

**M U N I  
M E D**

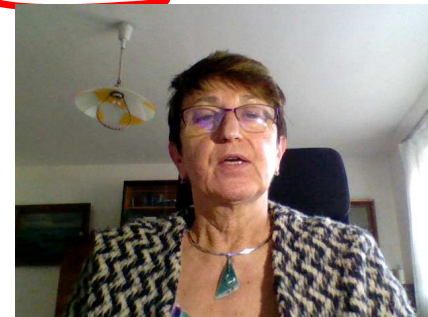
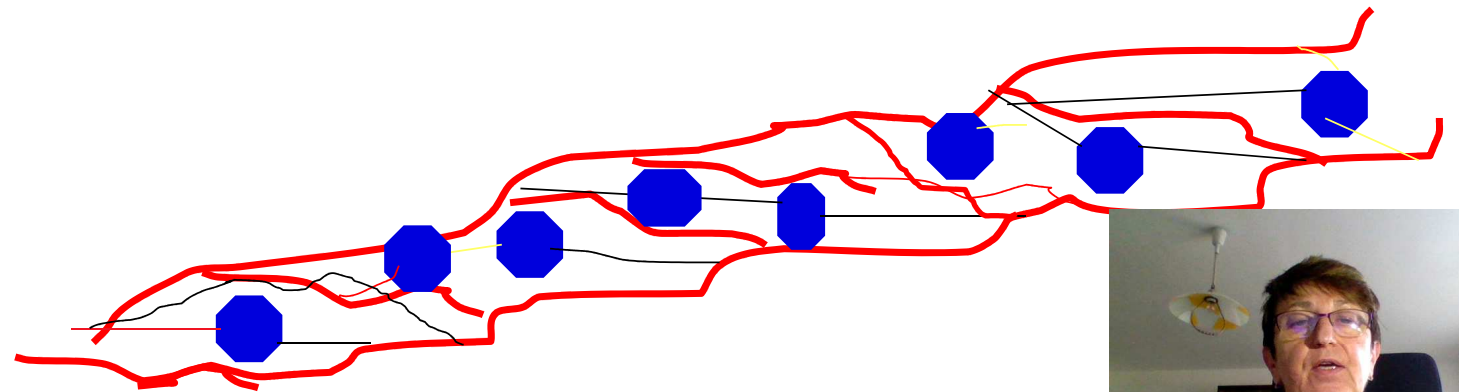
**Preclinical dentistry I.**

**Composite materials I.**



# Composite materials

Chemically bonded mixture of organic matrix and inorganic fillers



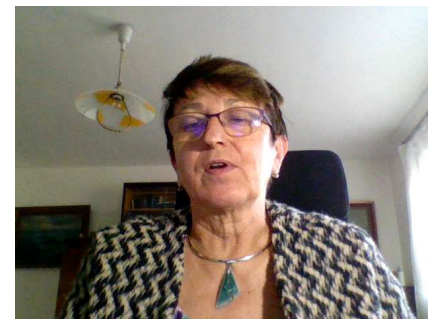
Coupling agent – binds organic matrix and the filler together



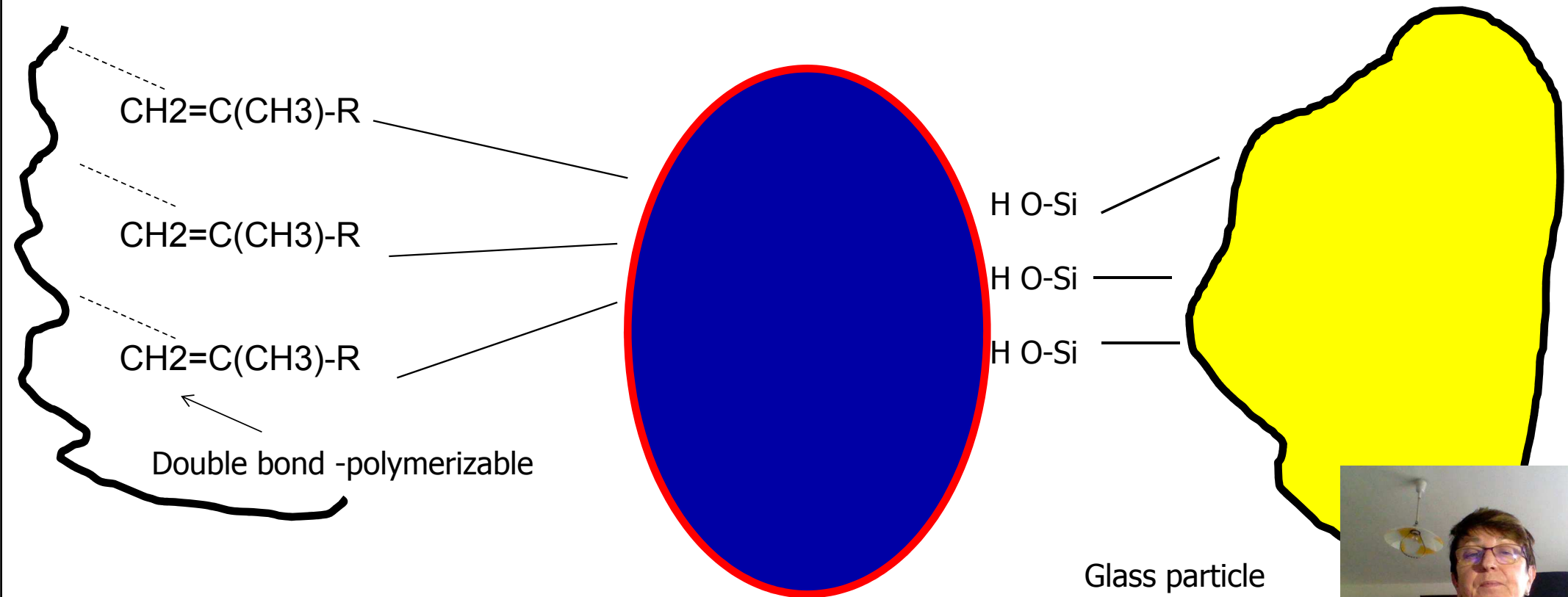
Homogenous distribution of the filler particles in the material



Excellent mechanical properties



# Binding of the coupling agents to glass particles



# Filler – material

- Milled quartz
- Aluminium silicate glass
- Silicium dioxide
- Prepolymer (composite material is polymerized with high pressure in fabrics, than milled – particles of the fiiler are made of cured composite)
- Complexes of microfiller (agglomerates) – e-g-. siliciumdioxide or zirconiumoxide



# Filler acc to the size of particles

- Macrofiller ( size of particles  $\mu\text{m}$  or tenth of  $\mu\text{m}$  )
- Microfiller (hundredths of  $\mu\text{m}$ )
- Nanofiller (nm)
- Combination– hybrid
  - Conventional ( $\mu\text{m}$  )
  - Microhybrid (hundredths of  $\mu\text{m}$ ,  $\mu\text{m}$ )
  - Nanohybrid (hundredths of  $\mu\text{m}$ ,  $\mu\text{m}$ , nm)



# Macrofiller

- Particles  $\mu\text{m}$  or tenths of  $\mu\text{m}$
- Good mechanical resistance , abrasion resistance, bad polishability.

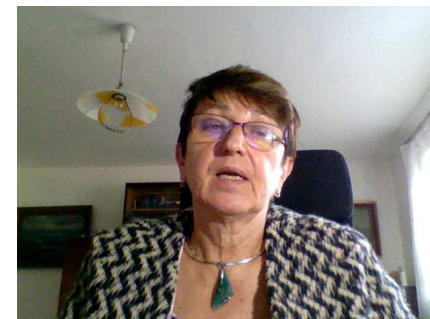


# Microfiller

- Silicium dioxide (pyrogenous)
- Particles hundreths  $\mu\text{m}$

Less amount of filler due to big surface

Lower mechanical resistance, good polishability.





# Microfiller in complex particles

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



# Nanoparticles

- Particles 10 nm and less

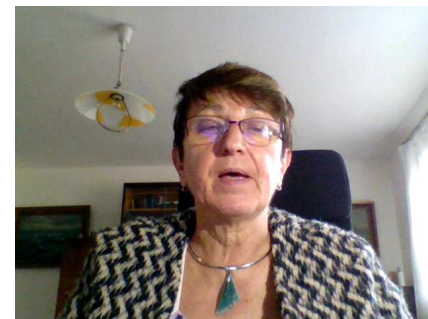
Special technology, size, shape and binding to monomer



# Today

- Microhybrid or nanohybrid composites:

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



# Matrix

Bis GMA – Bowen's monomer • (2,2-bis[4-(2hydroxy-3-metakryloyloxypropoxy)

- feny]propan)
- UDMA Urethandimetacrylate

Other dimetacrylate

- Dimethacrylates - mixture of materials with high and lower molecular weight

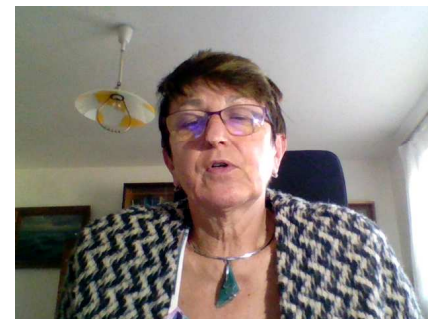
# Coupling agent

- G -methacryloxypropyltrimetoxysilan (A 174)



# Other components

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



# Selfcuring composites- two components material

– Tertiary amine      Dibenzolyperoxide



– **Activator**

Initiator

# Light curing composites

Initiator and sometimes also  
activator

Camphorquinon CQ  
Is the most common initiator in  
light curing composites





# Composite materials – basic characteristics

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



# Classification of composite filling materials

- According to the size of the filler particles

Macrofilled, microfilled hybrid

- According to the mode of curing

Selfcuring, light curing, dual curing

- According to the viscosity

flowable, thick



# Principle of retention

- Micromechanical retention

Microscopic spaces are created in enamel and dentine – composite material flows into them.

For the creation of the retentive pattern acid etching gel is used.



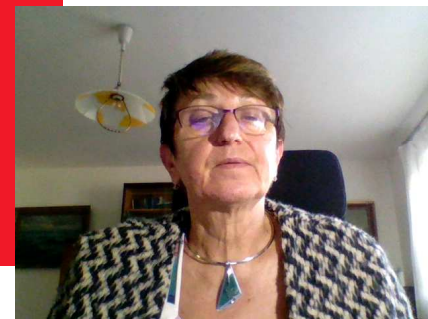
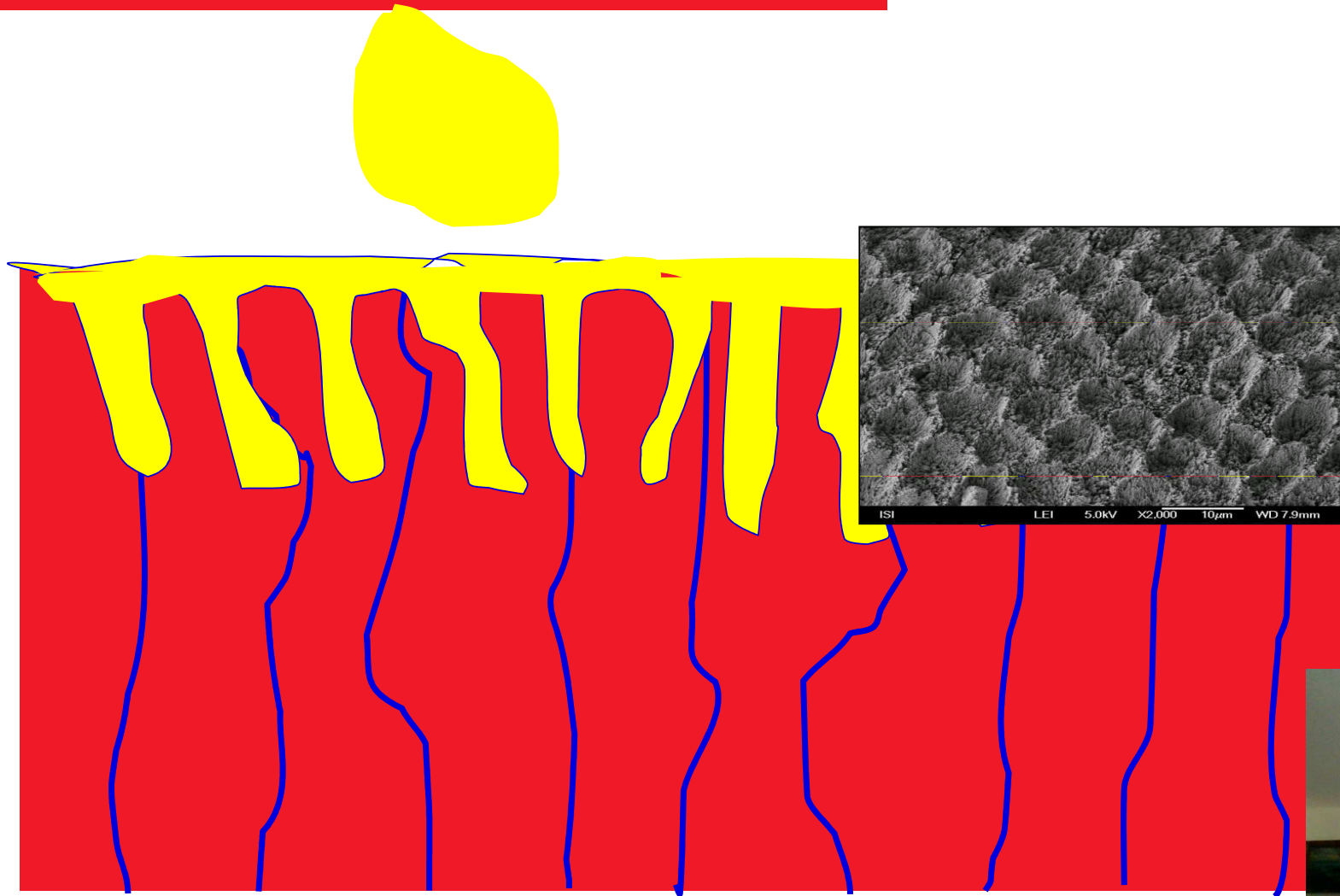
**35% - 37% phosphoric acid**

**silica particles**

**blue dye**



# Enamel



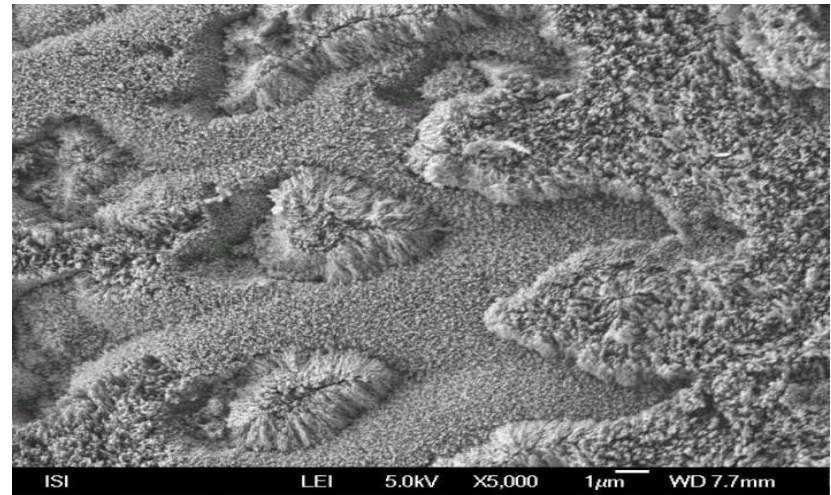
## How it works?

- Composite material is thick, it is not able to flow into these microscopic spaces – we need a flowable component – the bond.
- Bond is a resin of the same composition as organic matrix, it does not contain the filler – it flows into this retentive pattern.
- Bond comes together with the composite.

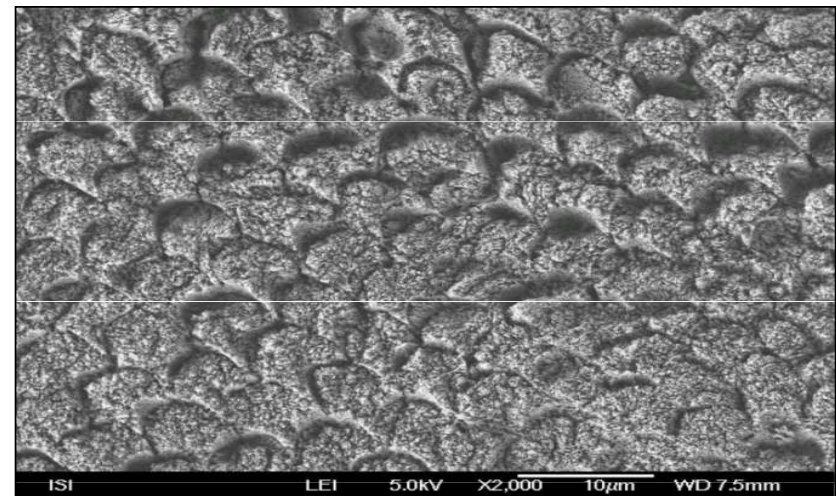




Acid on aprismatic enamel



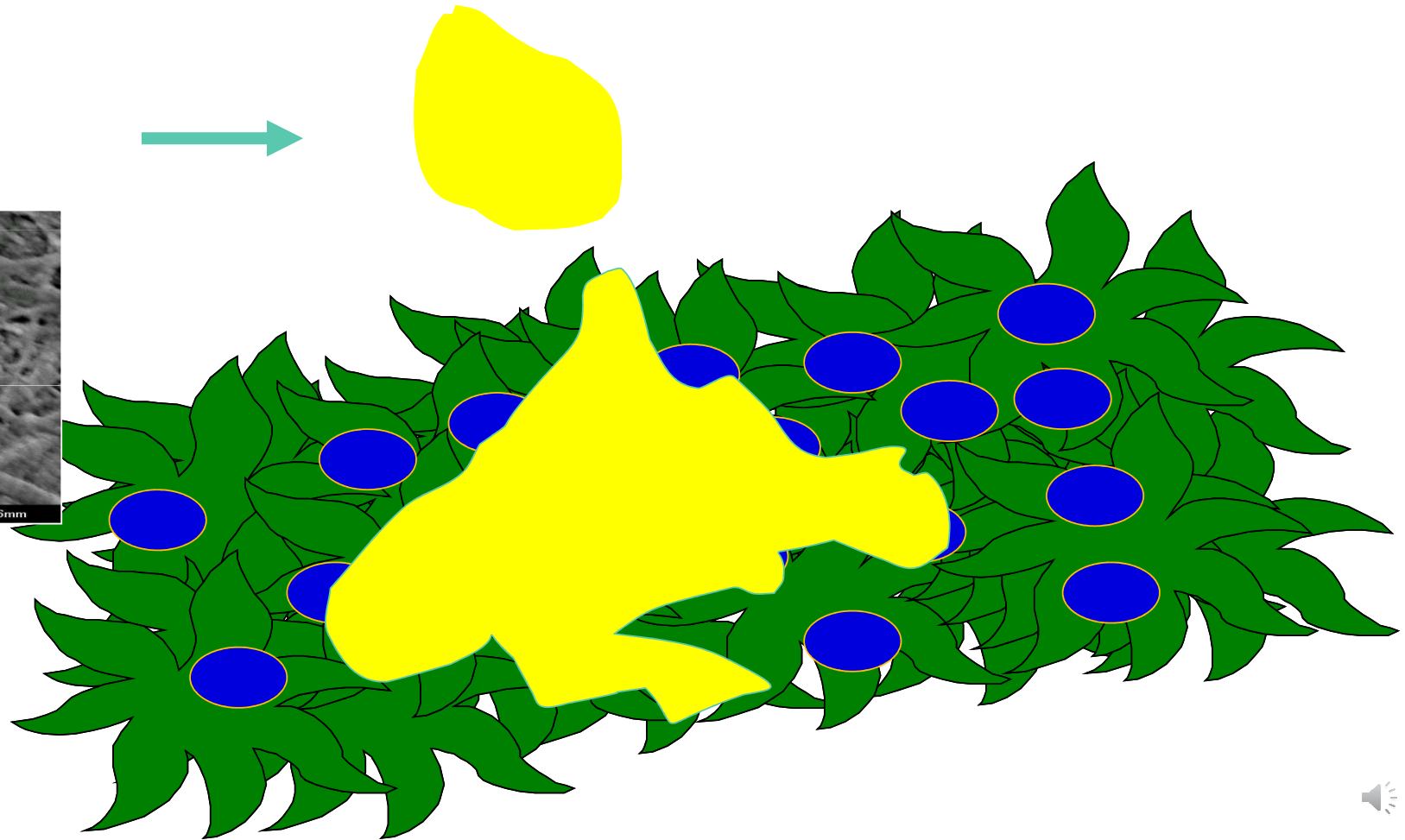
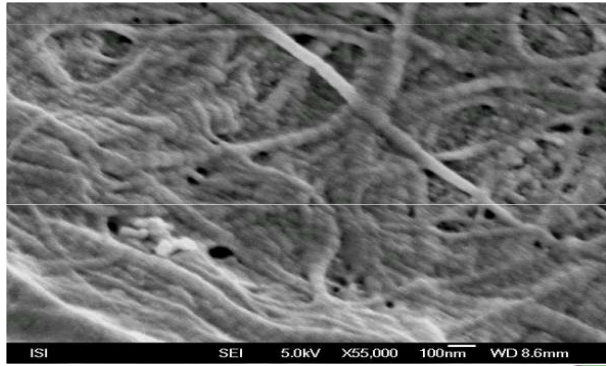
Acid on prismatic enamel





# 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 hydrophilic substance*

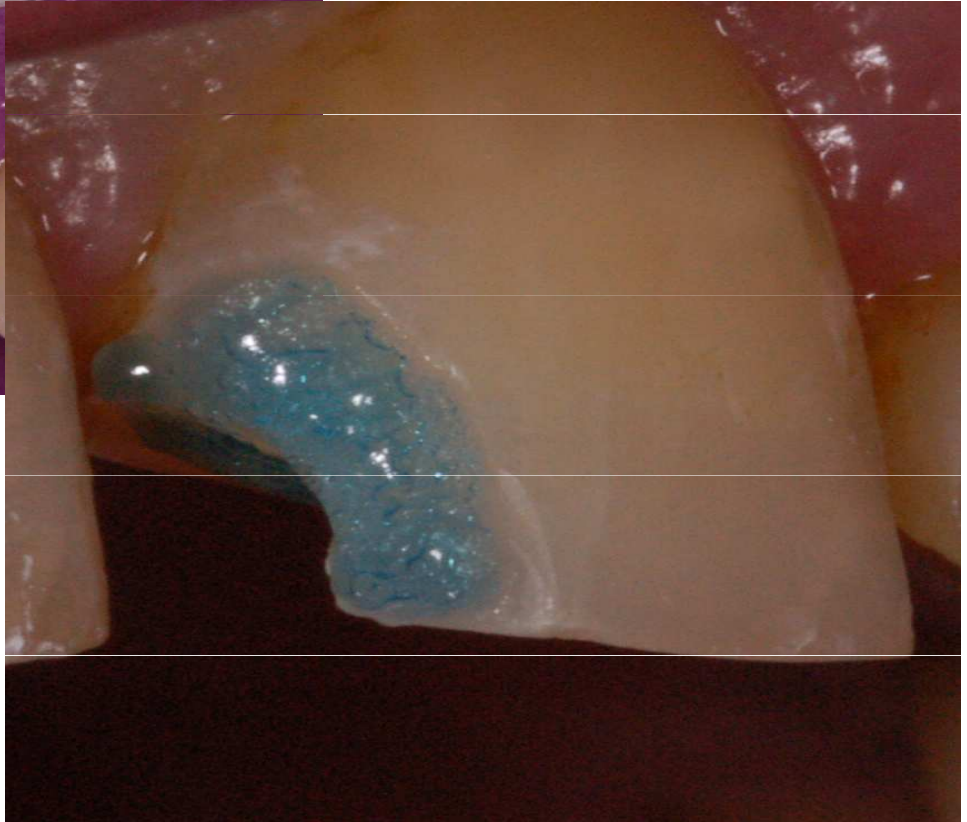
# Adhesive systems

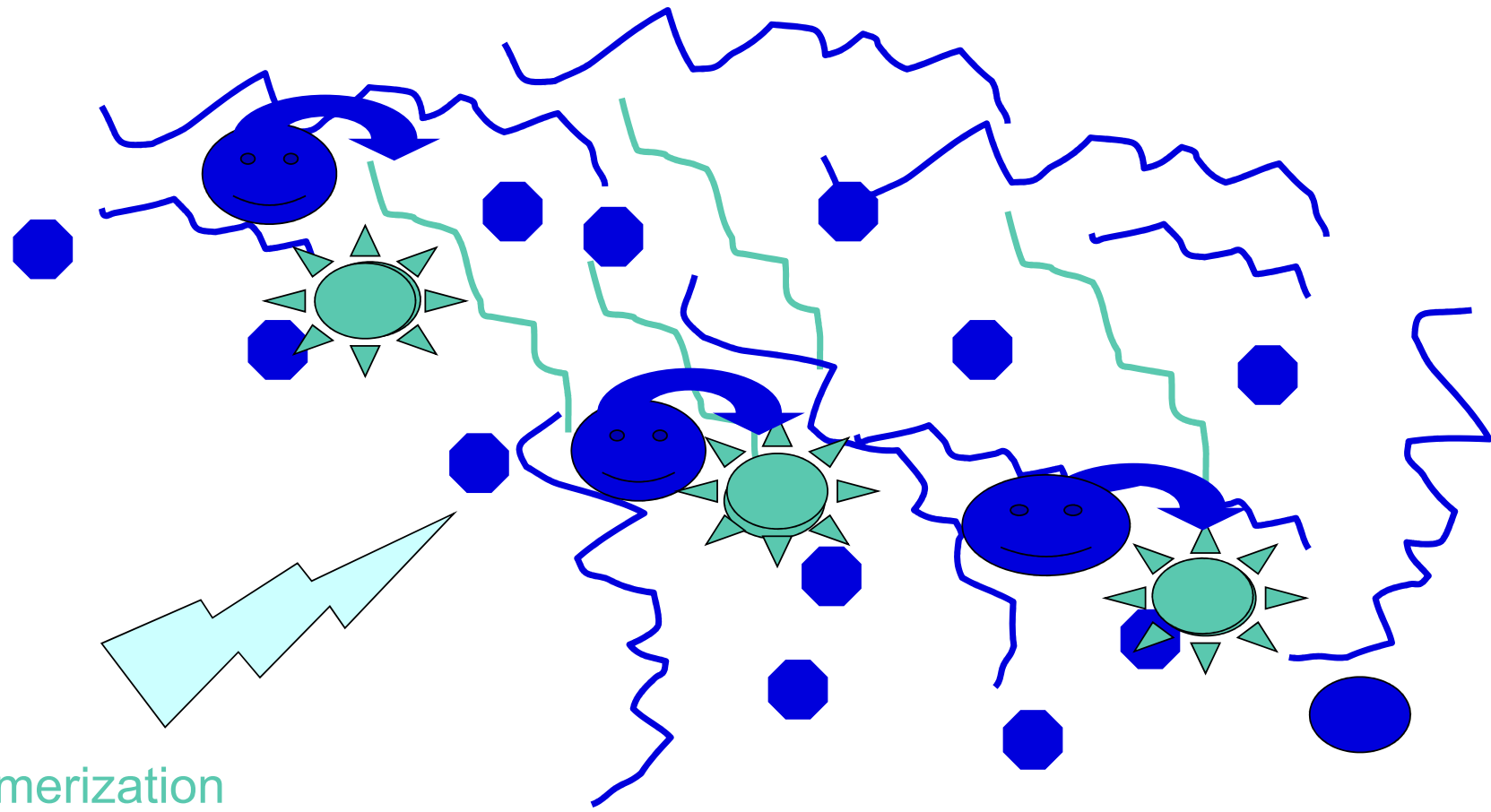
- Hydrophobic monomers - bond works in enamel it does not work in dentin without primer
- Amphiphilic monomers – hydrophobic + hydrophilic part - in primer

*Primer is necessary for dentin.*

*The hydrophilic 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.*

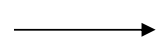




Light

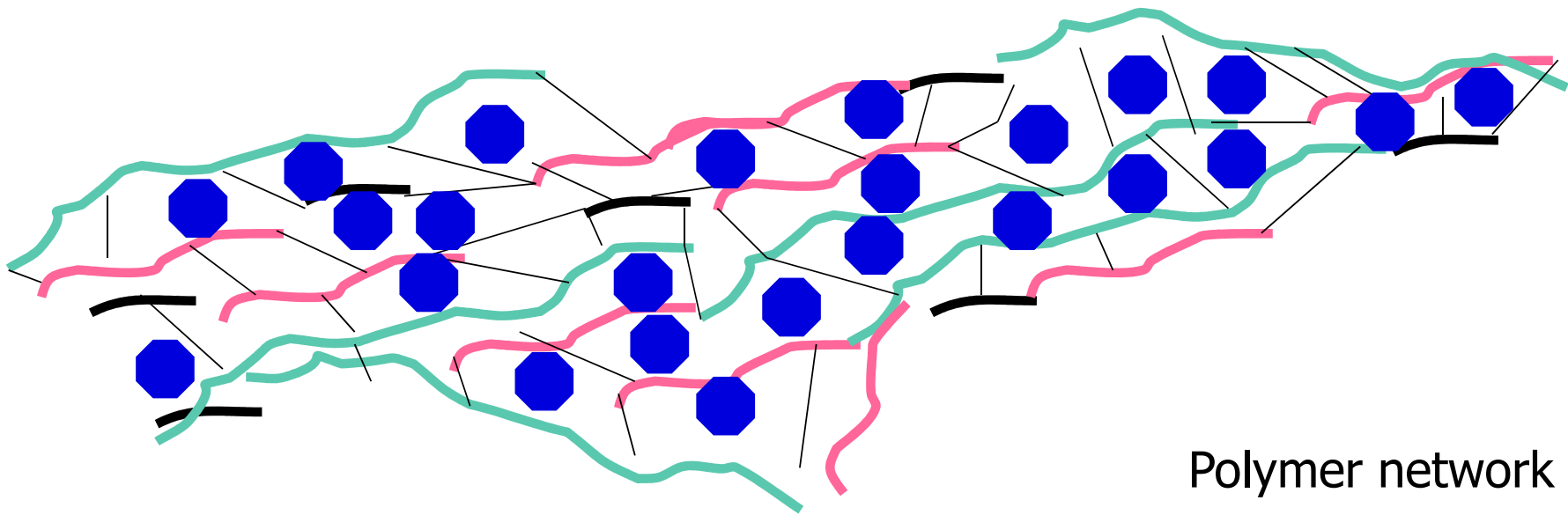
Polymerization

Monomer



Polymer





Polymer network

# Polymerization units

- Quarz halogen units (halogen lamp) appr. 40 s per layer
  
  
  
  
  
  
  
  
  
  
- LED units (diode – monochromatic light, need of more diodes)

Appr. 20 s per layer



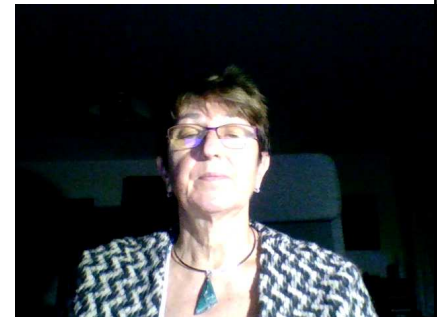
# Absorbtion spectrum of fotoiniciators

Photoinitiator	Absorbtion spectrum (nm)	Maximum (nm)
CQ	440 - 500	470
PPD	380 – 430	400
TPO	350 - 410	380

We use blue light

# 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





# Sequence of operation

- Preparation
- Bevel the enamel in most cases (no in class I.)
- Acid etching (20s enamel, 10s dentine)
- Washing (the same time as etching, at least 10s)
- Removing access of water
- Priming and bonding – microbrush and air syringe
- Curing of the bond
- Layering of composite (1,5mm – for good curing)
- Finishing and polishing (extrafine diamonds, rubber instruments)

**Air thin / Dry**

