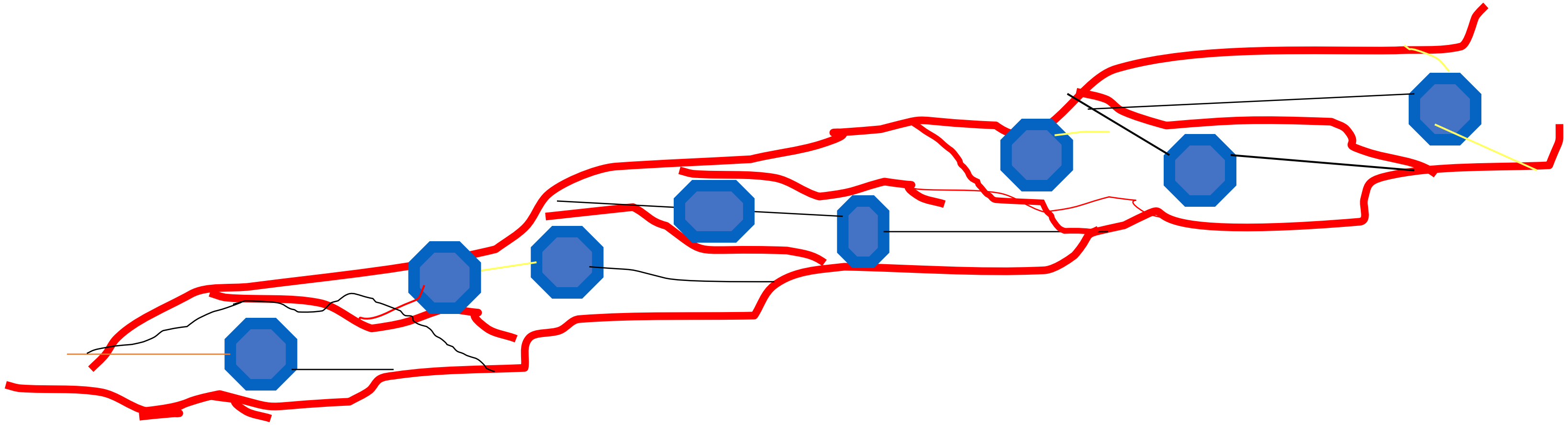
Adhesive technologies

L. Roubalíková

Composite materials

Chemically bonded mixture of organic matrix and inorganic fillers



Coupling agent – binds organic matrix and the filler together

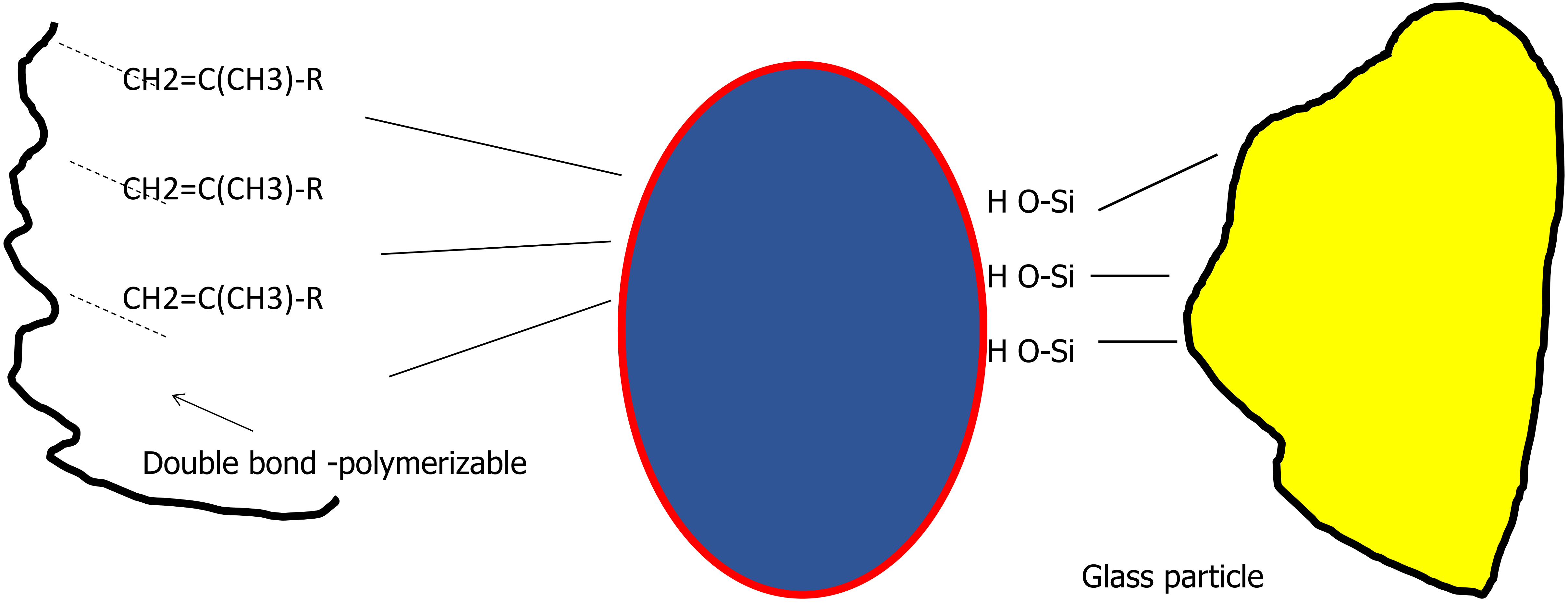
↓

Homogenous distribution of the filler particles in the material

↓

Excellent mechanical properties

Binding of the coupling agents to glass particles



Microfiller in complex particles

- Prepolymer
- Aglomerates

- Higher amount of filler, good mechanical resistance, good polishability

Nanoparticles

- Particles 10 nm and less

Special technology, size, shape and binding to monomer

Today

- Microhybrid or nanohybrid composites:

Good mechanical properties, good polishability, propagation of cracks is minimized.

Other components

- Activator and initiator
- Pigments
- Fluorescents
- Absorbers of light
- Inhibitors

Selfcuring composites

- Tertiary amine Dibenzolyperoxide

- Activator → Initiator

Light curing composites

- Initiator and sometimes also activator

- Camphorchinon CQ
- Phenylpropandion PPP
- Trimetylbenzoylphosphino xid TPO

Camphorchinon (CQ) - initiator

- Yellow colour
- Activator is present: etyl-4-(N,N'-dimetylamino)benzoát (4EDMAB), N,N'-dimetylaminoetylmetakrylat (DMAEMA)
- Light shades of composites: combination of CQ and other initiators.

- Maximum absorption – 470 nm.

Tje other fotoinitiators – shorter wave l.

Composite materials – basic characteristics

	Matrix	Filler
Compressive strength	↓	↑
Elasticity	↑	↓
Polymerization shrinkage	↑	↓
Polymerization stress	↓	↑
Water sorption	↓	↑

History

Dimetacrylates

Bowen 1960 – Bowen´s monomer

Buoconore 1955 – acid etching

History

- Fusayama 1979

Adhesion to dentin

Yoshida. Nakabaiashi

Van Meerbeck

35% - 37% phosphoric acid
silica particles
blue dye

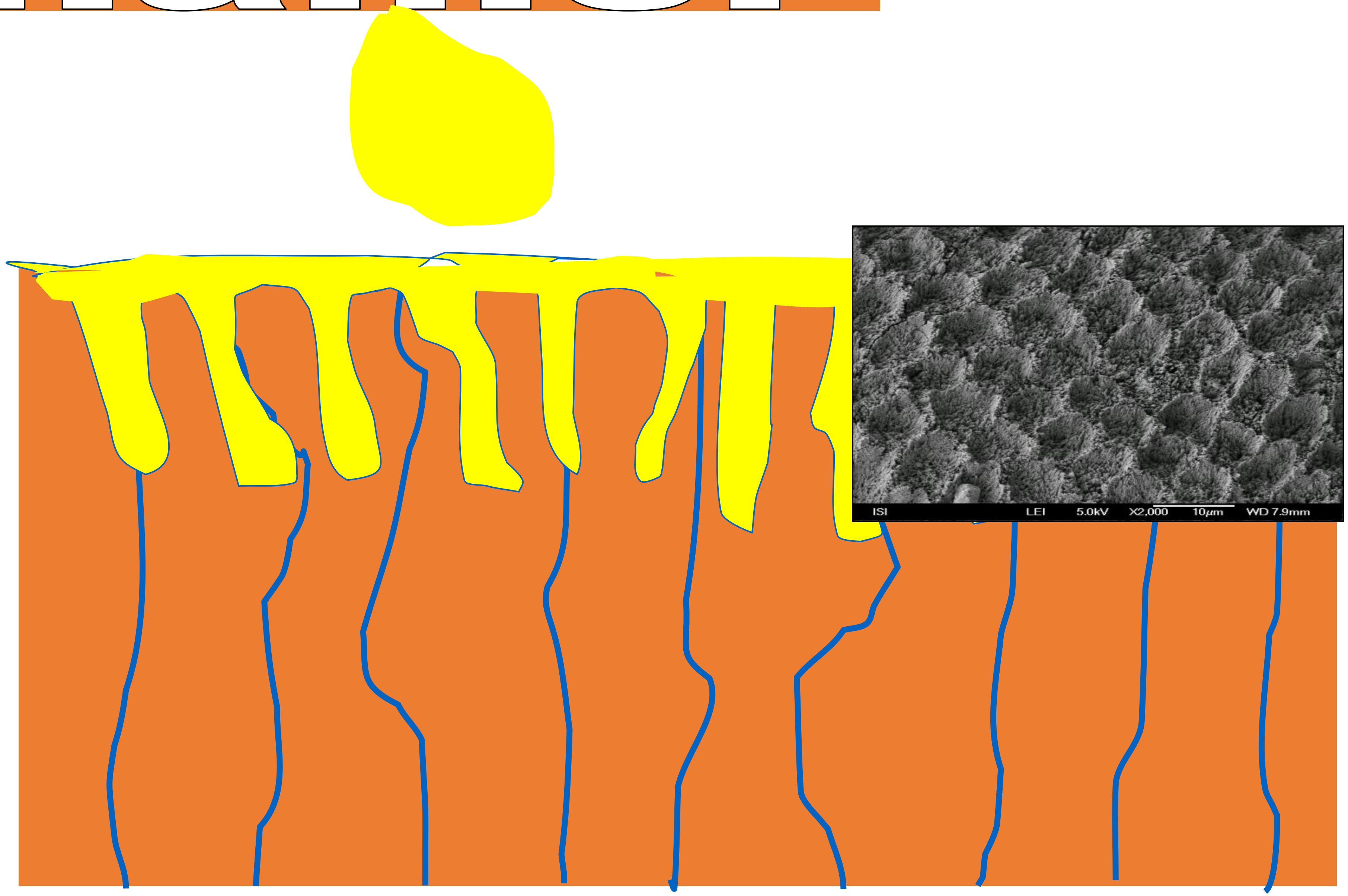
2
1
Prime
Simplicity
1
Simplicity
2
G-BOND
5mL
CE 0086
AdheSE
1
AdheSE
2
3M ESPE
Adhesive
7543
Single Bond

Adhesion

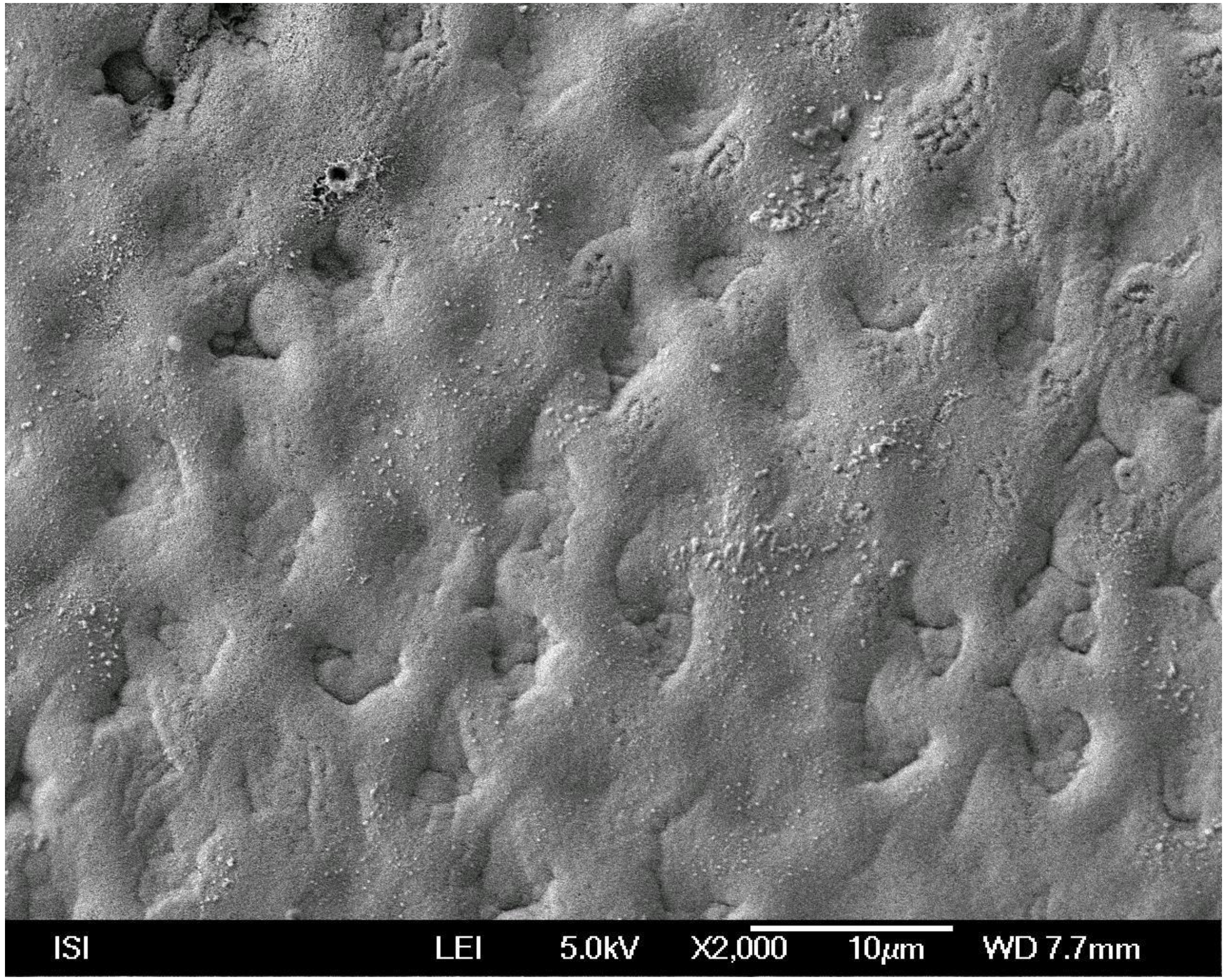
- Mechanical adhesion

- Specific adhesion
- Intermolecular forces
- Chemical binding

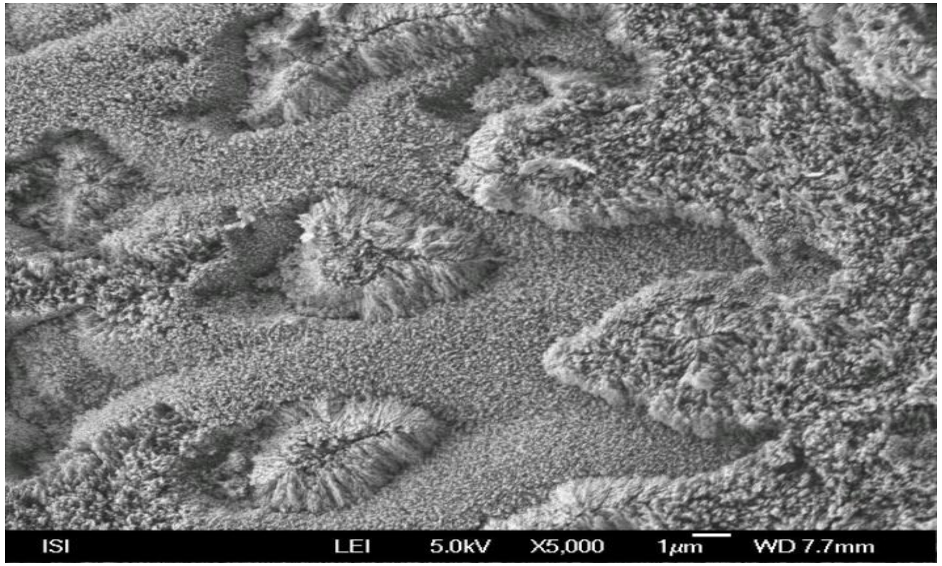
Enamel



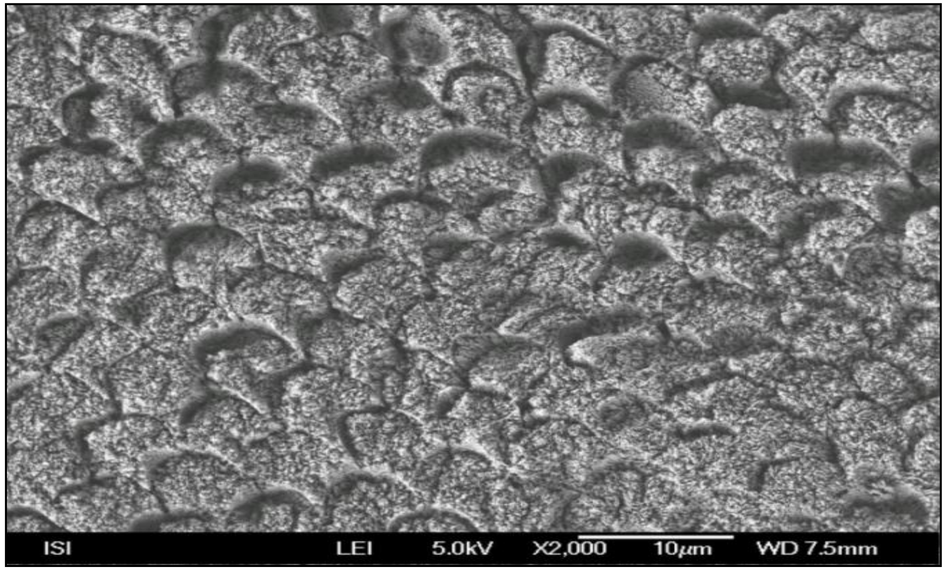
Aprismatic enamel



Acid on aprismatic enamel

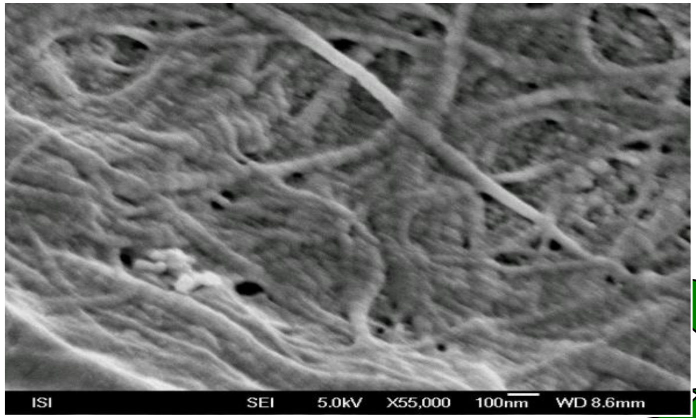


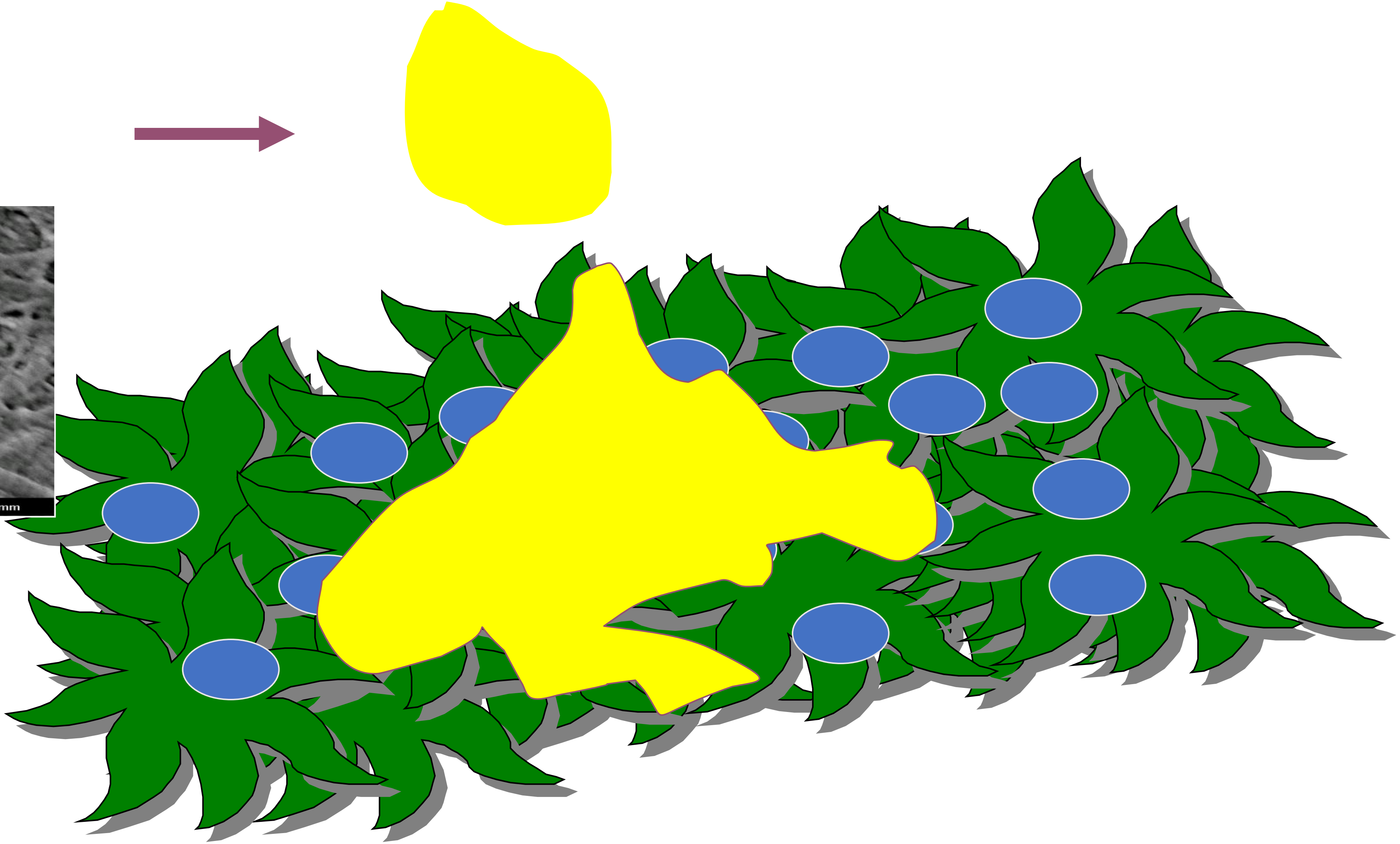
Acid on prismatic enamel



Dentin

Bonding agent





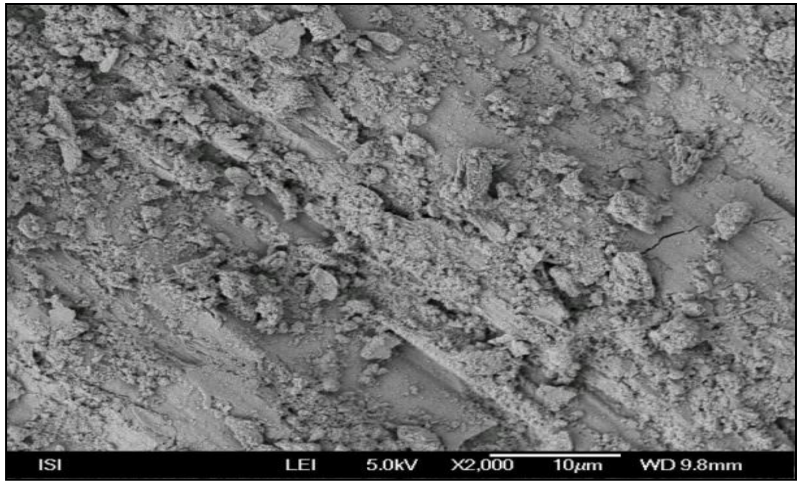
Adhesive system connects resin to enamel and dentin

- Bond is a hydrophobic resin principally of the same composition as composite filling material but without the filler or with a small amount of filler. It works in enamel. In dentin primer is necessary before bond.

Why?

Dentin – special composition

- More water – always wett
- Less minerals
- Low surface energy
- Smear layer



Composite is hydrophobic, we need hydrofilic substance

Adhesive systems contain resin monomers

- Hydrophobic monomers - bond works in enamel it does not work in dentin without primer
- Amphiphilic monomers – hydrophobic + hydrophilic part - in primer

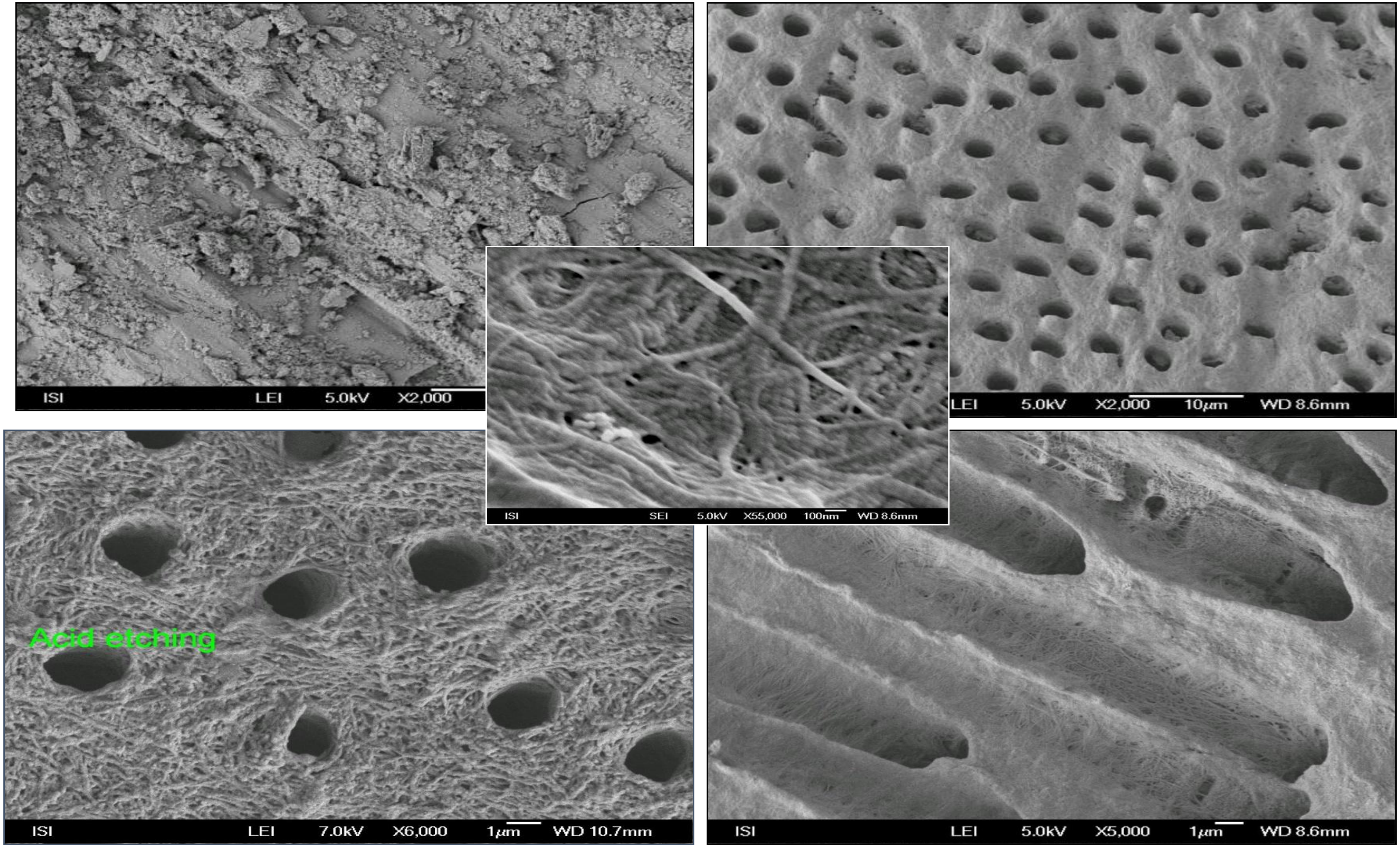
Primer is necesssary for dentin.

The hydrophillic part flows into dentin (tubules, spaces in collagen network) and keep the collagen network open, the hydrophobic part of primer binds to hydrophobic bond that flows into dentin pretreated with primer-

If primer applied on enamel – residual of water can be removed.

Dissolving agents

- Aceton
- Alcohol
- Water
- Water/alcohol


ISI LEI 5.0kV X2,000
LEI 5.0kV X2,000 10μm WD 8.6mm
ISI SEI 5.0kV X55,000 100nm WD 8.6mm
Acid etching
ISI LEI 7.0kV X6,000 1μm WD 10.7mm
ISI LEI 5.0kV X5,000 1μm WD 8.6mm

Clinically oriented classification of the adhesive systems acc to number of steps

<table>
<tr><td>Acid etching</td><td>Rinsing</td><td>Priming</td><td>Bonding</td></tr>
<tr><td>Acod etchin</td><td>Rinsing</td><td colspan="2">Priming a bonding</td></tr>
<tr><td colspan="3">Selfetching priming</td><td>Bonding</td></tr>
<tr><td colspan="4">Selfetching bonding)</td></tr>
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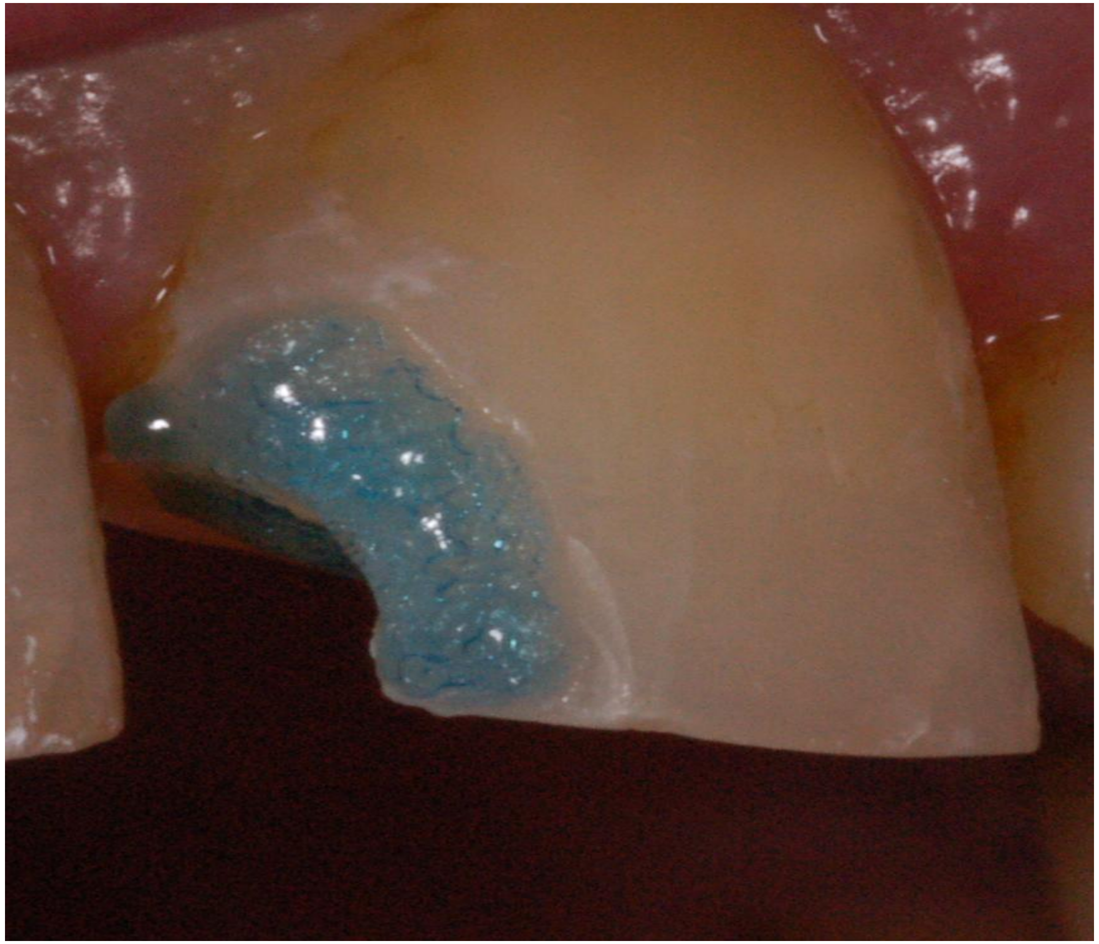
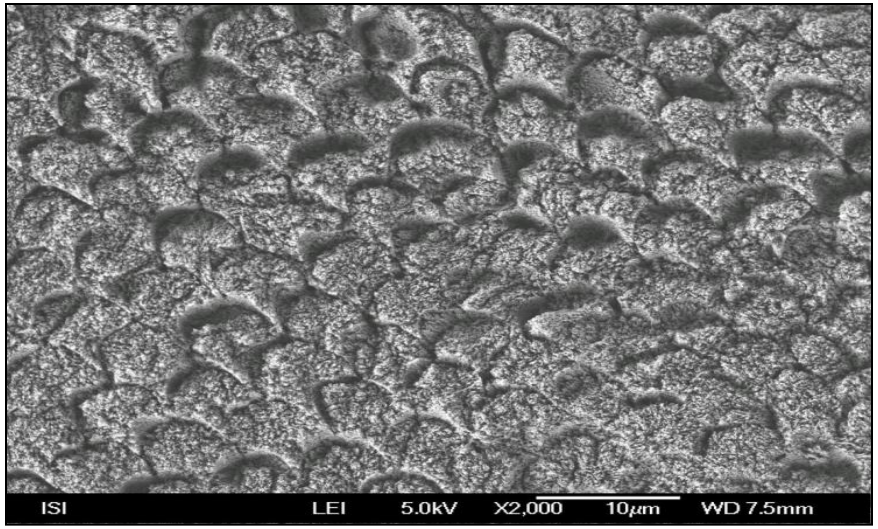
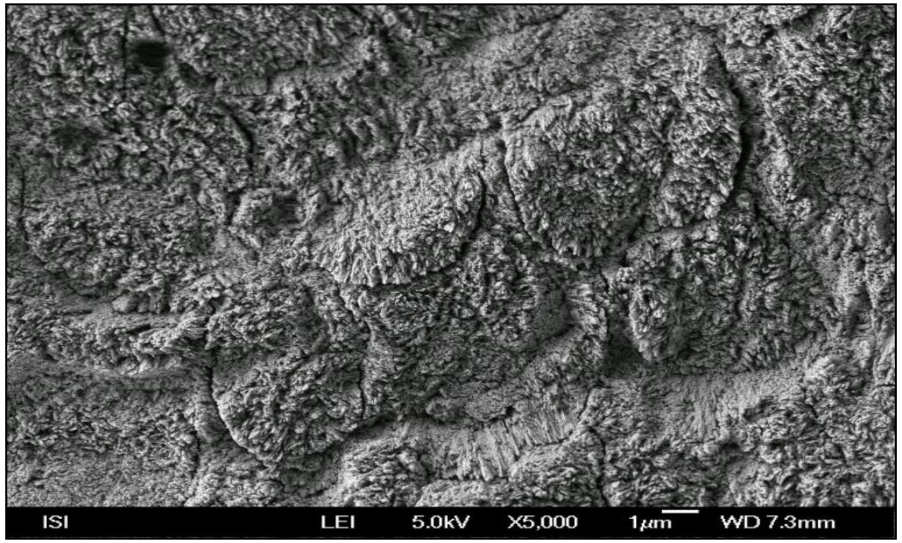


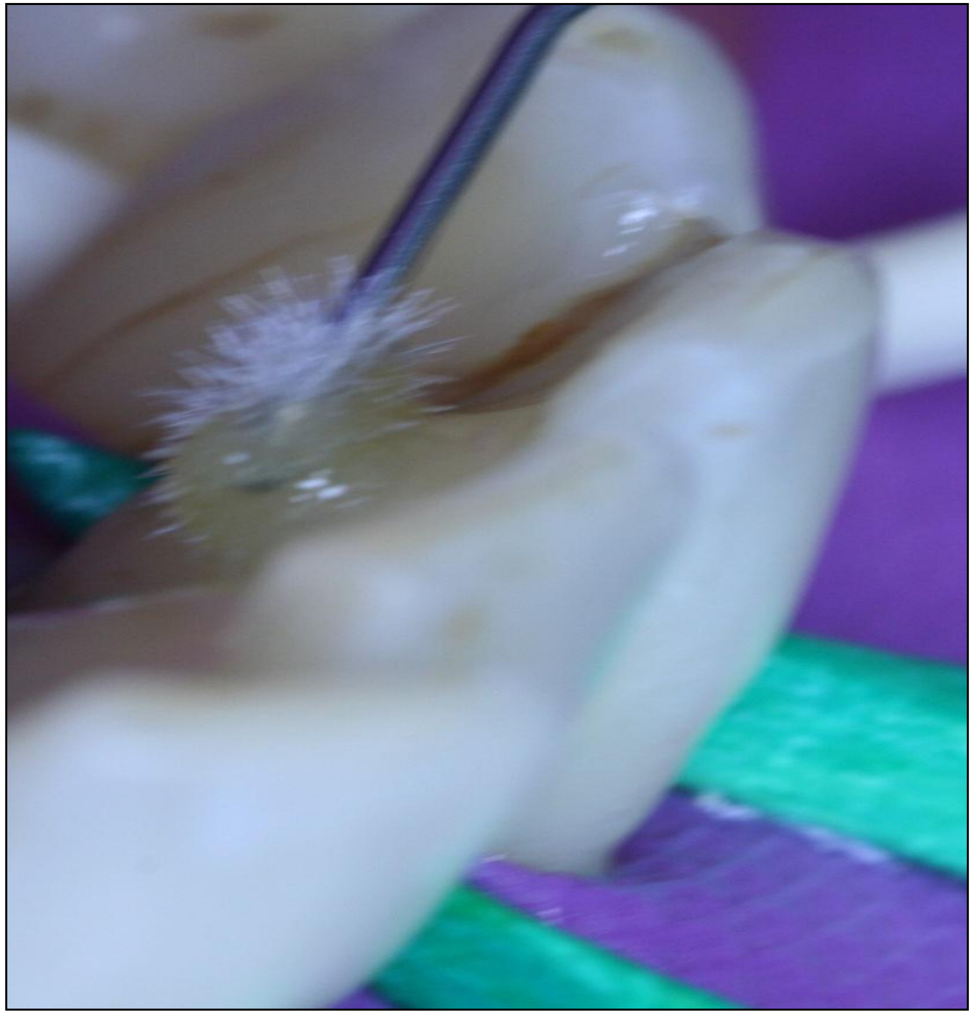
Srelfetching bonding agents



TE – Total etch,
ERA



SE – Self etching
SEA



Two steps selfetching agents

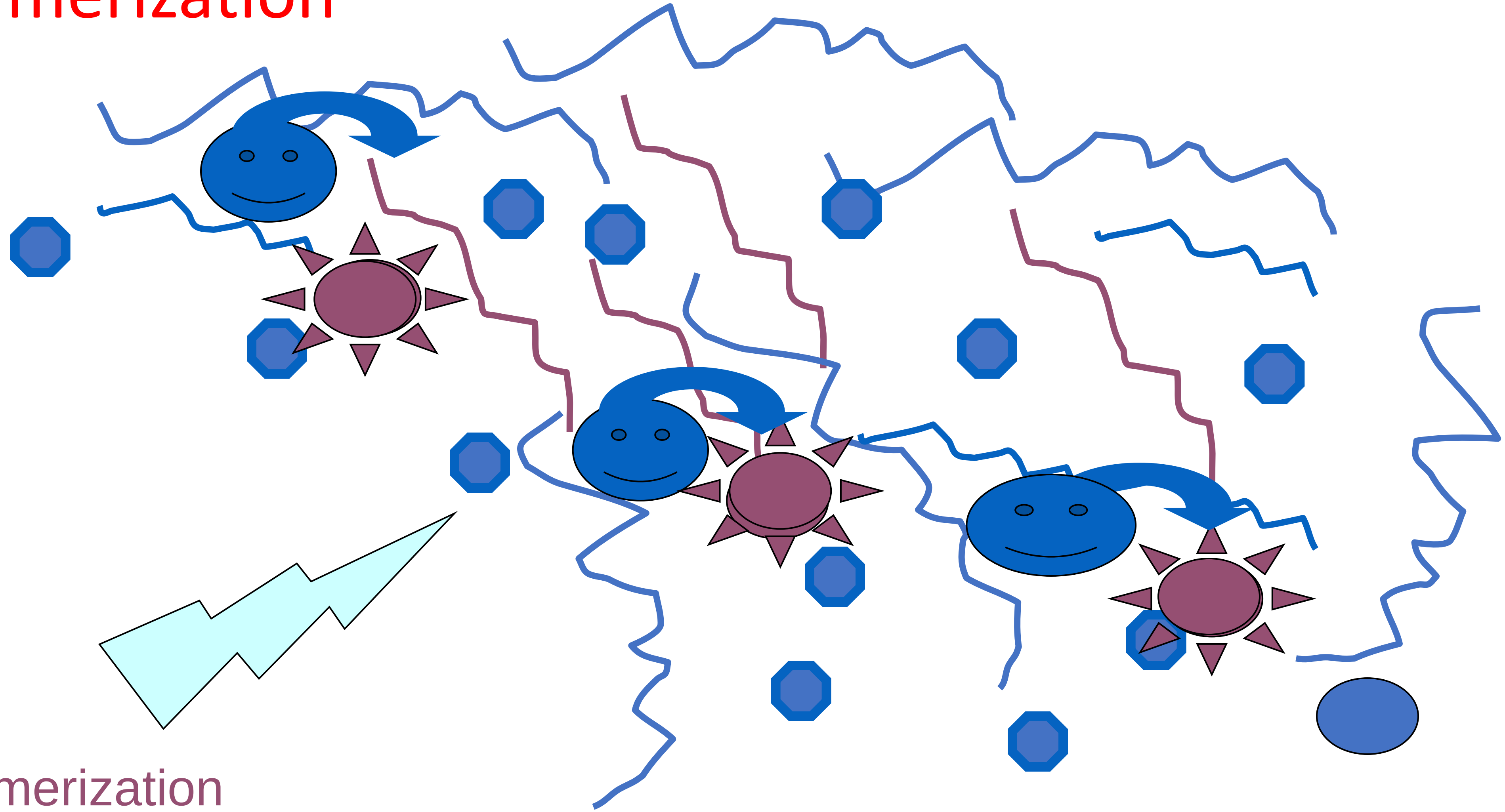
- Acidic hydrophilic primer – evaporation of the solvant, penetration, dissolving of the smear layer
- Hydrofobic bond – sealing of the surface

One step selfetching agents

- More vulnerable bonding

FAKT !!!

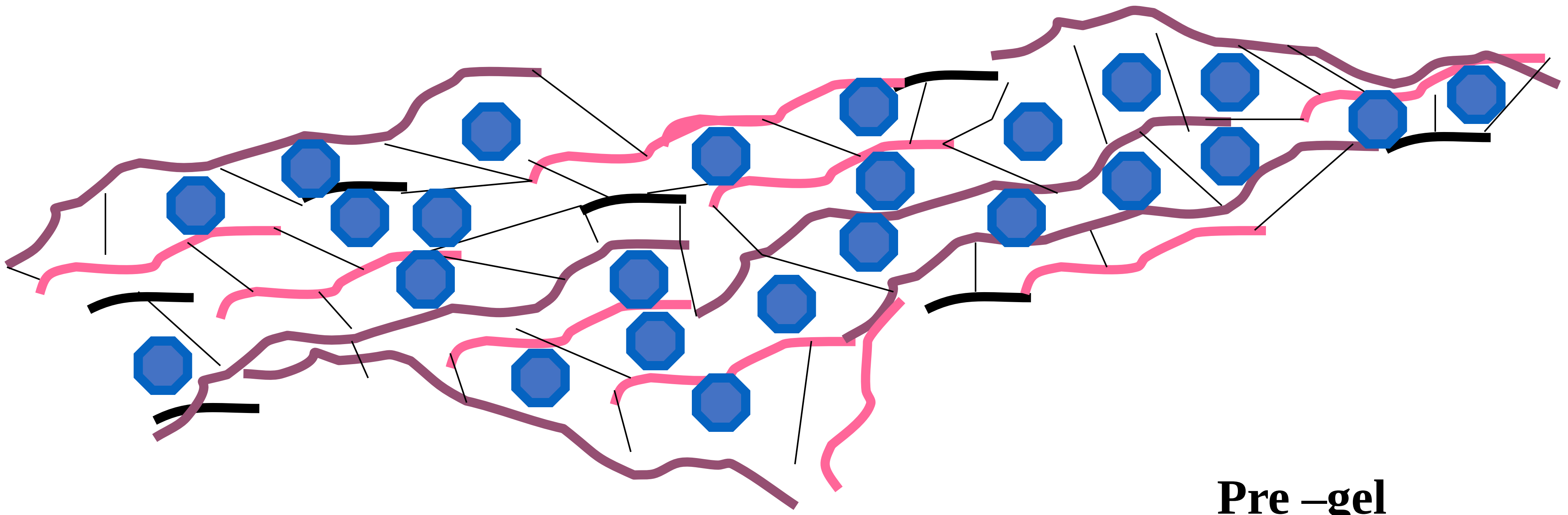
Polymerization



Light

Polymerization

Monomer → Polymer

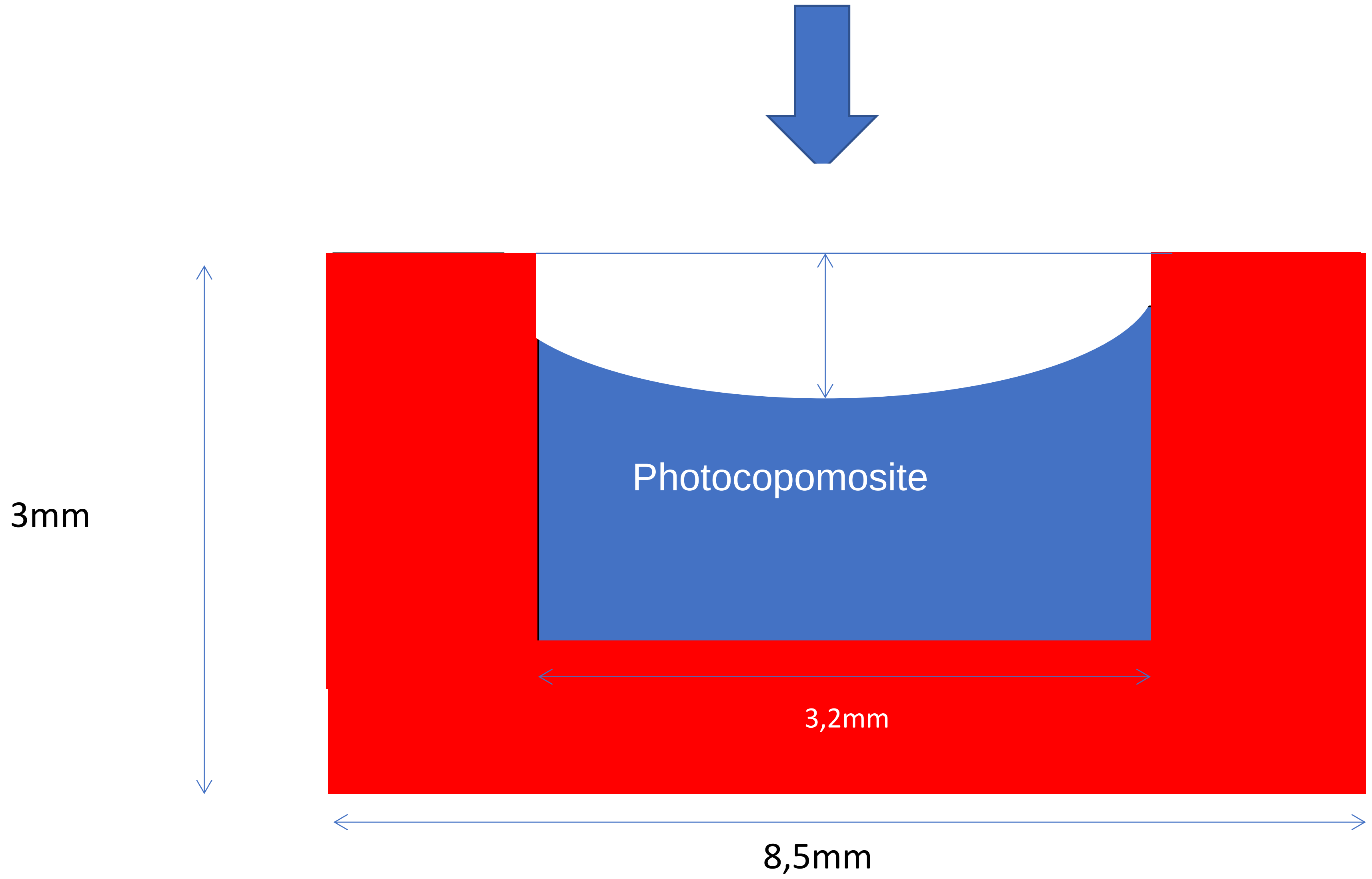


Pre –gel
Gel
Post -gel

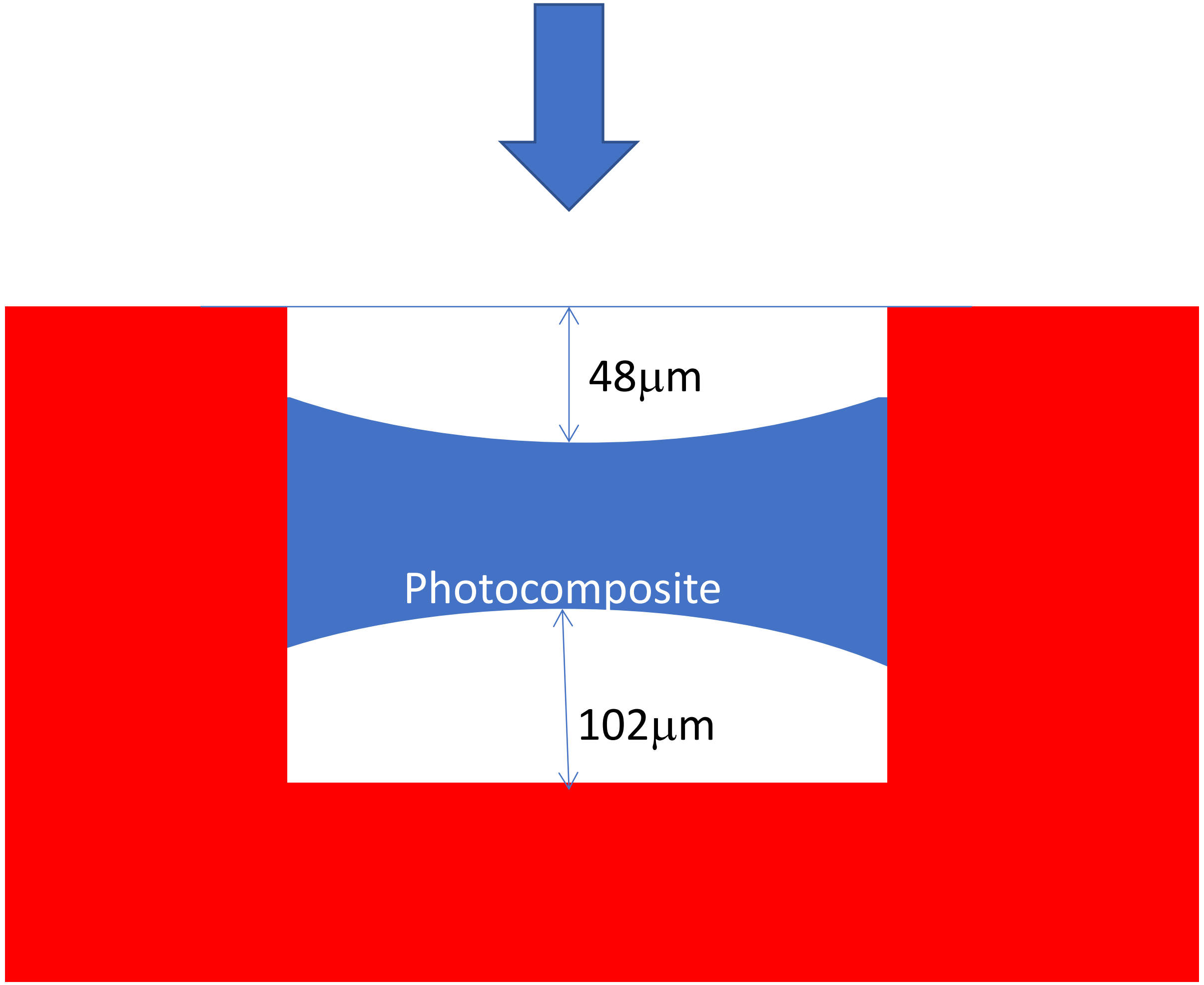
Three phases

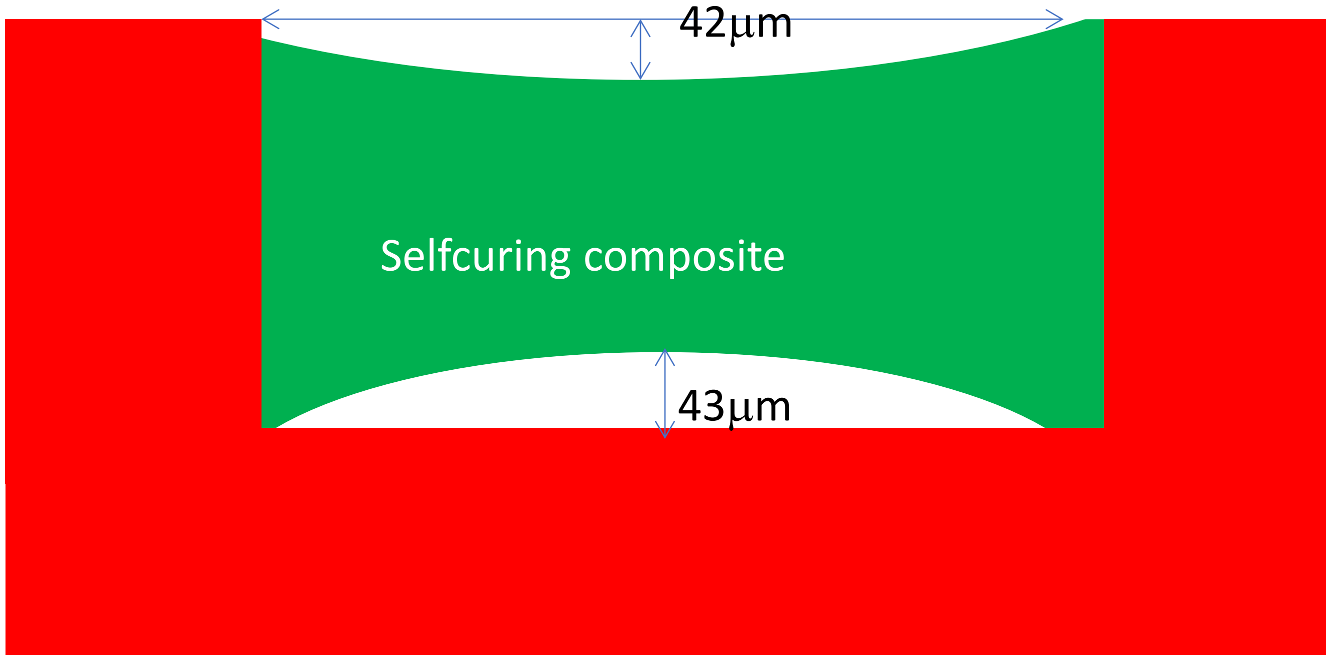
Phases

- Pre-gel – material is soft
- Gel-point – material became hard
- Post –gel – material is not soft, postgel shrinkage



Photocopomosite
3mm
3,2mm
8,5mm


48μm
Photocomposite
102μm


42μm
Selfcuring composite
43μm

Polymerization stress depends on

- Quality of the material
- C- factor
- Mode of application
- Mode of polymerization

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- Quality of the material
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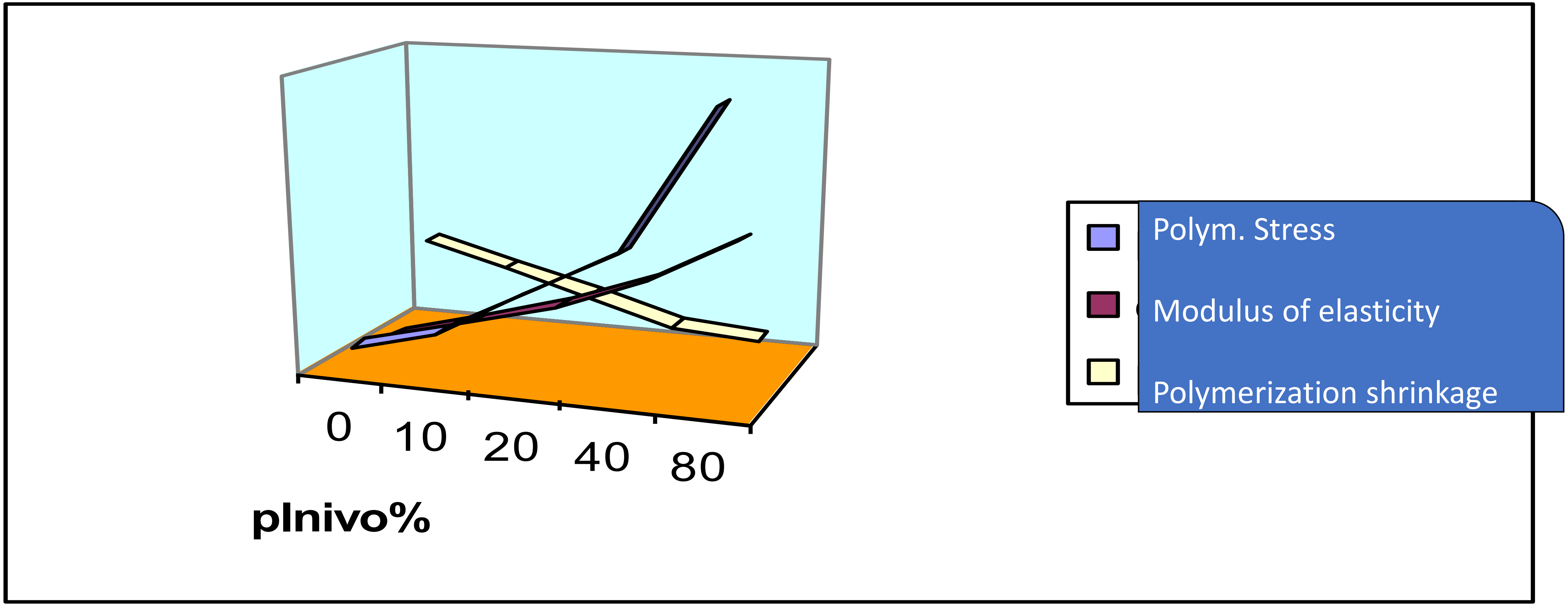
MUNI
MED

High content of filler increases the modulus of elasticity
High modulus of elasticity increases the polymerization stress
High content of filler decreases the polymerization shrinkage

Flowable materials – low modulus of elasticity. Low polymerization stress



Polymerization stress depends on

- Quality of the material
- C- factor
- Mode of application
- Mode of polymerization

5

2

1

Bonded area : Free area
1:1 and less - optimal

Polymerization stress depends on

- Quality of the material
- C- factor
- Mode of application
- Mode of polymerization

MUNI
MED

Mode of application

- **Incremental technique**

Layer by layer with big free surface

- *Importance of flowables*

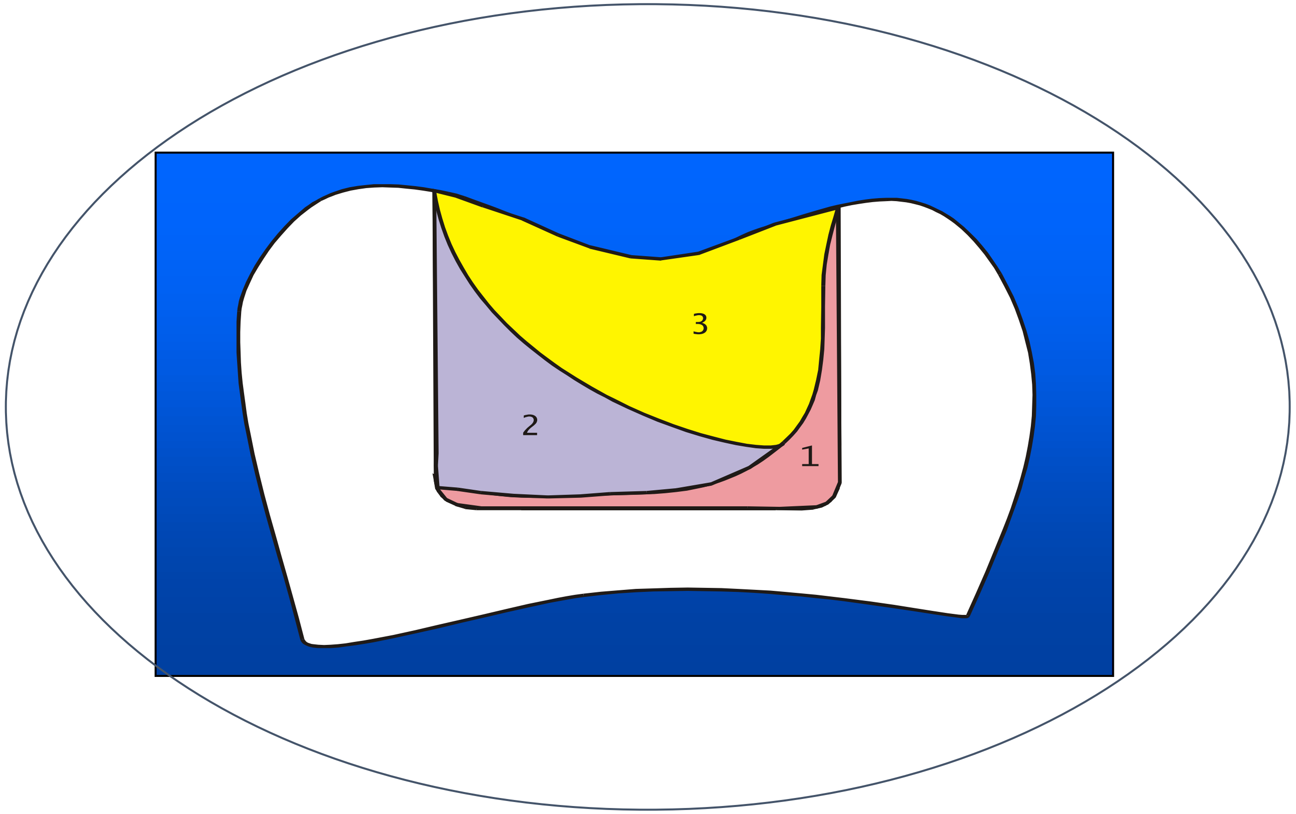
Thin layer of flowable first –big free surface

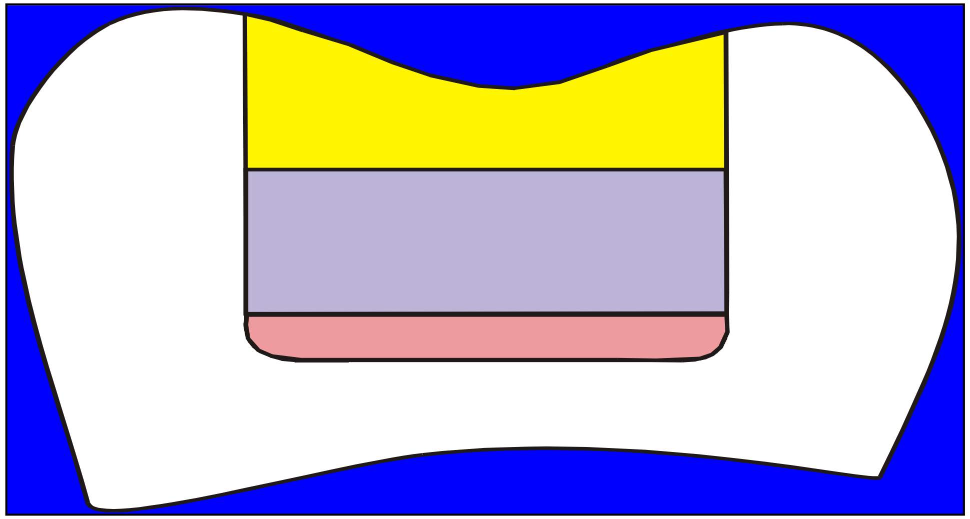
Good marginal adaptation

Compensation of the stress of the other layers

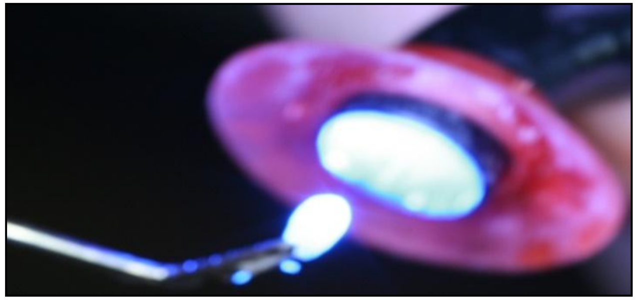
Bulk fill materials do not solve the problem with polymerization stress

Placement of the material



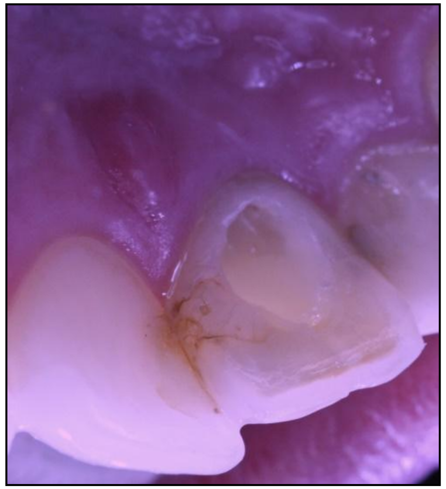


Placement of the material



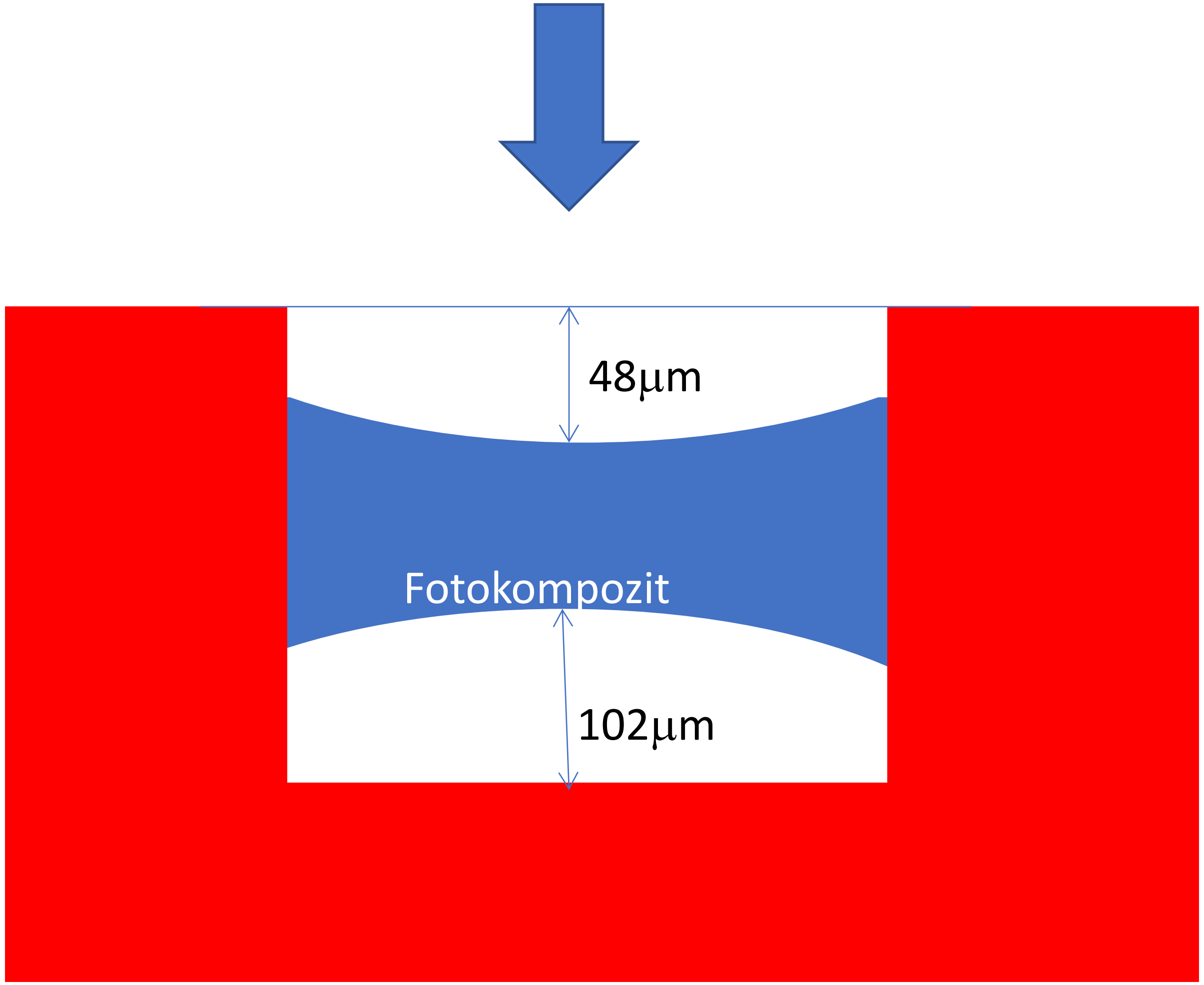
- Photocomposite
- Thin layer with the maximal free surface (with respect of C-factor of each layer)
- Combination of materials of various viscosity
- GIC + photocomposit (two visits better)
- Increment of cured material into the soft non

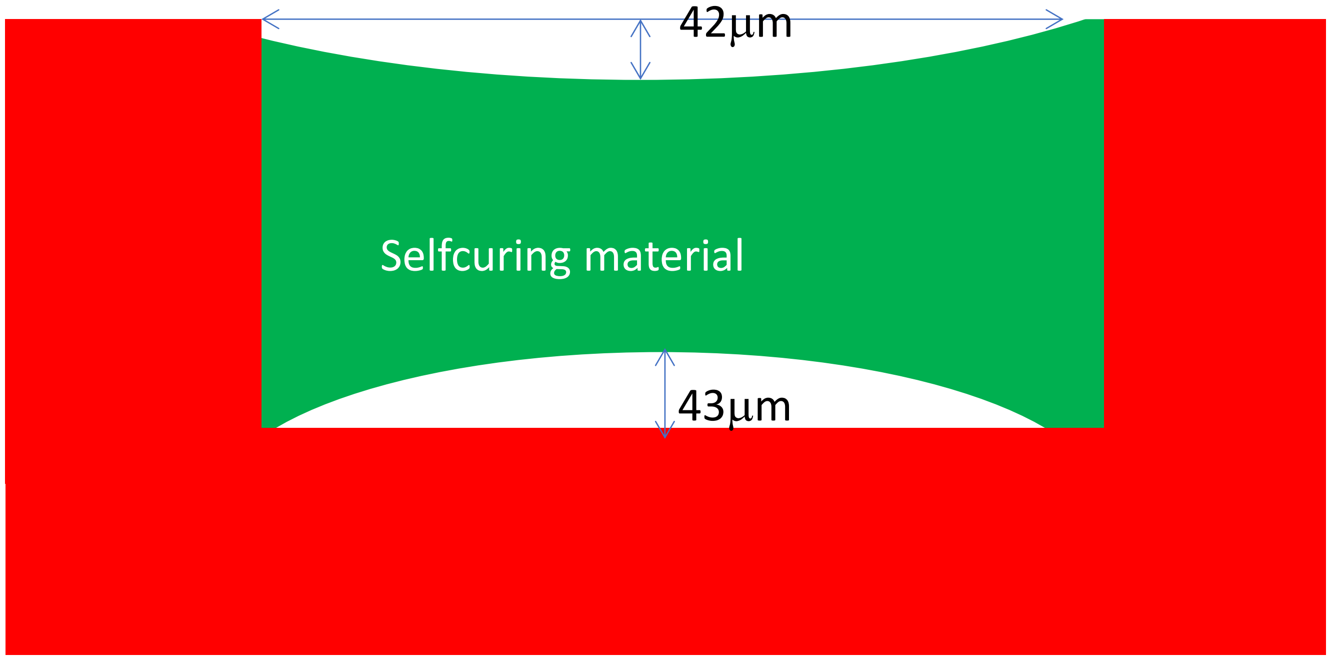
cured material



Polymerization stress depends on

- Quality of the material
- C- factor
- Mode of application
- Mode of polymerization


48μm
Fotokompozit
102μm


42μm
Selfcuring material
43μm

Duration of pre-gel phase

– Longer pre-gel phase is better for releasing of polymerization stress

- Soft start
- Combination of materials (selfcuring composite materials have longer pre gel phase)

MUNI MED

Polymerization units – output energy

Quarz halogen	600 -800 mW/cm^2
LED (3.generation)	1000 -1800 mW/cm^2 blue 50 – 100 mW/cm^2 purple
Plasma	1500 - 2000mW/cm^2

Flowables

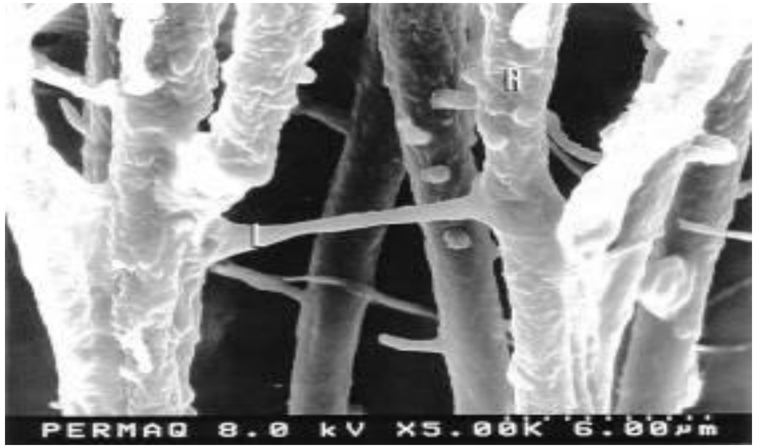
- – marginální adaptation (material flows)
- - small polymerization stress – importance in incremental technique
- - block out of undercuts
- - small cavities, corrections

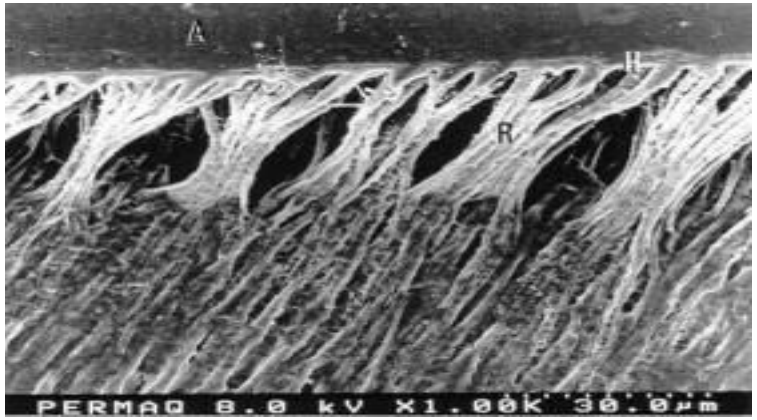
Composite materials with high viscosity

- Small polymerization shrinkage
- Hihg polymerization stress
- Worse marginal adaptation

Working procedure and variables affecting the bonding

What affects the quality of bonding?





The term hybrid layer

Variables that affect quality of bonding

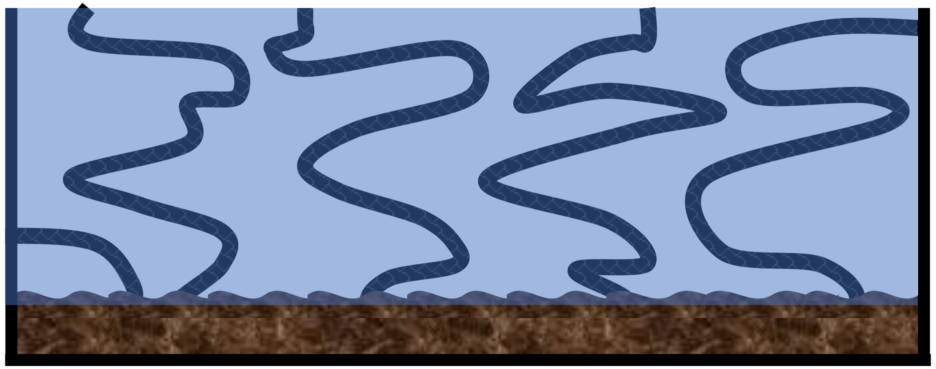
1) Etching

Etching too long can etch too deep, making it difficult for the resins to create good hybrid layer. Risk of degradation of the collagen.

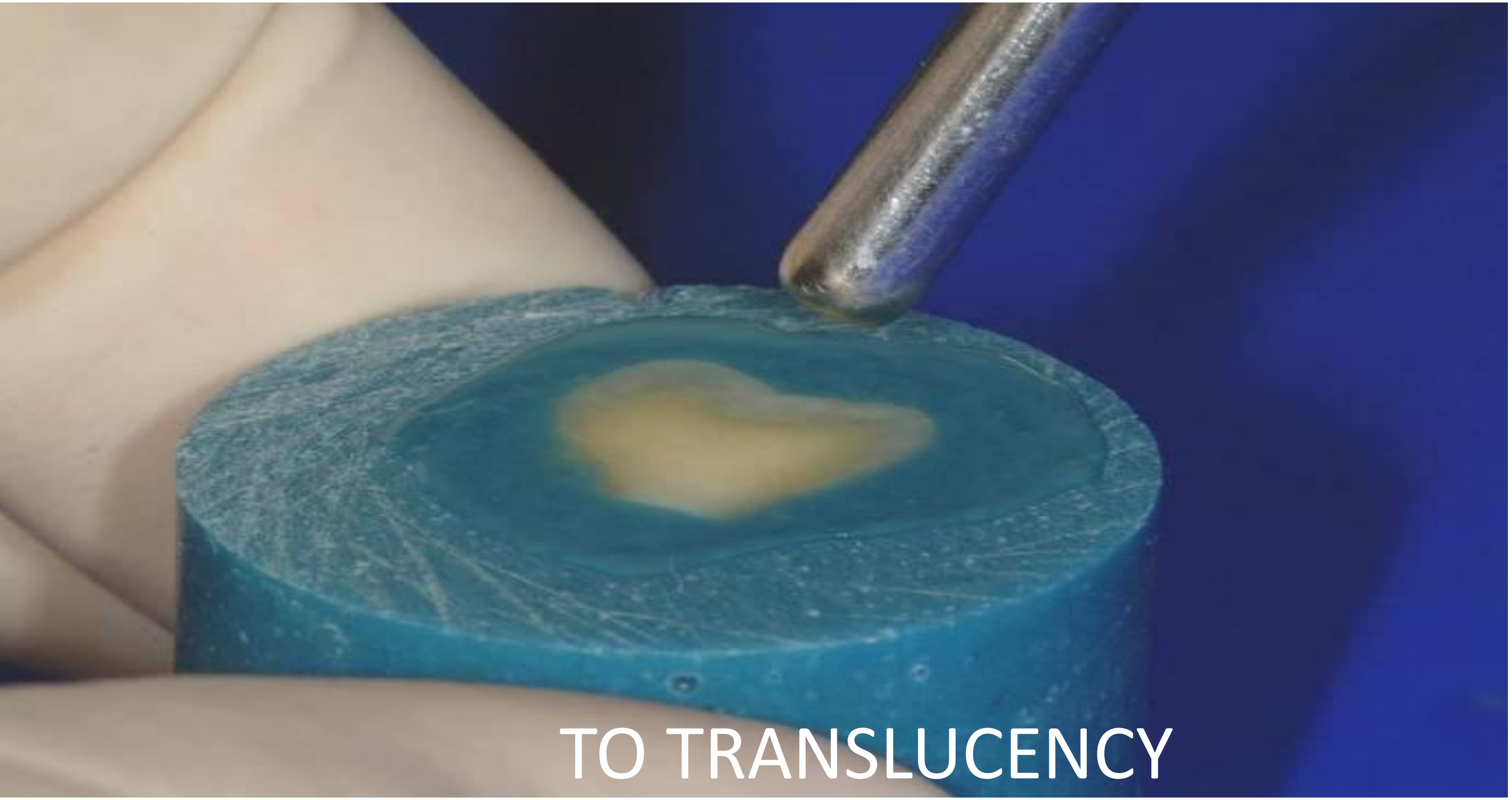
Variables that affect quality of bonding

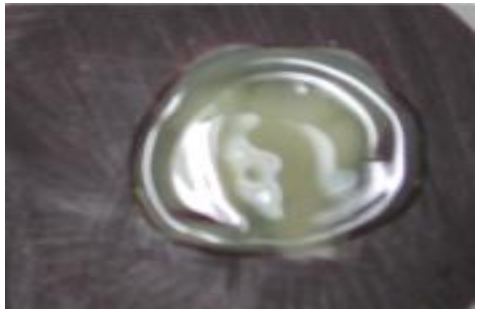
2) Drying dentin

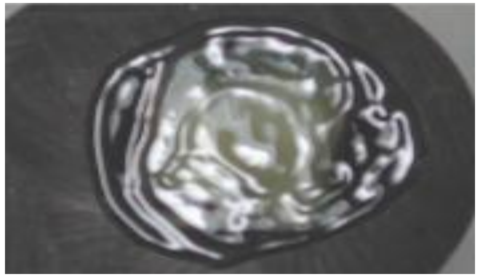
Over drying the dentin after etching – collaps of the collagen network of dentin

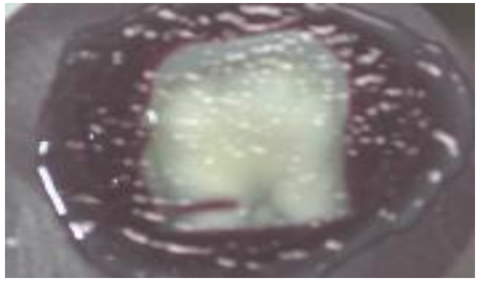


Air thin / Dry





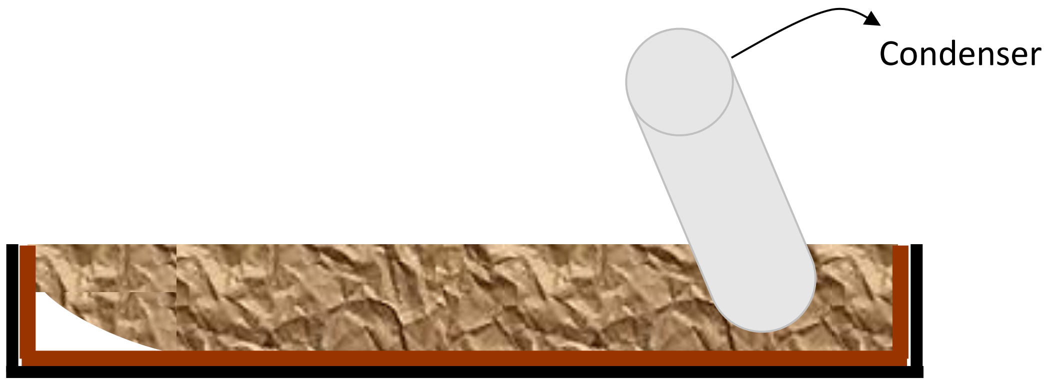




Variables that affect quality of bonding

5) Composite Placement

Improper adaptation of the composite to the adhesive can create voids at the bonding interface.



Variables that affect quality of bonding

7) Contamination

- **Blood**
- **Sulcular fluid**
- **Saliva**
- **etc…**

Indication of composite materials

- Filling of all classes:
- I., II. class: small to moderate restorations
- III. Class
- IV. Class
- V. Class
- *Other factors for consideration:*
- *Level of oral hygiene*
- *Occlusal loading*
- *Quality of hard dental tissues*

Contraindication of composite materials

- Bad level of oral hygiene
- Large cavities in posterior teeth (alternative is amalgam or inlay/onlay,
- Heavy occlusal stress (deep bite , bruxis)
- Cavities out of enamel (esp. cervical area)
- Social aspects