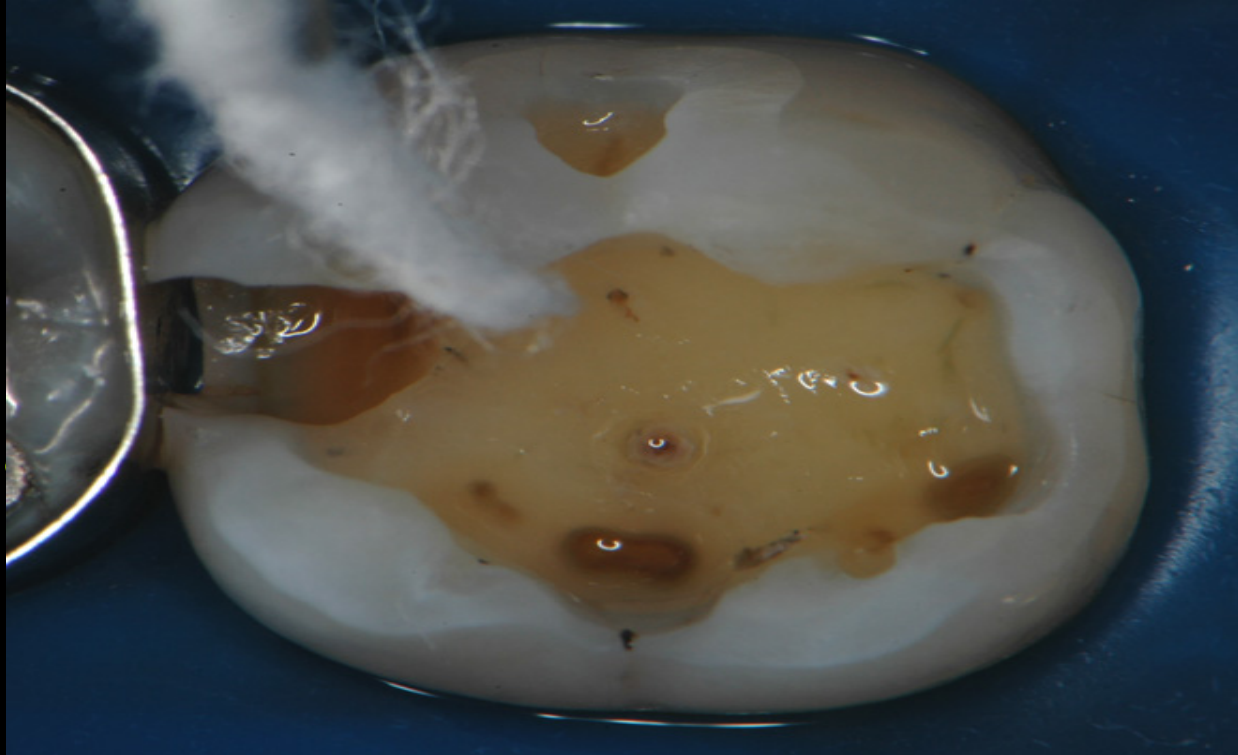
Esmalte

Tempo de secagem?
Pode esturricar!!!

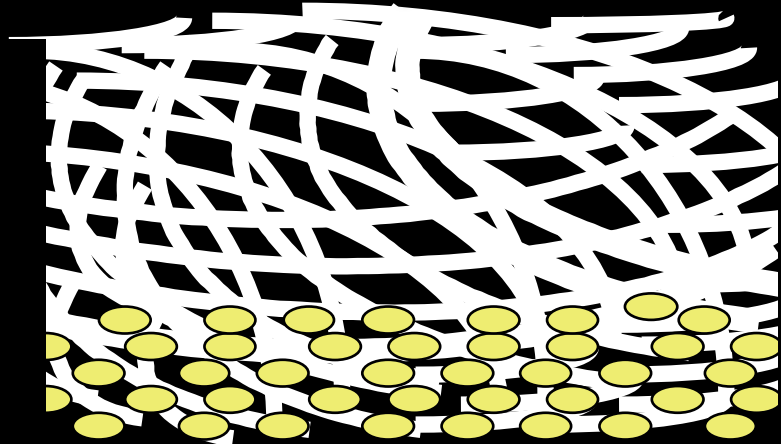
Obs: visualização do branco-opaco



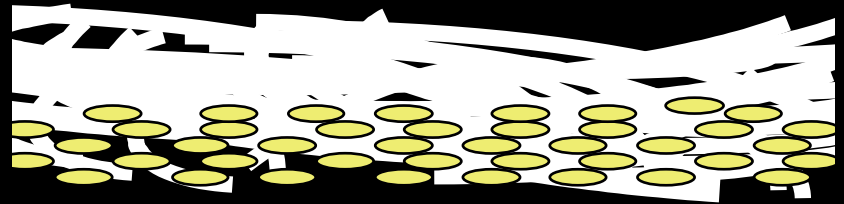
Tempo de secagem??
Deve ser mantida úmida



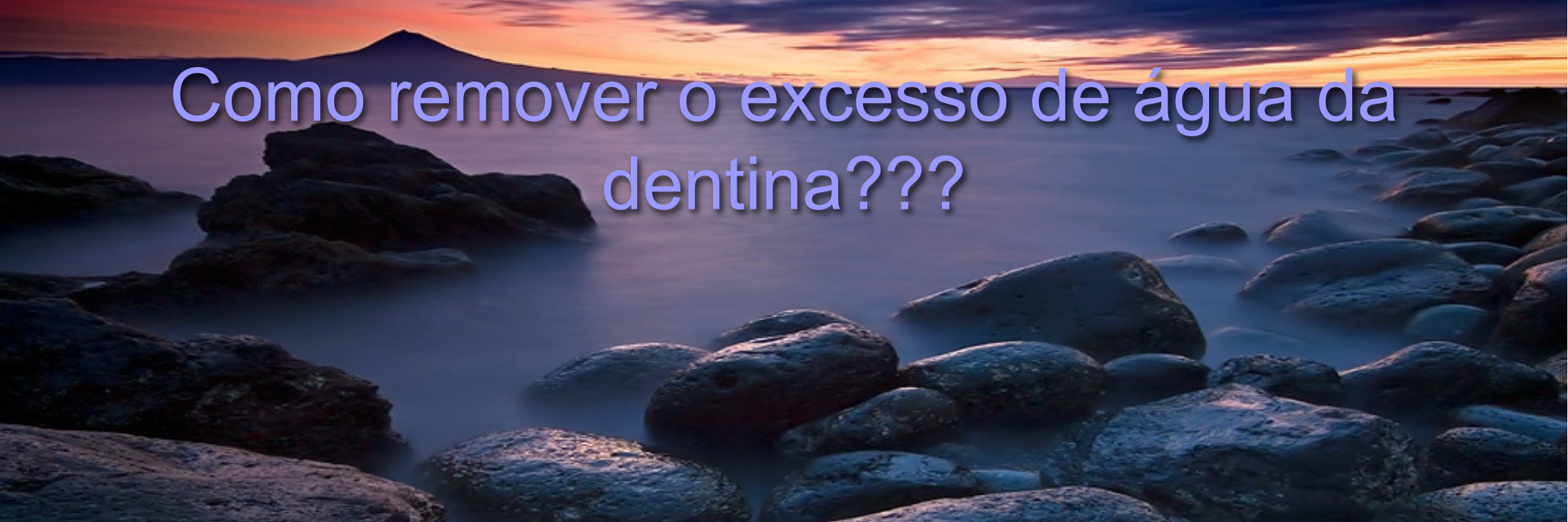
Por que não posso secar totalmente a dentina???



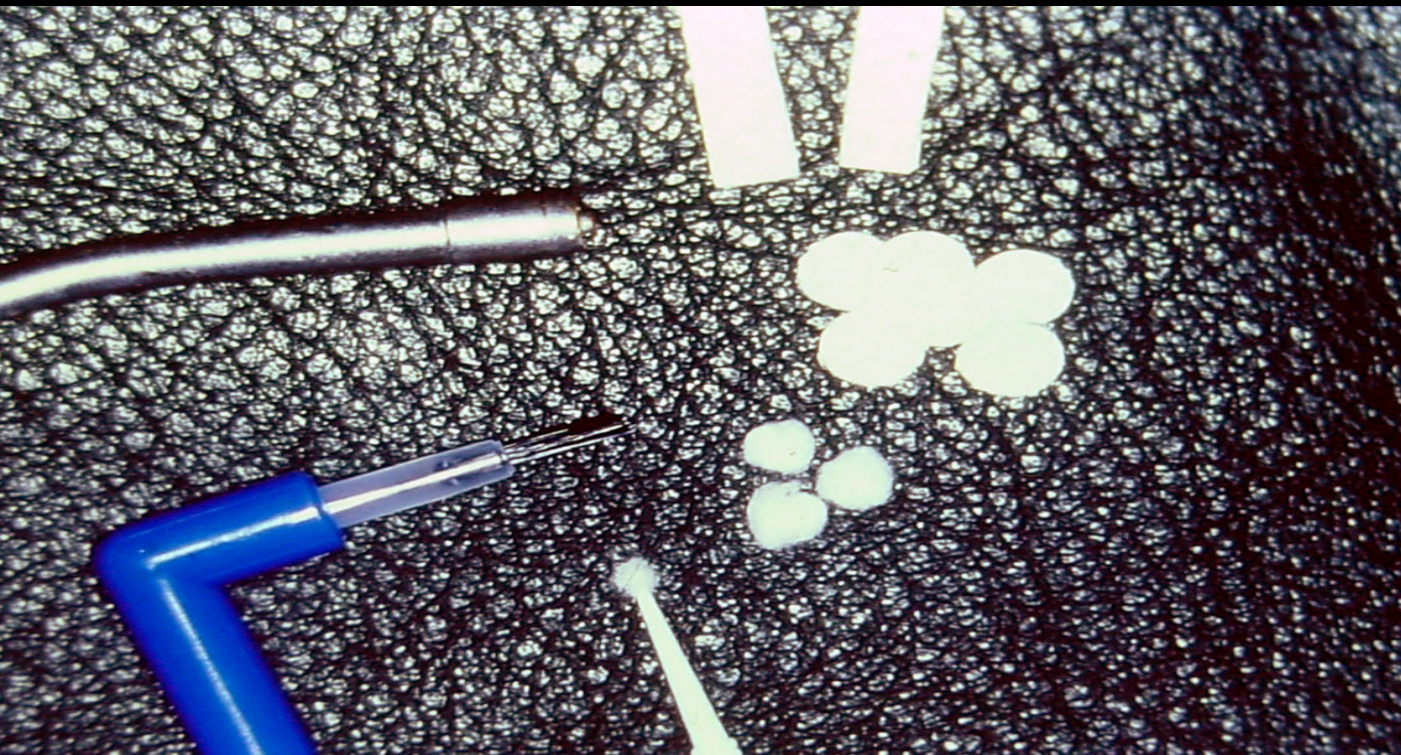
Reis et al., 2002



Colapso das fibras colágenas



Como remover o excesso de água da
dentina???



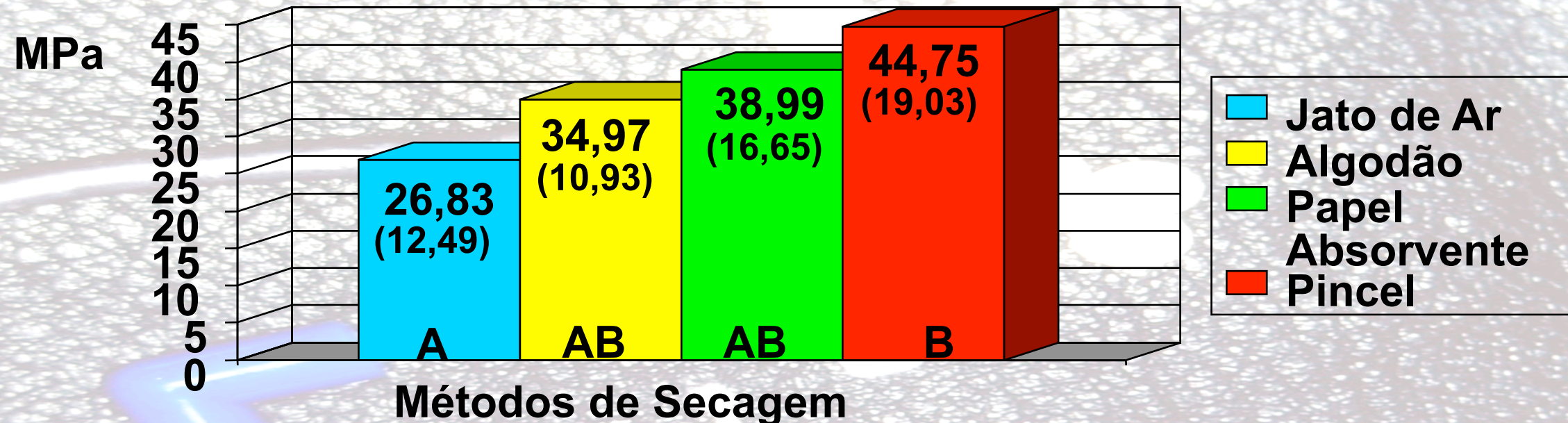
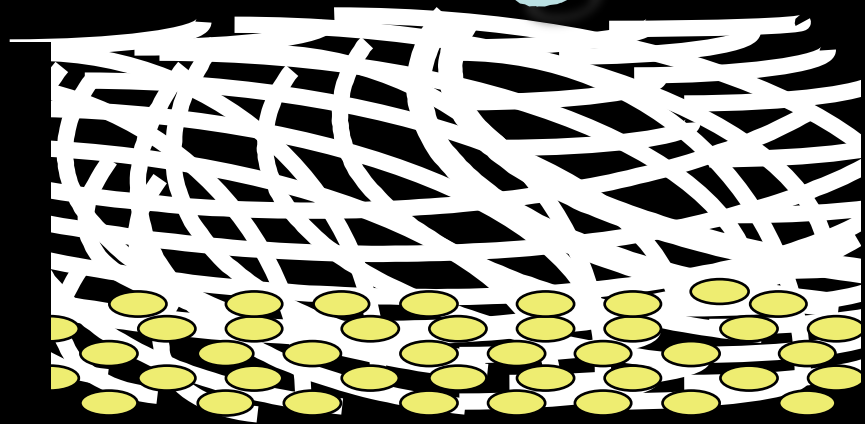
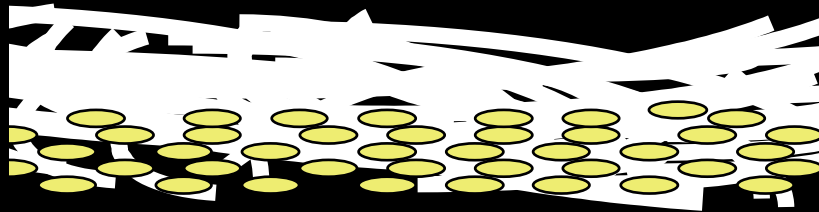


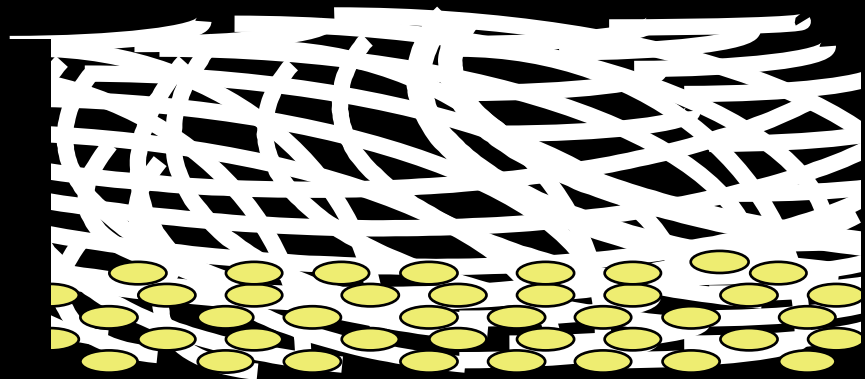
Gráfico 1 - Resistência de união (MPa) resultante dos diferentes métodos de secagem

É se houver excesso de secagem?



Reis et al., 2002

Reumedecimento da dentina



Água da seringa tríplice, **Próprio primer (!)**

Clorexedina; Aqua-prep

Reis et al., 2002

Mas, e se houver excesso de água?

OVERWETTING

- Diluição do “primer” e separação das fases
- Incompleta infiltração e polimerização dos monômeros
- Vedamento tubular deficiente

Sensibilidade, microinfiltração, cárie

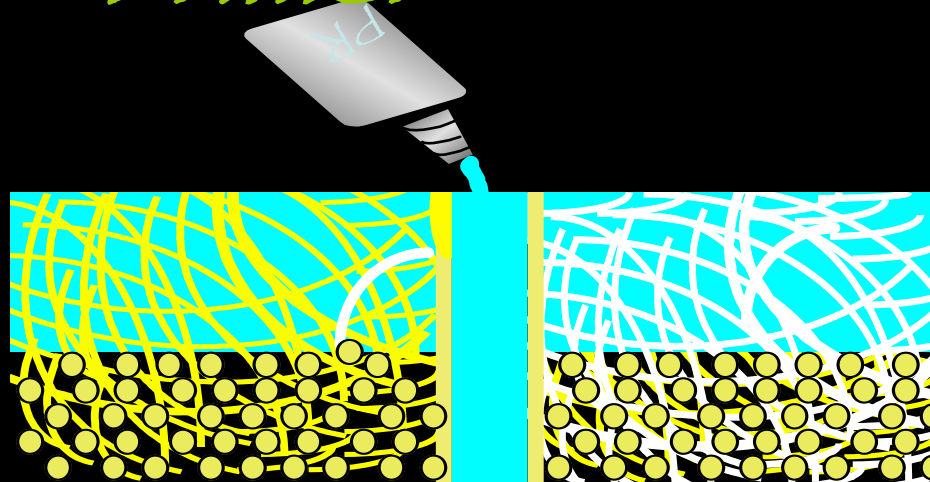


Primer - Constituição básica

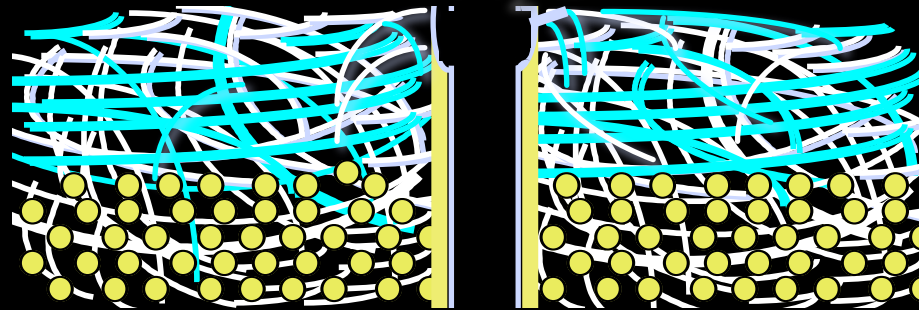
- Solvente: água, etanol, acetona ou a mistura deles
- HEMA
- Bís-GMA

Dentina

Primer



Solvente
+ H₂O



Impregnação por monômero

Será que a umidade ideal da dentina
desmineralizada é a mesma para sistemas
adesivos com *prímer* à base de água,
etanol ou acetona?

Solventes

Acetona

**One-Step
Prime & Bond *NT*
Bond 1
Gluma One Bond**

Água

**Adper Prompt L Pop
One-Up Bond F
Clearfil L Bond 2V
Clearfil SE B**

Etanol

**Excite
Optibond Solo Plus
PermaQuick
PQ 1**

**Matrixx Cabrio
Tenure
Syntac Sprint**

**Adper Single Bond
Optibond FL
Adper Scotchbond MP
Gluma Confort Bond
+Desensitizer**

Solventes

Acetona

Etanol

Prime & Bond *NT*

Dual Cure

All Bond 2

Tyrian SPE/

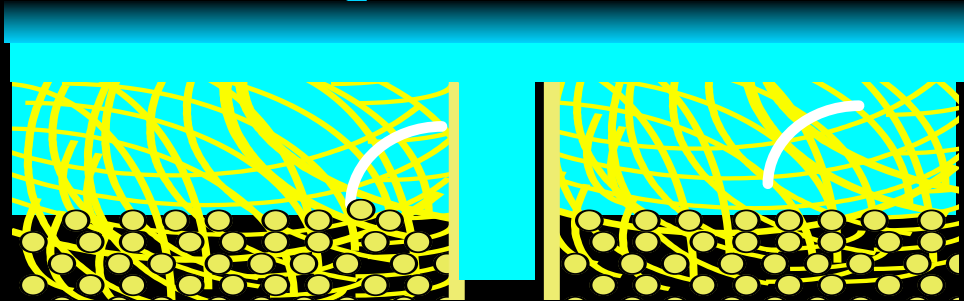
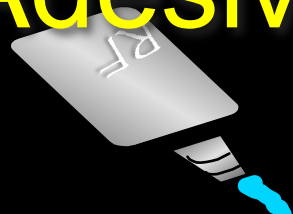
One –Step Plus

Água

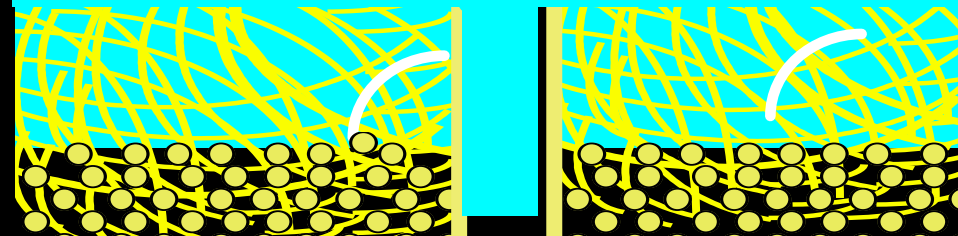
Adesivo- *Constituição básica*

- monômeros (HEMA, Bis-GMA)
- iniciadores

Adesivo



Resina composta



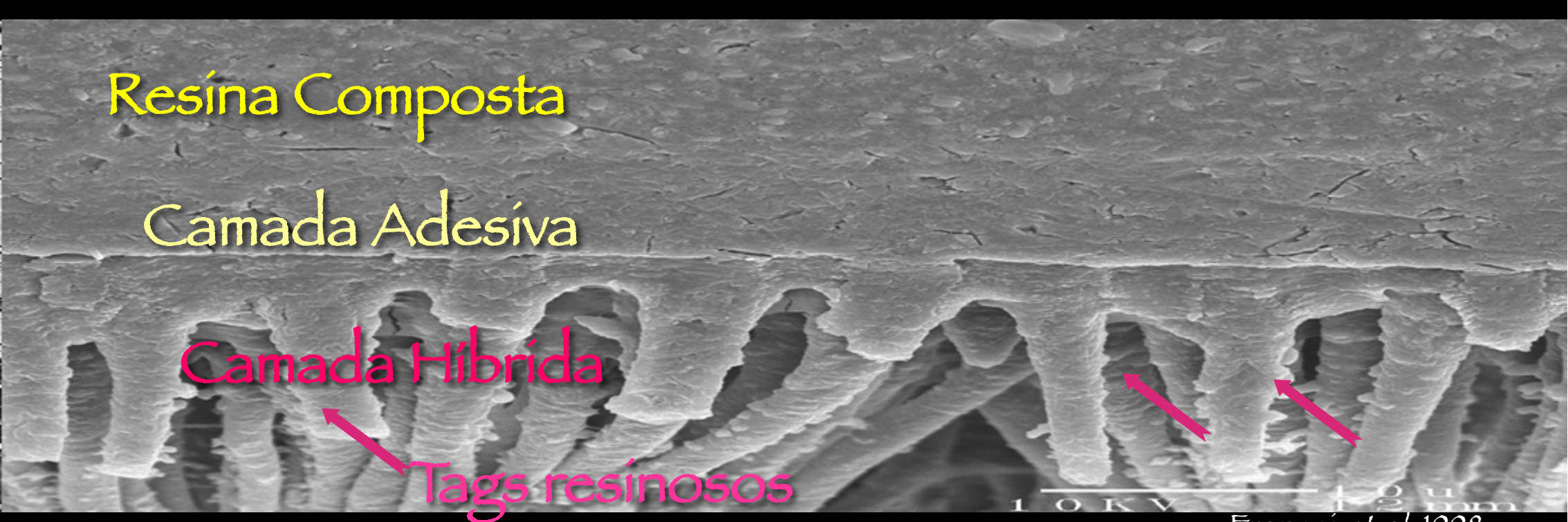
Camada híbrida ou zona de interdifusão resínosa

Resína Composta

Camada Adesiva

Camada Híbrida

Tags resinosos



Pesquisas atuais

~ Envelhecimento da interface adesiva:

Degradação dos monômeros resinosos (sistemas simplificados e subpolimerização)

Degradação hidrolítica e enzimática das fibrilas colágenas (sobretudo se desprotegidas)

ADM, 2006

Como aumentar a estabilidade da união

- Uso de uma camada adicional de um adesivo hidrofóbico
- Aplicar várias camadas dos sistemas simplificados
- Deixar evaporar bem os solventes entre elas
- Aumento do tempo de polimerização do adesivo

ADM, 2006

Sistemas adesivos
Self-etch ou
Autocondicionantes

Minimizar problemas durante:

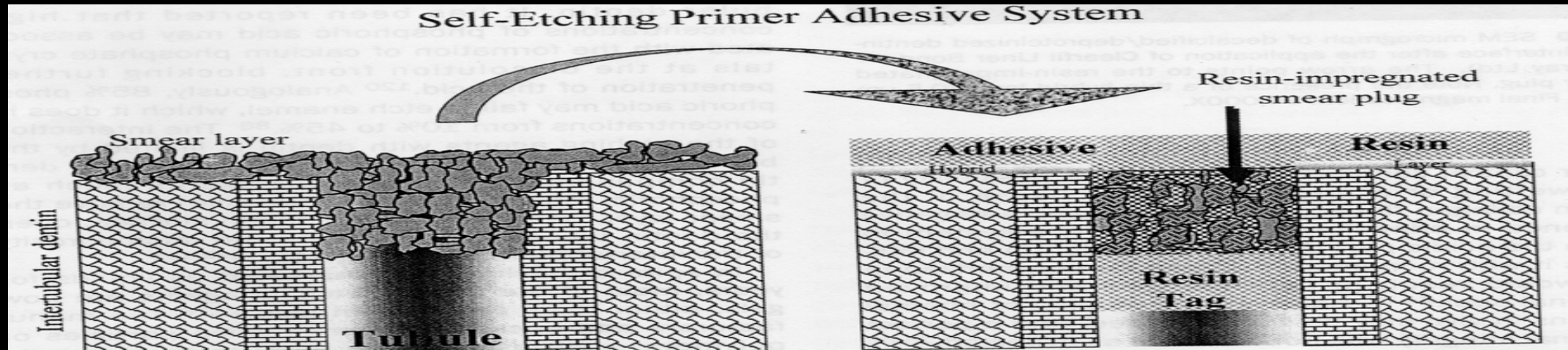
- Condicionamento da dentina
- Secagem da dentina
- Permeação dos monômeros adesivos

Permanência da *Smear Layer*

Modificação da *Smear Layer*

Concomitante desmineralização e
hibridização

Sistema Adesivo "Self-Etch"



Primer Autocondicionante- Constituição

- Monômeros acídicos (MDP, MDPB, etc)
- Solventes
- HEMA
- Bis-GMA
- 4-META

Adesivo- Constituição

- Monômeros (Bis-GMA)
- Iniciadores

Sistemas adesivos *Self-etch*

2 tipos (passos):

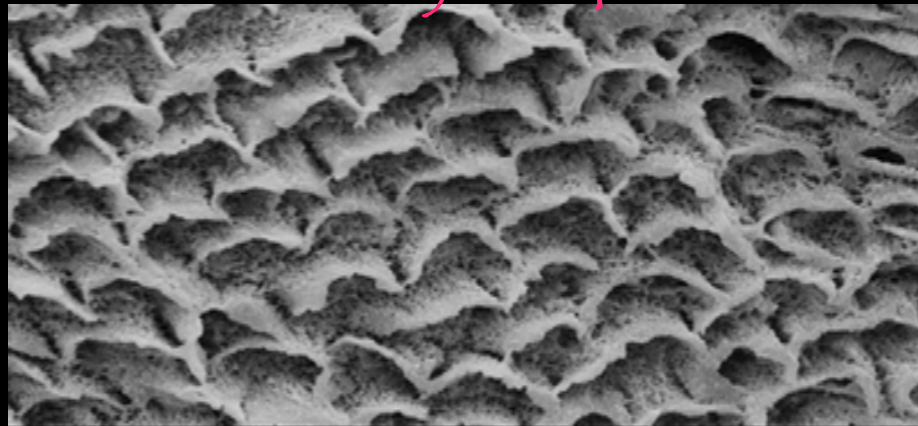
- 1 passo: autocondicionantes
- 2 passos: com *primers* autocondicionantes

3 tipos (pH):

- Forte ($\text{pH} < 1,0$)
- Moderado ($1,0 < \text{pH} < 2,0$)
- Fraco ($\text{pH} > 2,0$)

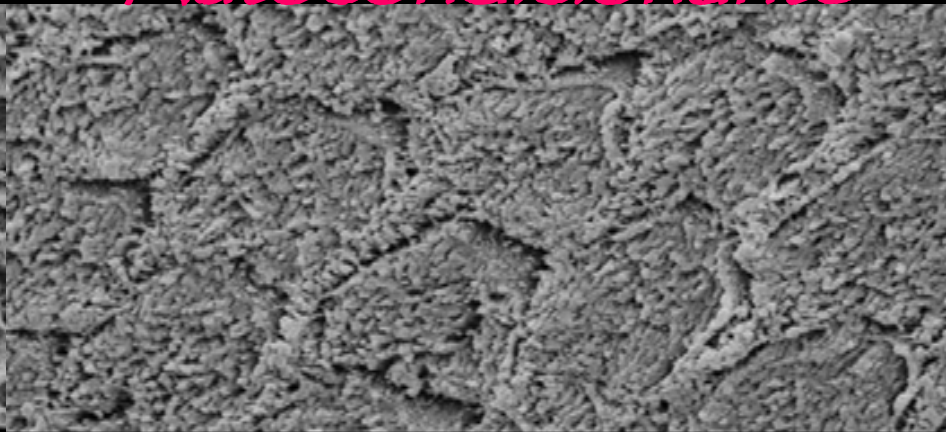
Efeito sobre o esmalte

H_3PO_4



EHT=20.00 kV WD= 20 nm Mag= 5.00 K X
1µm Photo No.=3 Detector= SE1

Autocondicionante



EHT=20.00 kV WD= 14 nm Mag= 5.00 K X
1µm Photo No.=19 Detector= SE1

“Ácido forte”



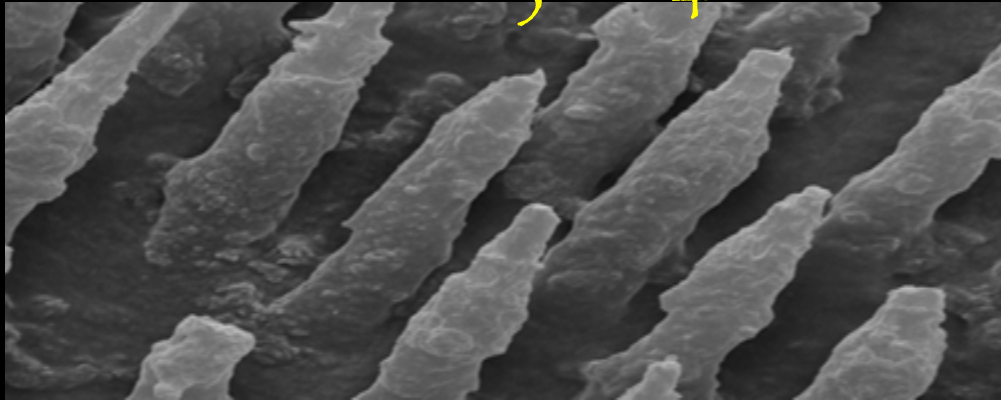
“Ácido moderado”



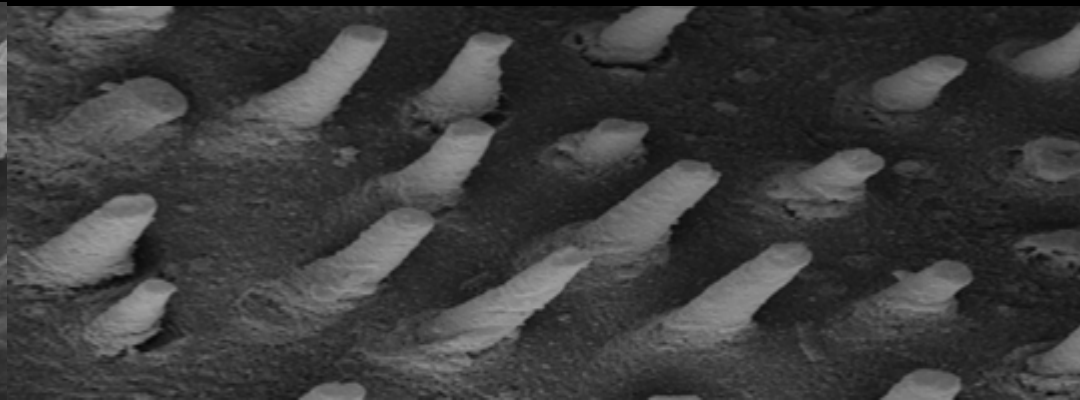
Efeito sobre a dentina

Diferenças na Camada Híbrida/Tags

H_3PO_4



Autocondicionante



Apesar da menor espessura da camada híbrida formada com esses adesivos, os valores de resistência de união à dentina são semelhantes àqueles da técnica do condicionamento ácido total.

Mas, e a

Longevidade...

Variações térmicas e Cargas mecânicas
cíclicas???

Autocondicionante - esmalte intacto?

Alternativas:

Asperizar a superfície do esmalte

(Kanemura, 2001)

Autocondicionante - esmalte intacto?

Alternativas:

Aplicar o primer pelo dobro do tempo

(Ferrari et al., 2000)

Autocondicionante - esmalte intacto?

Alternativas:

Condicionamento prévio do esmalte – H_3PO_4
(Perdigão et al., 2000)

2 passos



Clearfil SE Bond
(Kuraray)



AdheSE
(Ivoclar-Vivadent)



Clearfil Liner Bond
2V
(Kuraray)



DUAL

OptiBond Solo
Plus Self-Etch
(Kerr)

2 passos



Tyrian SPE + OS,
OSP ou AB2
(Bisco)



One-Up Bond F
(Tokuyama)



Etch & Prime 3.0
(Degussa)

1 passo
2 frascos



Xeno III
(Dentsply)



A Q Bond
(Degussa)



i BOND
(Heraeus Kulzer)

1 passo
"1 frasco"



Prompt L-Pop



Clearfil Protect Bond
(Kuraray)

Novas tendências



Clearfil S³ Bond
(Kuraray)

Outros cuidados

1. Preparo da dentina com pontas diamantadas deve ser evitado
2. Após a aplicação do *primer*, aguardar 20 s e depois secar veementemente por 10s ou mais (*Miyazaki et al., 1999*)

Outros cuidados

3. Começar a secagem de longe (10 cm) e depois ir aproximando (*Pereira, 2002*)
4. Deve ser mantido sempre em geladeira (baixo prazo de validade – 6 meses) – hidrólise do HEMA em soluções ácidas



Single-step adhesives are permeable membranes

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Abstract

Objective: This study tested the hypotheses that micro-tensile bond strengths of all currently available single-step adhesives to dentine are adversely affected by delayed activation of a light-cured composite, and that such a phenomenon only occurs in the presence of water from the substrate side of the bonded interface.

Methods: In experiment I, a control three-step adhesive (All-Bond 2, Bisco) and six single-step adhesives (One-Up Bond F, Tokuyama; Etch&Prime 3.0, Degenne; Xeno CF Bond, Rankin; AQ Bond, Sun Medical; Reactivator Bond, Shofu and Prisma I-Pop, 3M ESPE) were bonded to smear, hydrated dentine. A microfilled composite was placed over the cured adhesive and was either light-activated immediately, or after leaving the composite in the dark for 20 min. In experiment II, three single-step adhesives (Etch&Prime 3.0, Xeno CF Bond and AQ Bond) were similarly bonded to completely dehydrated dentine using the same delayed light-activation protocol. In experiment III, a piece of processed composite was used as the bonding substrate for the same three single-step adhesives. The microfilled composite was applied to the cured adhesives using the same immediate and delayed light-activation protocols. Bonded specimens were sectioned for micro-tensile bond strength evaluation. Fractographic analysis of the specimens was performed using SEM. Stained, undemineralised sections of unstained, bonded specimens were also examined by TEM.

Results: When bonded to hydrated dentine, delayed light-activation had no effect on the control three-step adhesive, but significantly lowered the bond strengths of all the single-step adhesives ($p < 0.05$). This adverse effect of delayed light-activation was not observed in the three single-step adhesives that were bonded to either dehydrated dentine or processed composite. Morphological manifestations of delayed light-activation of composite in the hydrated dentine bonding substrate were exclusively located along the composite–adhesive interface, and were present as large voids, resin globules and honeycomb structures that formed partitions around a myriad of small filaments along the fractured interfaces.

Conclusion: These features resembled the ‘‘crescent phenomenon’’ that was previously reported along the dentine–adhesive interface of some acetone-based three-step adhesives. The cured adhesive layer in single-step adhesives may act as semi-permeable membranes that allow water diffusion from the bonded hydrated dentine to the intermixed zone between the adhesive and the uncured composite. Osmotic blistering of water droplets along the surface of the cured adhesive layer and emulsion polymerization of immiscible resin components probably account for the compromised bond strengths in single-step adhesives after delayed activation of light-cured composites.

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Keywords: Single-step adhesive; Delayed light-activation; Light-cured composite; Semi-permeable membrane; Osmotic blistering

1. Introduction

Dentine adhesives are currently available as three-step, two-step and single-step systems depending on how the three cardinal steps of etching, priming and bonding to tooth

substrates are accomplished or simplified [1]. Two-step systems are sub-divided into the self-priming adhesives that require a separate etching step, and the self-etching primers that require an additional bonding step [2]. The recently introduced all-in-one adhesives further combined these three bonding procedures into a single-step application. Irrespective of their packaging designs, these systems are supplied as two-component assemblies to maintain adequate shelf-lives. They are mixed together immediately before use, and

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“A camada de adesivo polimerizada em sistemas adesivos de passo único funcionam como membranas semi-permeáveis que permitem a difusão de água da dentina unida e hidratada à zona intermediária localizada entre o adesivo e o compósito não-polimerizado.”

“Single bottle adhesives remained highly permeable after polymerisation due to the lack of hydrophobic resin coatings and permit fluid transudation across the bonded dentine in vivo.”

Yiu, 2006. J Dent , 34: 106-16



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Single-bottle adhesives behave as permeable membranes after polymerisation. II. Differential permeability reduction with an oxalate desensitiser

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