Restorative dentistry – aesthetics I.

Contemporary trends

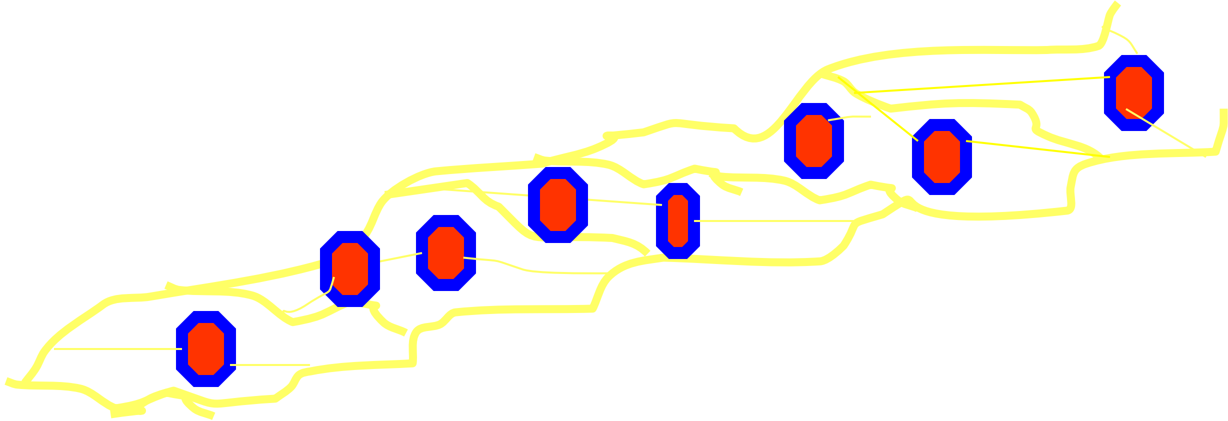
- Minimally invasive approach
- Adhesive materials and techniques

- direct composite restorations
- indirect composite and ceramic restorations (luted adhesively)

Composites

Composites in dentistry

Chemically bonded mixture of organic matrix and inorganic filles



matrix – transfers mechanical loading on inorganic fillers, protects the filler against moisture

filler - support of the material, carries the loading

coupling agents- enable the homogenous distribution of the filler in matrix

Composition **- matrix**

- Bis GMA – Bowen´s monomer
- (2,2-bis[4-(2hydroxy-3-metakryloyloxypropoxy)
- fenyl]propan)
- Bis DMA
- UDMA
- TEGMA /triethylenglykoldimethacrylate
- EGMA ethylenglykoldimethacrylate
- eBis –GMA
- HDMA hexandioldimethacrylate

Composition - matrix

- Acid modified resins (compomers)
- Polysiloxa   chains with polymerizable groups (ormocers)
- Silorans (ring opening monomers)

Filler

- Milled quartz
- Aluminimum silicate glass
- Silicium dioxide
- Prepolymer
- Complexes of microfiller (aglomerates)

Macrofiller

- Particles µm or tenths of µm

Good mechanical resistance , abrasion resistance, bad polishability.

Microfiller

- Silicium dioxide (pyrogenous)

- Particles hundreths µm

Less amount of filler. Lower mechanical resistence, good polishability.

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

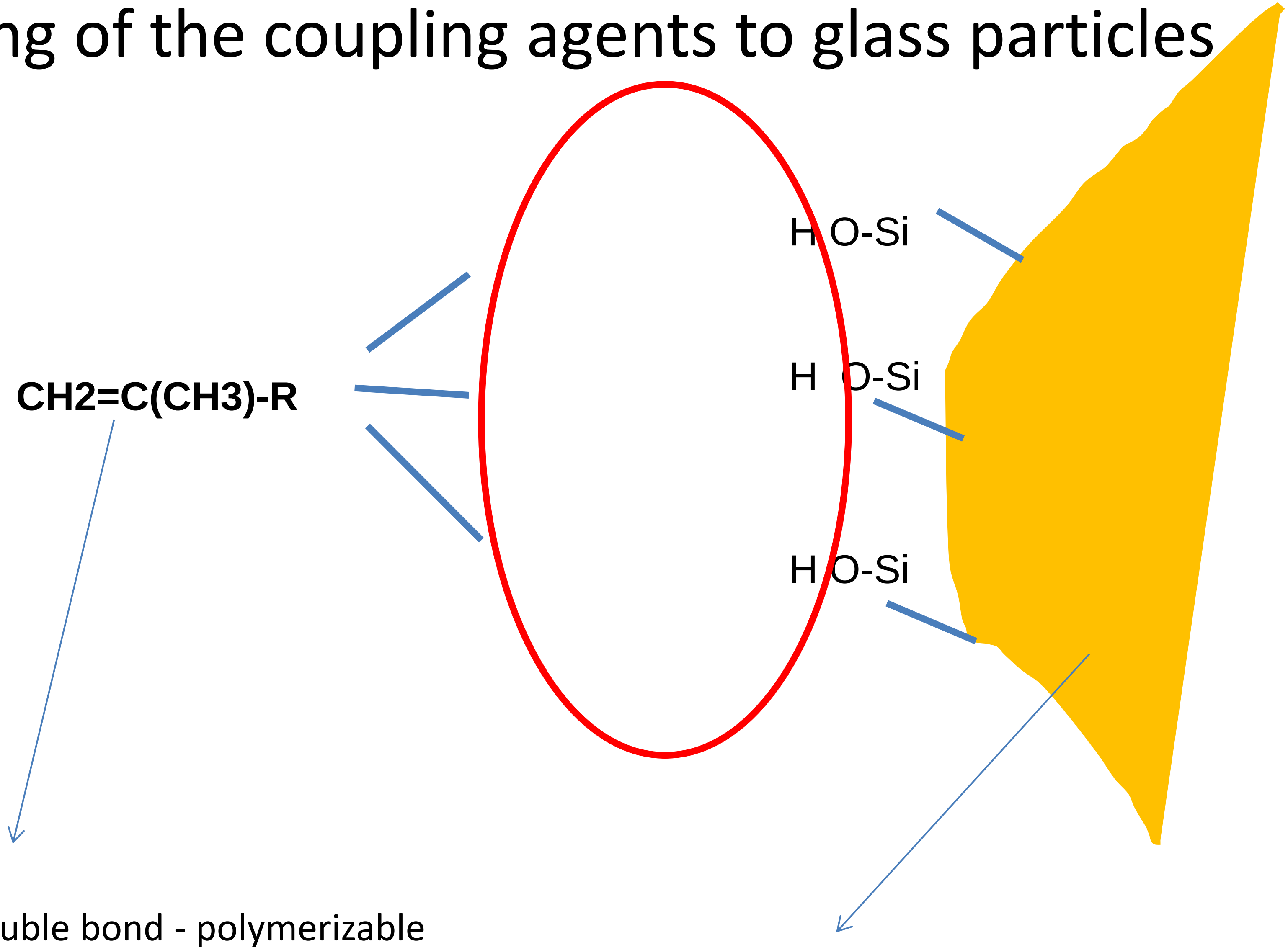
Hybrid filler

- Macro particles + microparticles
- Macro particles + microparticles+ prepolymer
- macroparticles + microparticles + prepolymer + nanoparticles

Coupling agent

G -methacryloxypropyltrimetoxysilan
(A 174)

Binding of the coupling agents to glass particles



Activator and initiator

Pigments

Fluorescents

Absorbers of light

Inhibitors

Polymerization

- Selfcuring composites

Dibenzoylperoxide – terciary amin

Low colour stability

Light curing composites

- Initiator and sometimes also activator

- Camphorchinon CQ
- Phenylpropandion PPP
- Trimetylbenzoylphosphinoxid TPO

Camphorchinon - CQ

Yellow colour

Activator: etyl-4-(N,N’-dimetylamino)benzoát (4EDMAB), N,N’-dimetylaminoetylmetakrylát (DMAEMA)

Light shades of composites: combination of CQ and other initiators.

Specrum of absorbtion

Fotoiniciator	Spectrum o absorption (nm)	Maximum (nm)
CQ	440 - 500	470
PPD	380 – 430	400
TPO	350 - 410	380

Bonding

Adhesion

- Mechanic
- Specific

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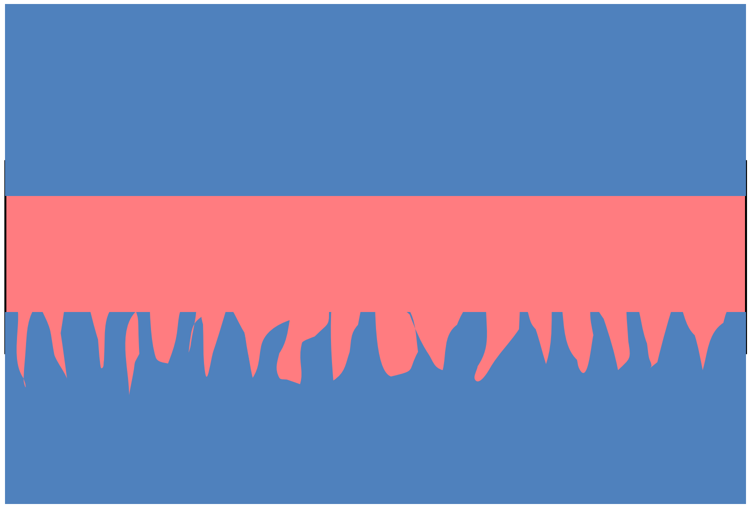
Adhesion

Mechanic

Irregulartiies of the surface



Adhesion

- **Specific**

Physical

Chemical

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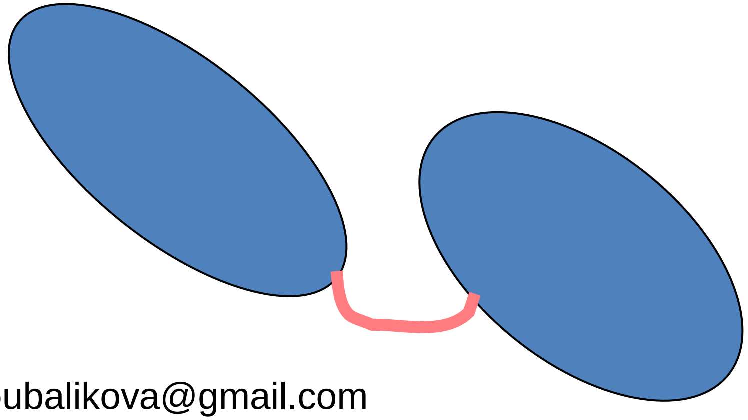
Adhesion

- **Specific**

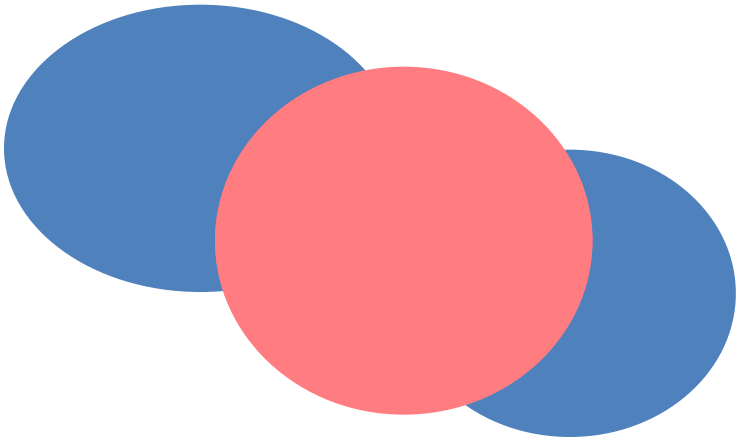
Physical – intermolecular forces - Van der Waals, hydrogenium bridges



Adhesion

- **Specific**

Chemical



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Adhesion

- **Sandblasting**
- **Electrolytic**
- **Silanization**
- **Plazma coating**
- **Silanization**

Adhesive preparation of surfaces

- Creates irregularities
- Increases surface energy

Adhesion of dental materials

Composites - micromechanical

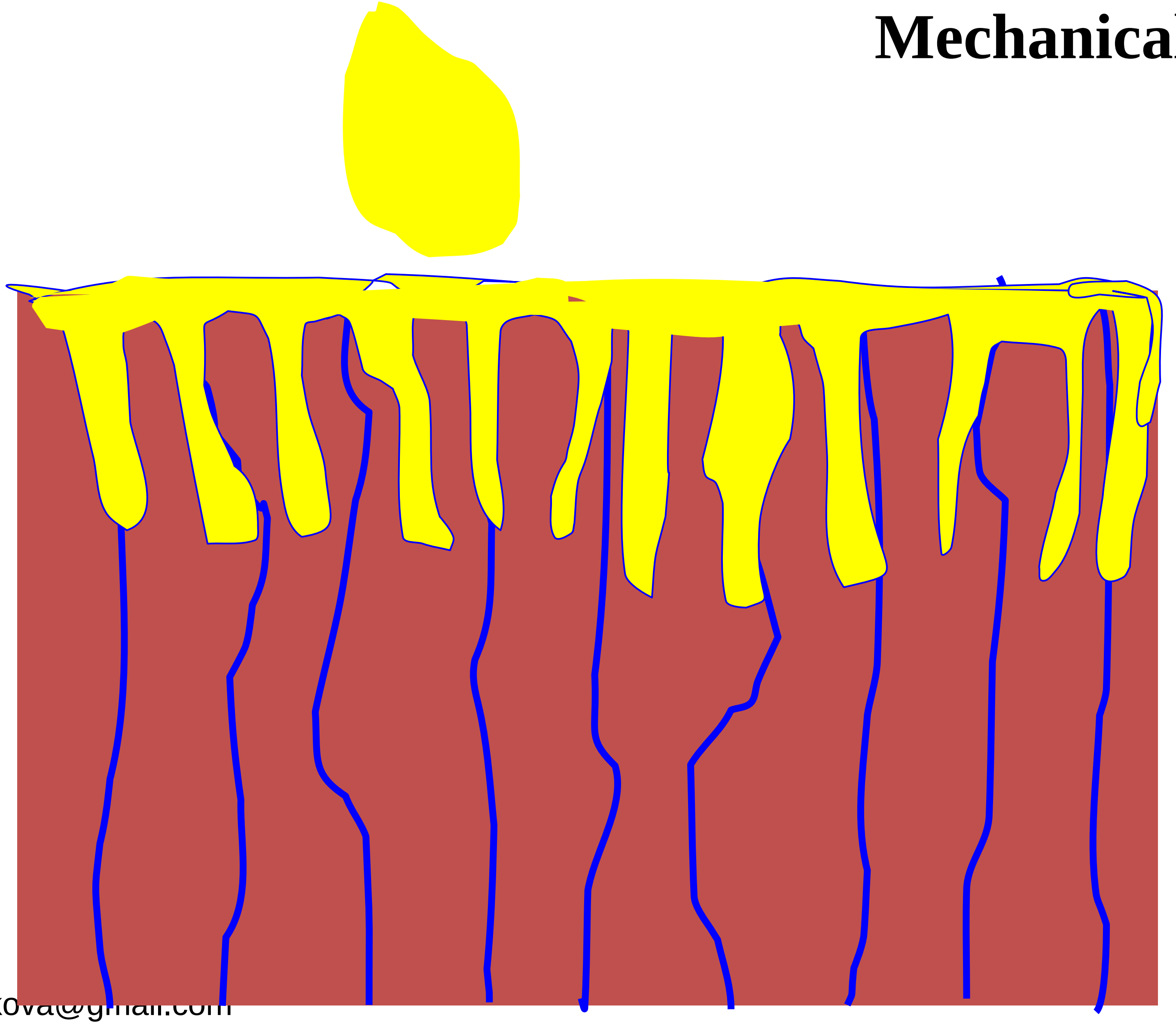
Adhesives – micromechanical, specific

Glassionomers - specific

Composits

Connection to enamel

Mechanical



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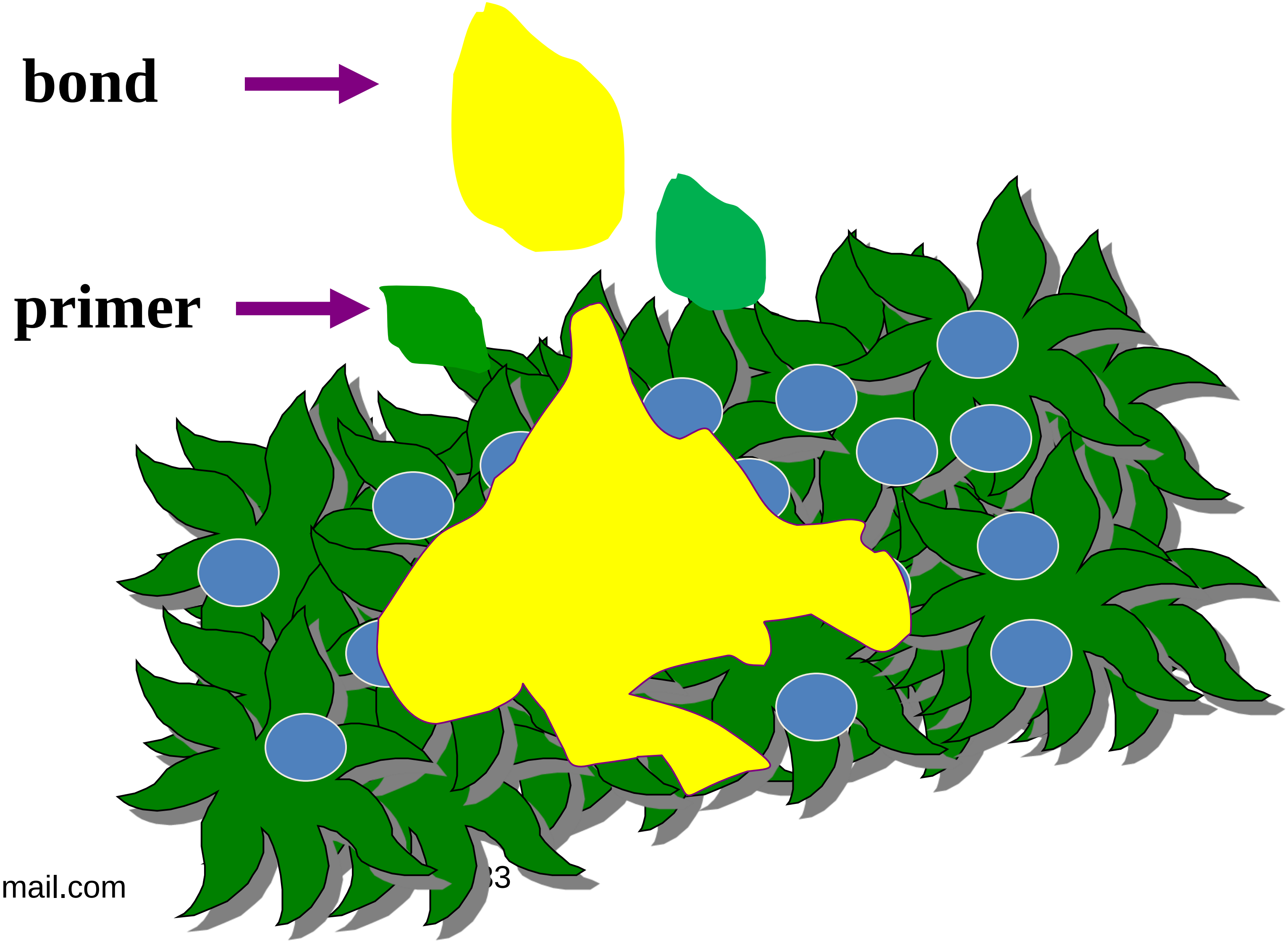
Adhesion to dentin
Dentin:

- More water and organic substances in comp to enamel
- Low surface energy
- Tubular liquid
- Connection with pulp chamber
- Smear layer

Connection to dentin

Mechanical



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BONDING AGENTS

Generations

1st Generation: (1956)

- Glycerophosphoric acid
- DMA Resin
- Resin to tooth
- No longer used (poor clinical results: 1-3 MPa)

2nd Generation: (1970's)

- Unfilled Resin
- Bis-GMA or HEMA
- Ionic bond to calcium
- No longer used (weak bond strength, microleakage)

Generations

3rd Generation: (1980's)

- Etch + Hydrophilic Primer + Unfilled Resin
- Partial removal and/or Modification of smear layer
- Resin did not penetrate through smear layer

4th Generation: (1982)

- Total Etch (Phosphoric Acid) + Primer + Adhesive
- Complete removal of smear layer
- "Wet bonding" (risk of being too wet or dry)
- Formation of hybrid layer and resin tags
- Good clinical results

Generations

5th Generation: (1990's)

- Total Etch + Adhesive
- Hydrophilic monomers
- Formation of hybrid layer and resin tags

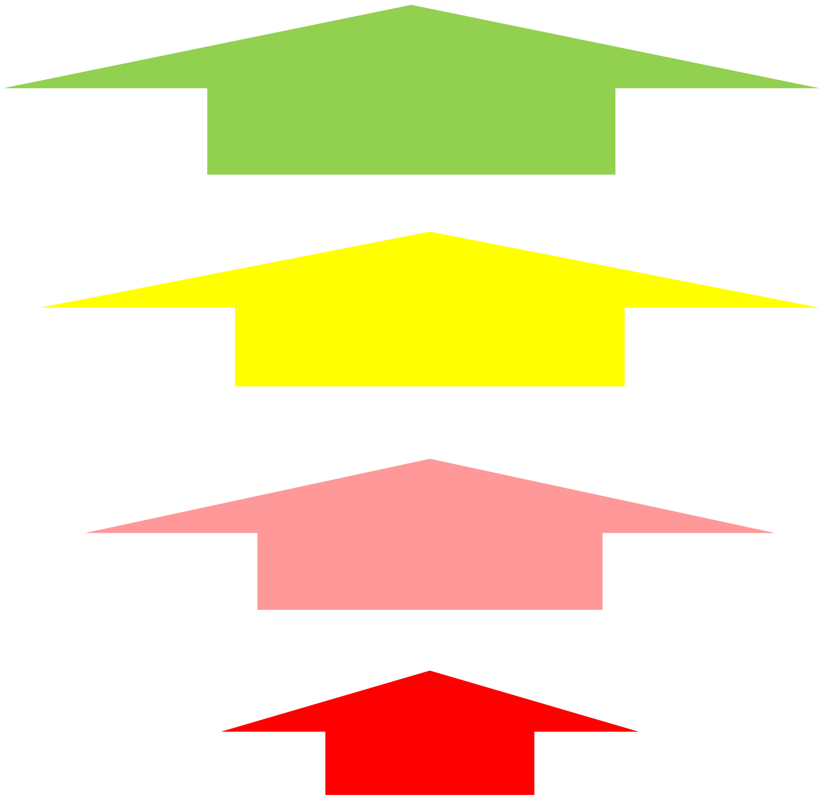
6th Generation: (late 1990's – 2000)

- Self-etching primer + Hydrophobic adhesive
- Partial removal of smear layer
- Chemical instability of primer

7th Generation: (2000's)

- One bottle
- Partial removal of smear layer
- Chemical instability

Adhesive materials



- Connection without gap
- Less invasive preparation
- Less risk of secondary caries
- Hihger resistance
- No problem with mercury

Amalgam

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Adhesive systems contain resin monomers

- 4-META
- HEMA
- TEGMA
- PENTA P
- 5-NMSA
- Bis-GMA

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Adhesive systems contain resin monomers

- Hydrophobic monomers - bond

Works in enamel

Does not work in dentin without primer

- Amphiphilic monomers – hydrophobic + hydrophilic part

  - primer

Primer is necesssary for dentin

If applied on enamel – residual of water can be removed

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Dissolving agents

- Aceton
- Alcohol
- Water
- Watwer/alcohol

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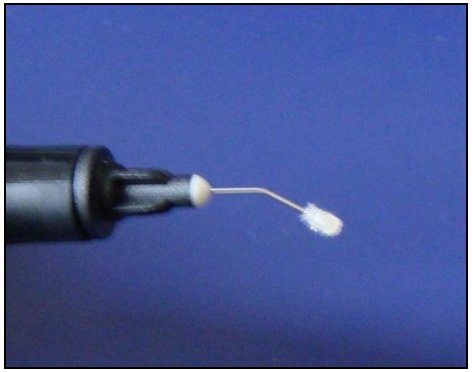

Adhesives – classification acc to clinical steps

3- ERA	Acid etching	Washing	Priming	Bonding
2- ERA	Acid etching	Washing	Priming a bonding	
2- SEA	Selfetching priming			Bonding
1- SEA	Selfetching bonding			

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Adhesives

- Acid etching technique
- Selfetching adhesive systems

Adhesives

- Acid etching technique

Etching

Washing

Priming Bonding

Adhesives

- Selfetching adhesive systems

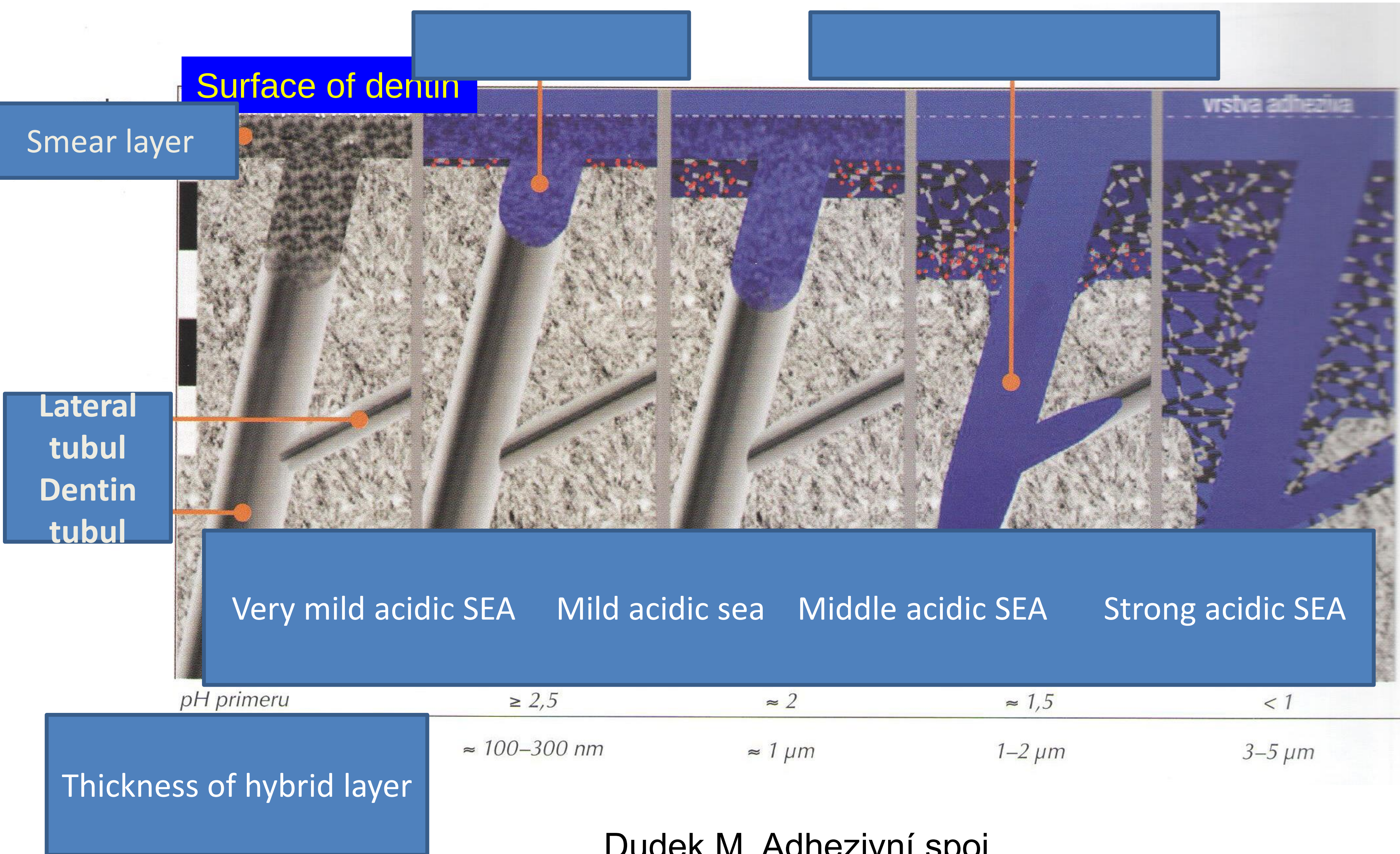
Priming

Bonding

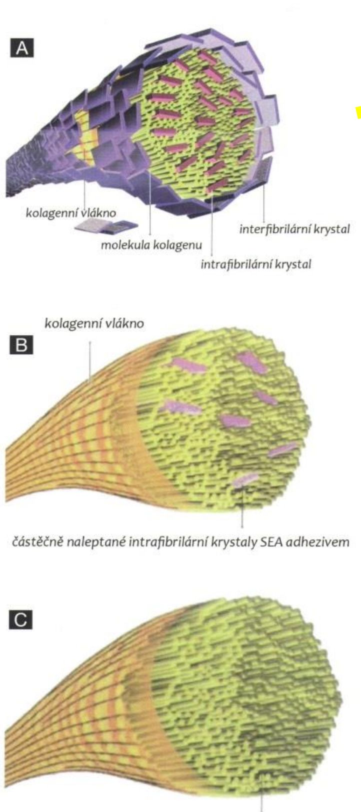
Less bonding strength in comparison to acid etching technique

Smaer layer infiltrated with adhesive systém

Dentin tag



Dudek M. Adhezivní spoj
a adhezivní systémy I. LKS 11/2013



Collagen fibers with mineral salts
(peri and intra)

Collagen fibers with
intrafibrillar crystals

Collagen fibers without any crystals

(*risk of hydrolysis and degradation with metaloproteinasis*)

Dudek M. Adhezivní spoj
a adhezivní systémy I. LKS 11/2013

Adhesives

- Active and passive bonding

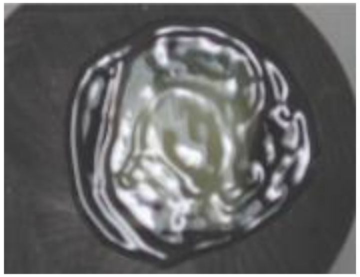
Active – rubbing with microbrush (SEA, dentin)

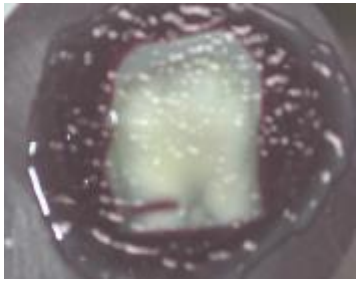
Passive – without any rubbing (ERA, enamel)

Blow up

Too thin layer does not allow complete conversion (polymerization) due to oxygen

Too thick layer can contain still dissolving agent.





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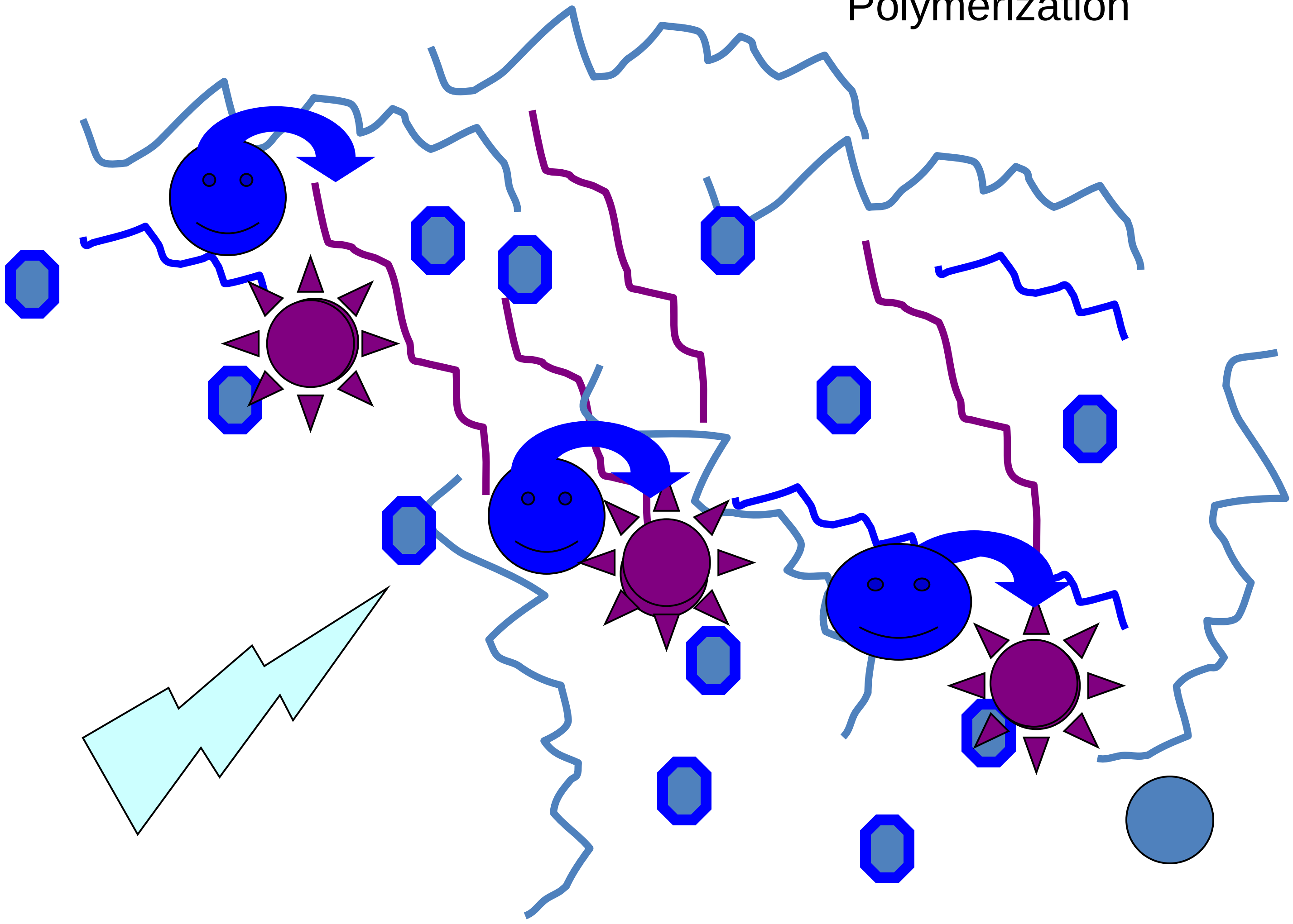
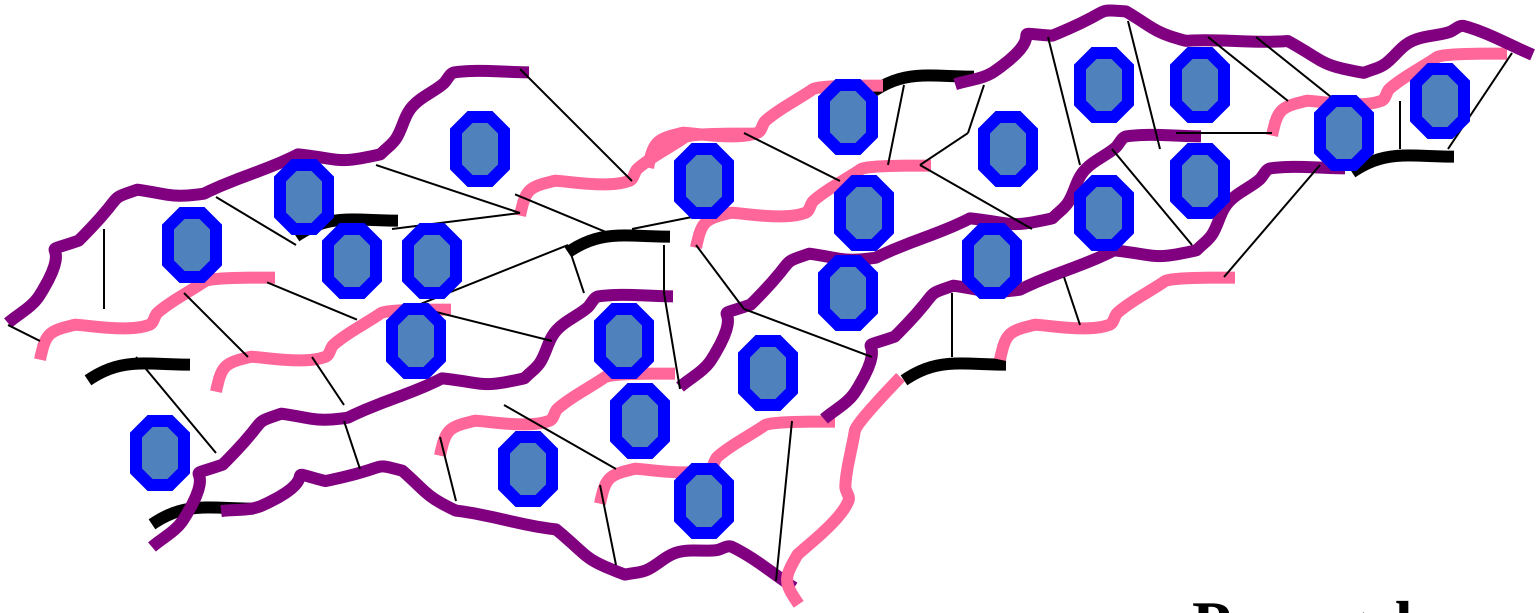
Polymerization



Polymer network



Pre –gel
Gel
Post -gel

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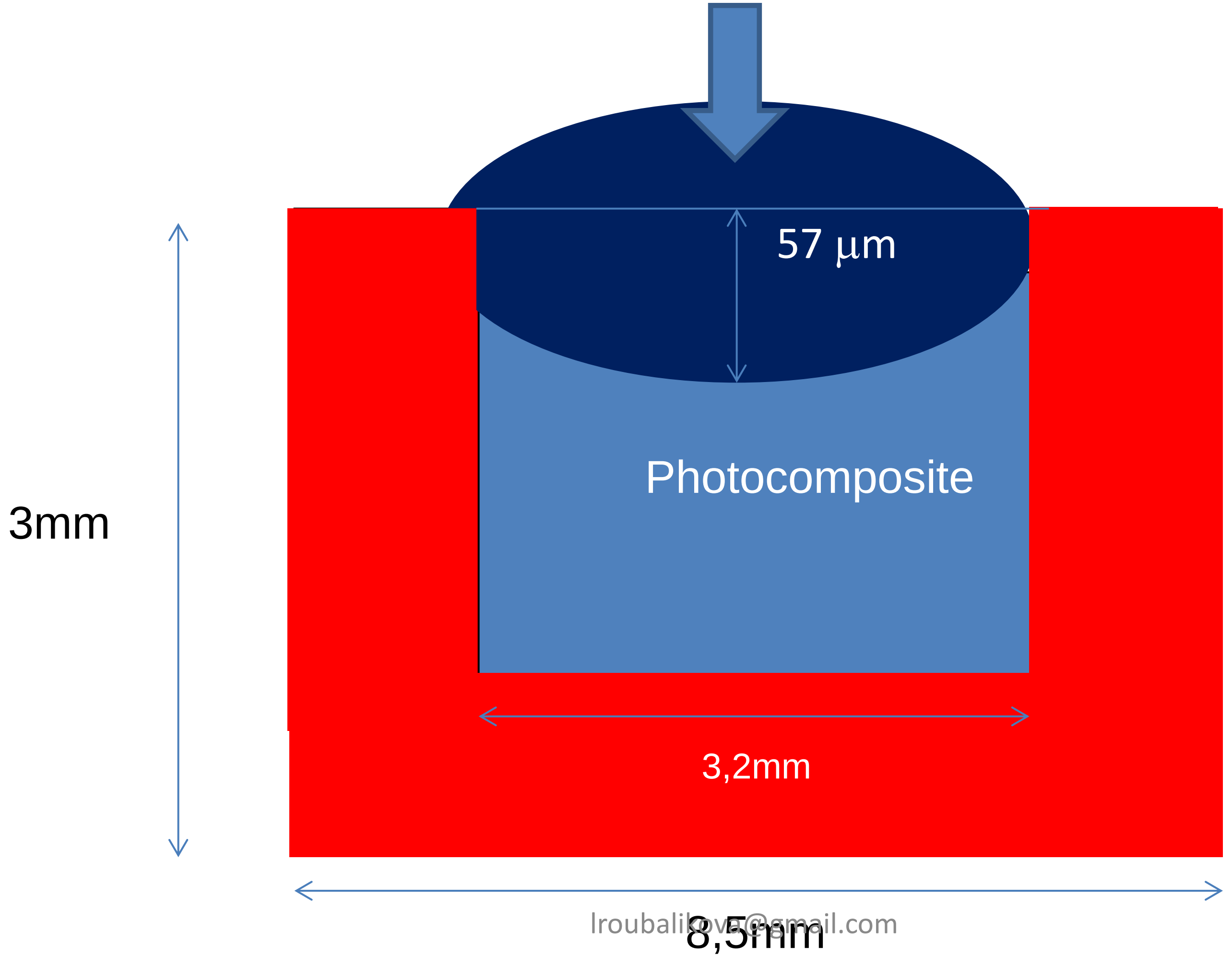
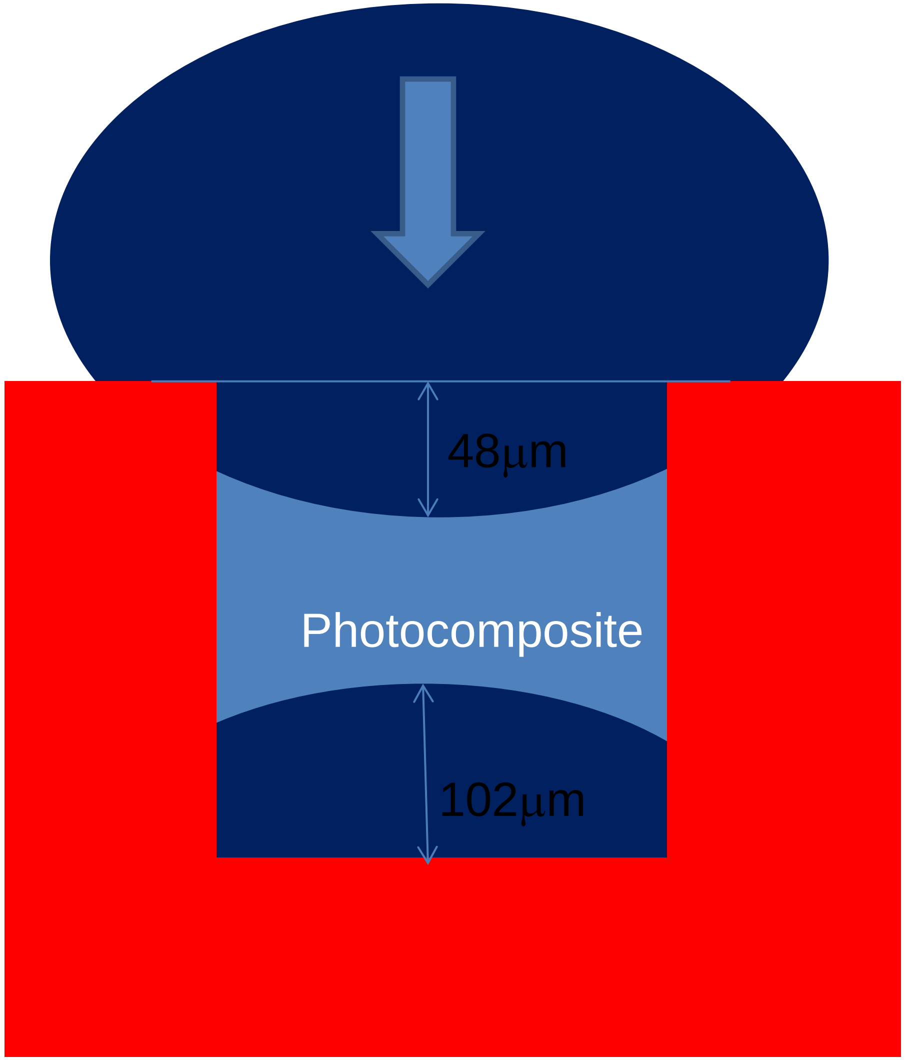
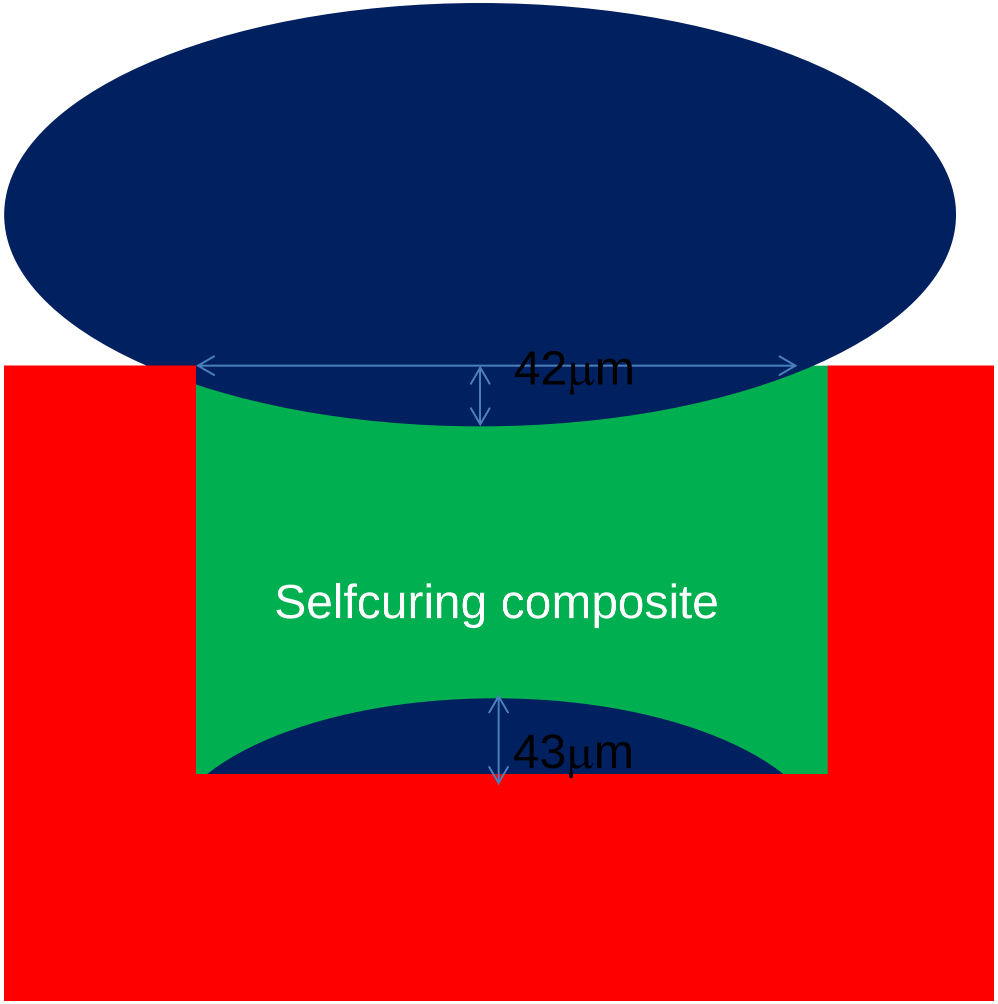
Byung, Suh
Principles of adhesion dentistry
2013



Polymerization strain and stress



Polymerization strain and stress



Pregel phase

- The material is still soft, forces of polymerization ahrinkage can release, deformation of the surface

Gel point

- Material became hard

Postgel phase

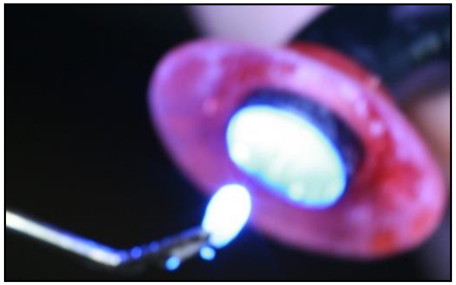
- Material is not soft, polymerization continues, due to polymerization shrinkage the polymerization stres occurs – forces on bonded surfaces can cause gaps or cracks.

- Selfcuring composites – longer pregel phase
- Photocomposites – Gel point comes earlier

Forces of polymerization shrinkage depend on

- Composite material (content of filler)
- Geometry of the cavity (C-factor)
- Placement of the composite
- Mode of polymerization

Light curing



Too short illumination, low output energy causes lower conversion of material, the risk of fracture is higher, material changes the colour.

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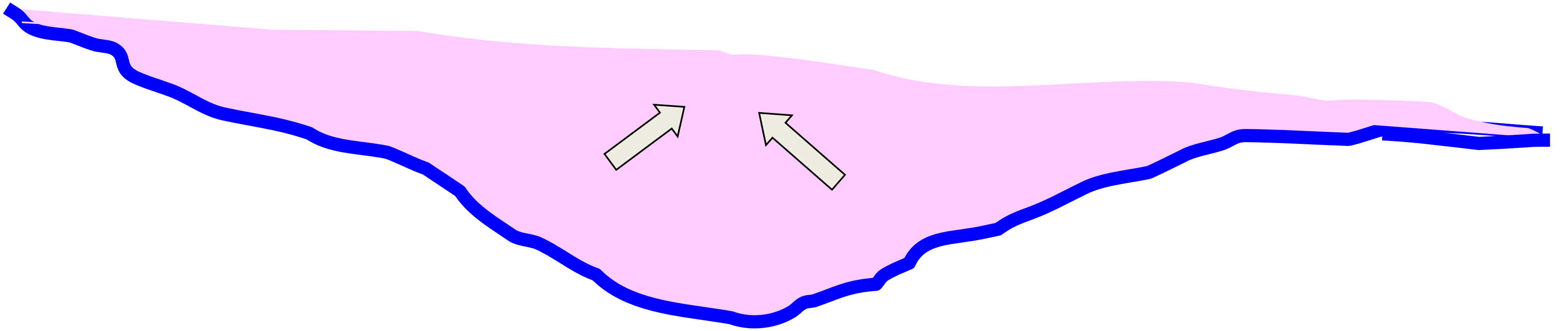
C – factor (Configuration factor)

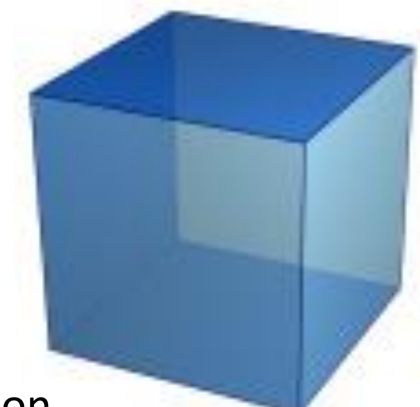
Surface of adhesion/free surface of the filling



1/1 and less is optimal

5

2



1

Big free surface – lower polymerization stress,
The forces can easier release through free surface – its deformation

Forces of polymerization shrinkage depend on

- Composite material (content of filler)

Higher content of filler - lower shrinkage, higher polymerization stress.

Mode of polymerization

- Longer pre gel phase – realeasing of polymerization forces

Continual polymerization

Min. 500 mW/cm^2 40 s

2 step polymerization

10 s cca 140 mW/cm² → *750 mW/cm² 30 s*

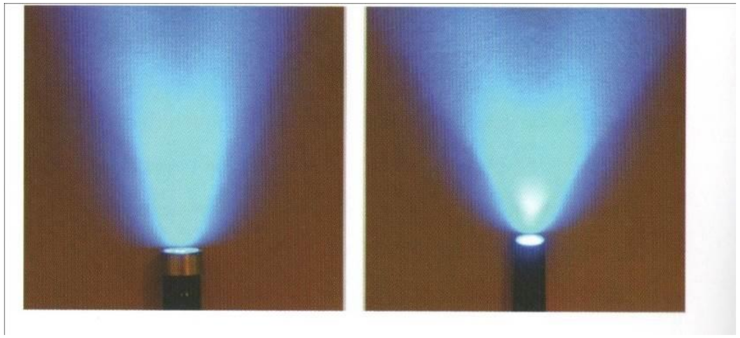
Soft start

Continuos increasing to 750 mW/cm^2
during 10 s and polymerization 30s

step polymerization with interruption

100 – 300 mW/cm^2 3-5 s, přerušoi na 3 min, pakpolymerovat 750 mW/cm^2 po 30 s

Period of pre gel phase



Dentists polymerize mostly from the distance 4 mm – 10 mm.Diffusion of lihgt. Soft start programm is not necessary.

Polymerization units

Quartz tungsten halogen (QTH)

- Light emitting diode (LED)
- Plasma – arc (PAC)

- Energy and spectrum

Polymerization units

Quartz tungsten halogen (QTH)

600 -800 mW/cm^2

- Light emitting diode (LED)

1000 -1800 mW/cm^2 modré

50 – 100 mW/cm^2 fialové

- Plasma – arc (PAC)

1500 - 2000mW/cm^2

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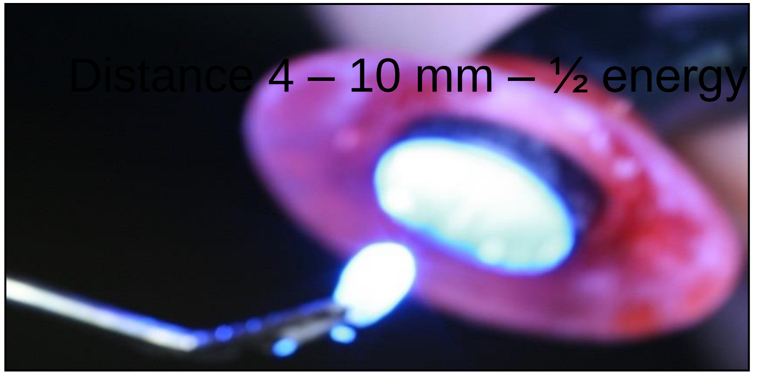
Time of polymerization

- Recommended output power 12000 – 16000 mJ/cm²



$$\frac{12\,000\ mWs/cm^2}{Intensity\ mW/cm^2} = \text{Time of polymerization in s}$$

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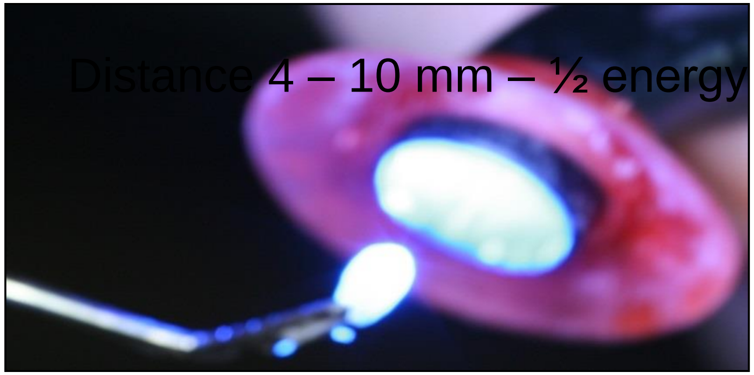
Time of polymerization

- Recommended output power 12000 – 16000 mJ/cm^2



$$\frac{12\,000\ mWs/cm^2}{Intensity\ mW/cm^2} = \text{Time of polymerization in s}$$

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Photoiniciators – spectrum of absorption

Photoiniciator	Spectrum of absorption (nm)	Maximum (nm)
CQ	440 - 500	470
PPD	380 – 430	400
TPO	350 - 410	380

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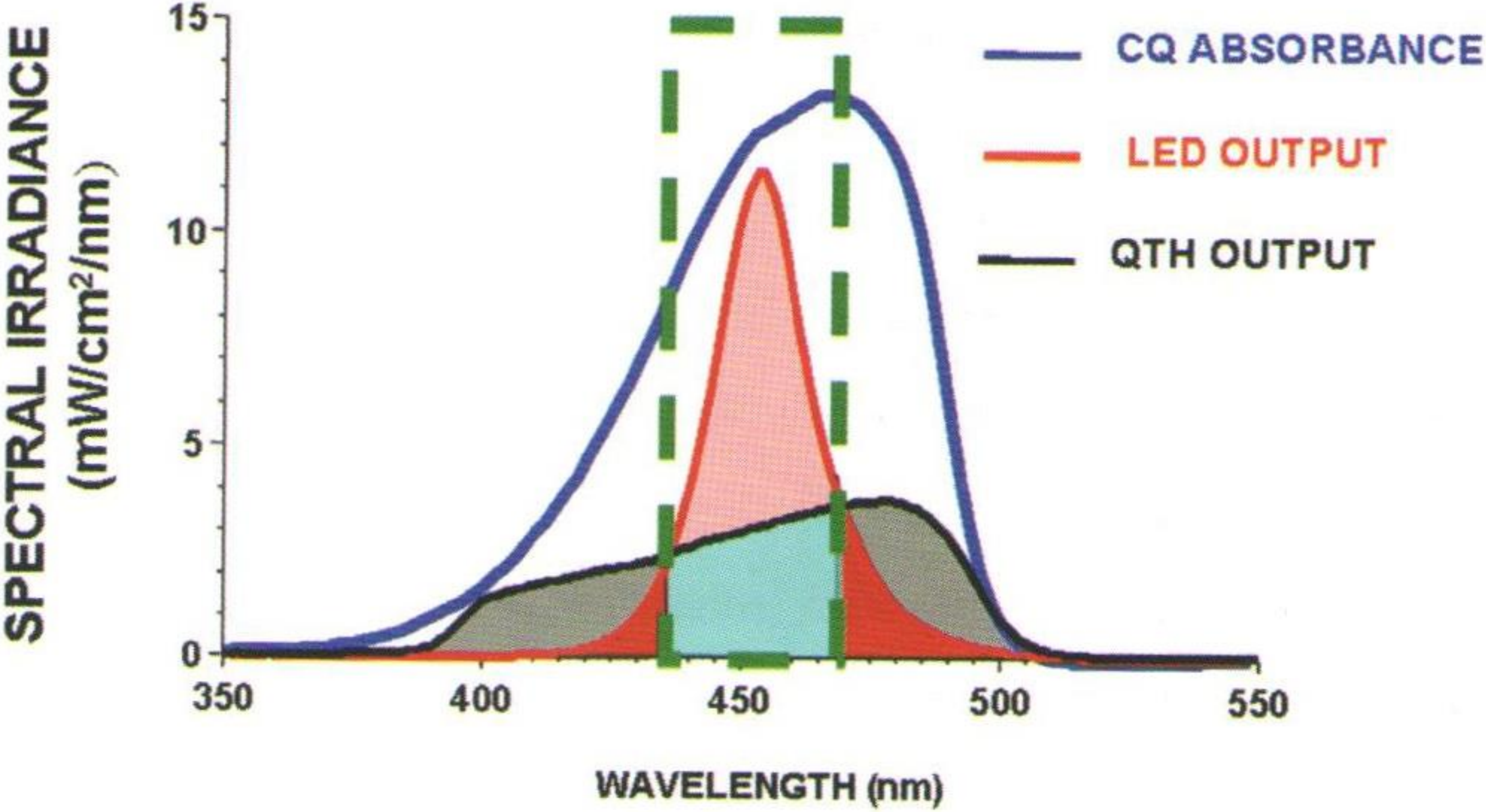
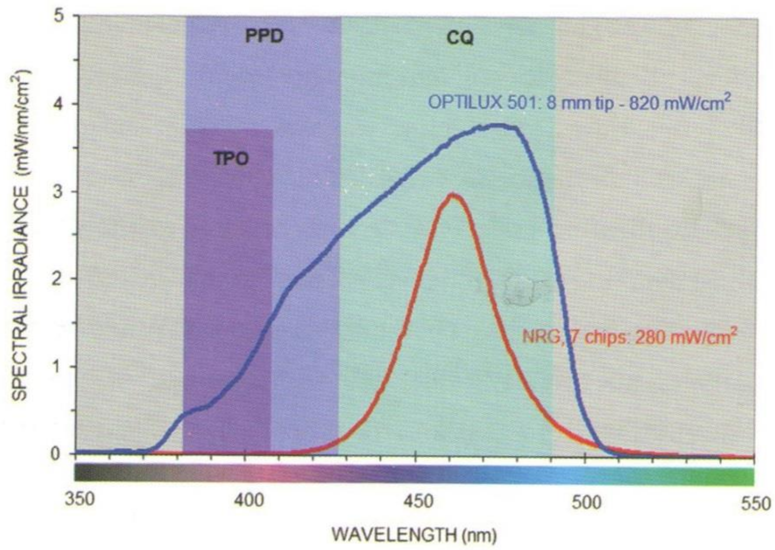
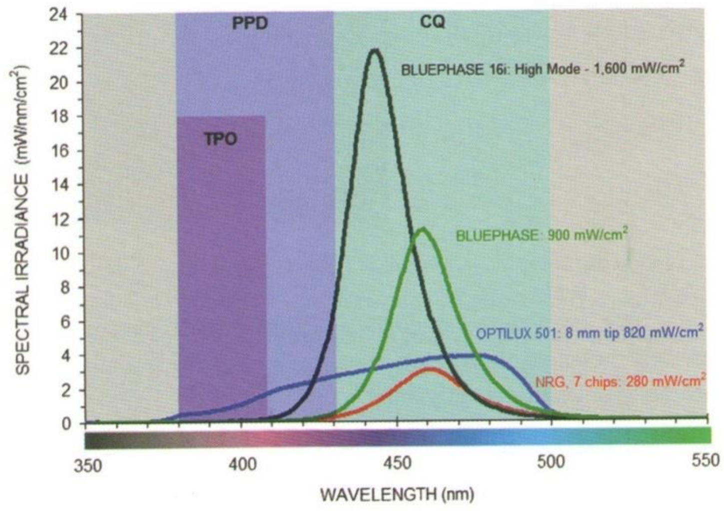
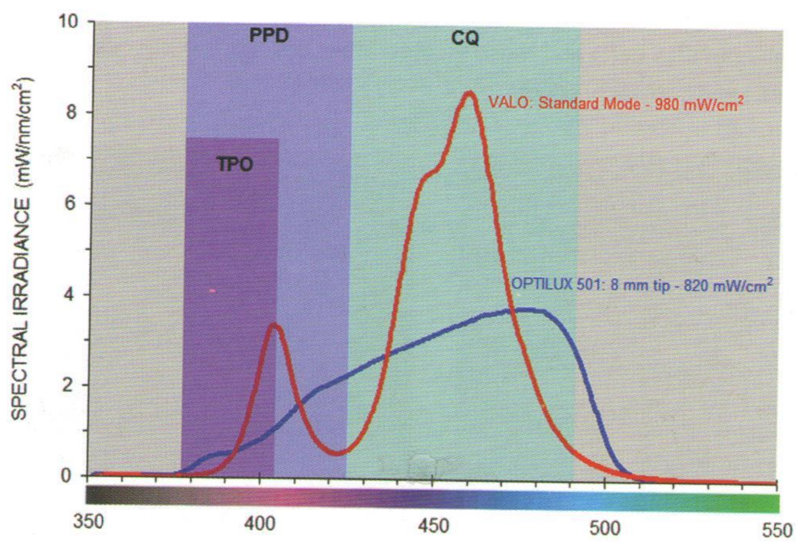
ABSORPTIVE REGION THAN FROM QTH LIGHT

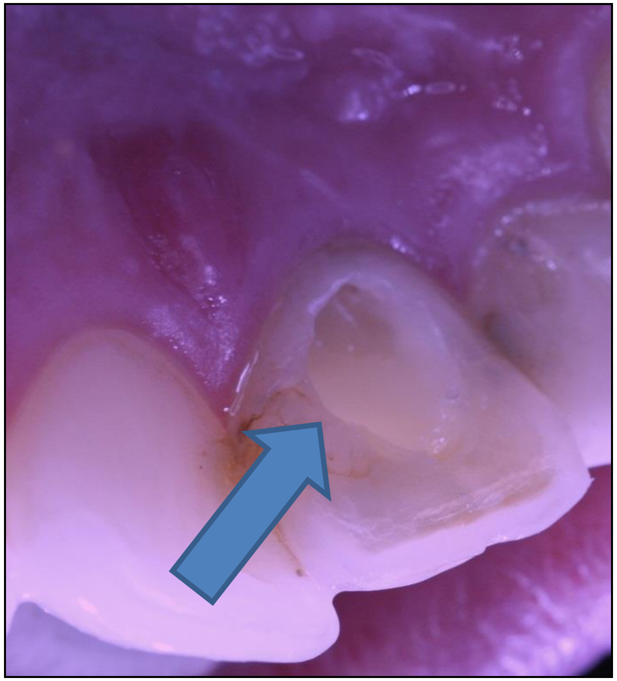


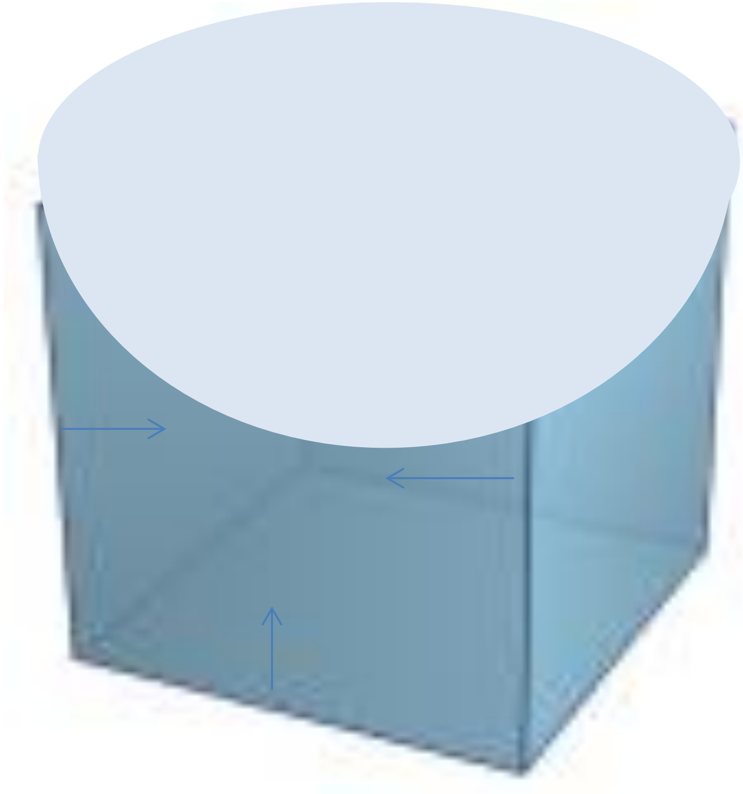

PPD
CQ
TPO
OPTILUX 501: 8 mm tip - 820 mW/cm2
NRG, 7 chips: 280 mW/cm2
SPECTRAL IRRADIANCE (mW/nm/cm2)
WAVELENGTH (nm)


PPD
CQ
TPO
BLUEPHASE 16i: High Mode - 1,600 mW/cm2
BLUEPHASE: 900 mW/cm2
OPTILUX 501: 8 mm tip 820 mW/cm2
NRG, 7 chips: 280 mW/cm2
SPECTRAL IRRADIANCE (mW/nm/cm2)
WAVELENGTH (nm)


PPD
CQ
TPO
VALO: Standard Mode - 980 mW/cm2
OPTILUX 501: 8 mm tip - 820 mW/cm2
SPECTRAL IRRADIANCE (mW/nm/cm2)

High C- faktor



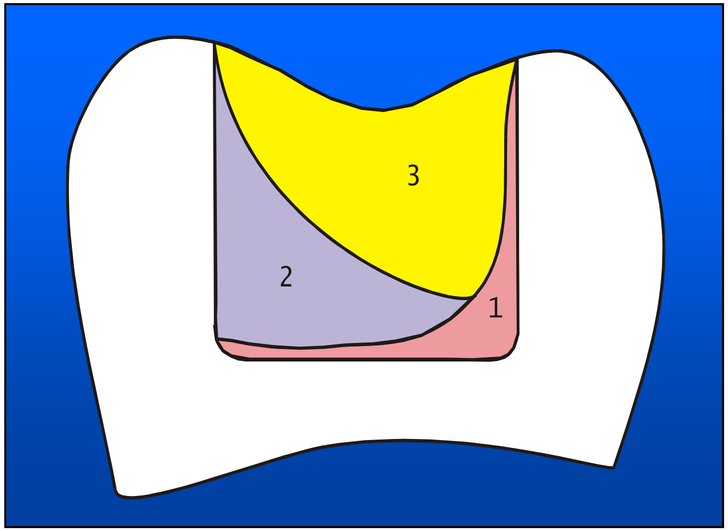


GAP in dentin, cracks in enamel

Working with layers

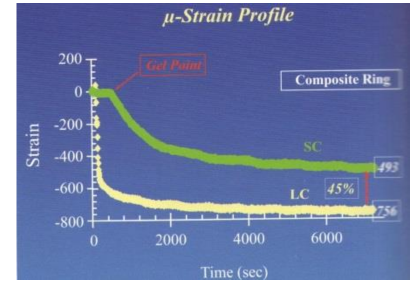
- Incremental technique

Flowable +thin layers

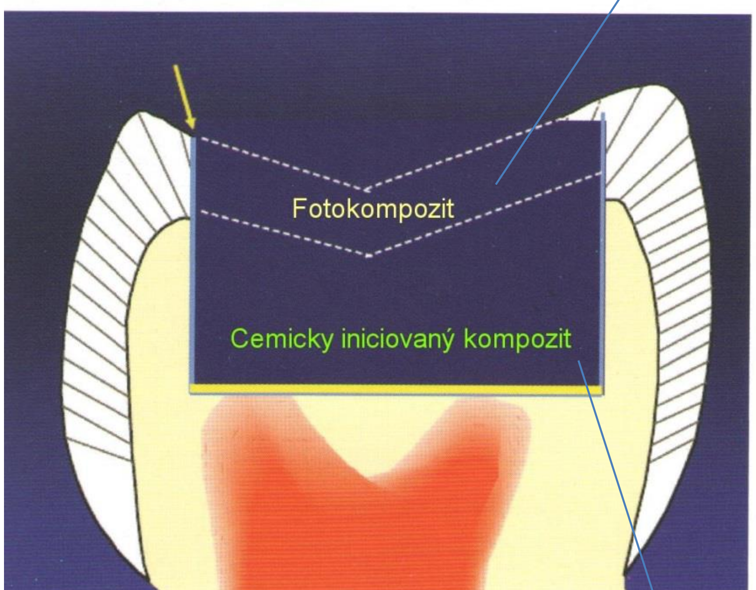


Free surface – as big as possible in each layer

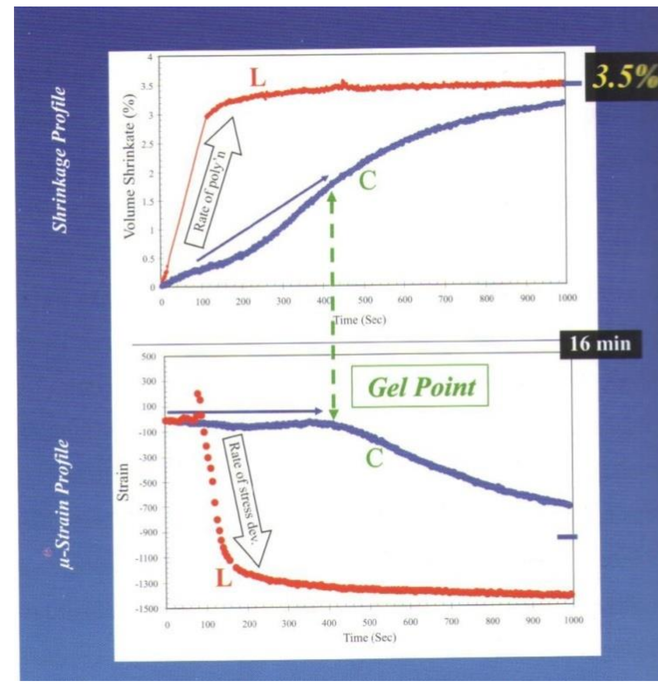
COMBINATION OF MATERIALS



Light curing composite



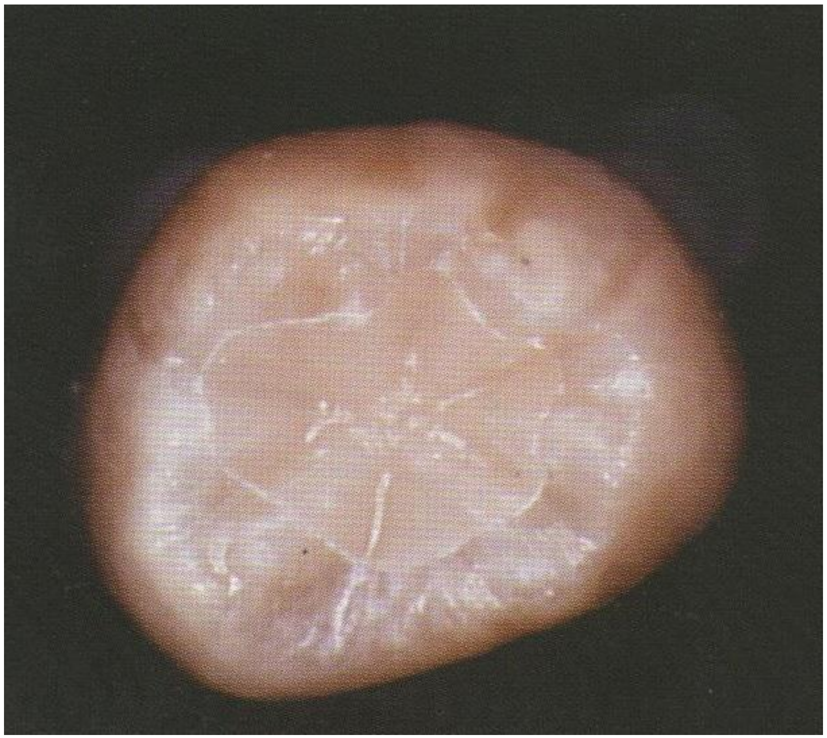
Selfcuring composite

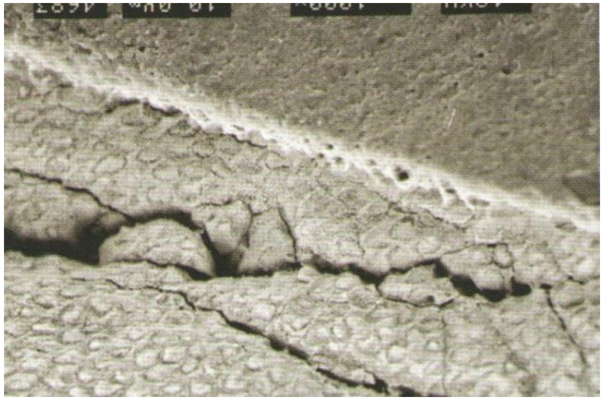


Glassionomer and composite

Sandwich technique
GIC replaces lost dentin
Composite replaces lost enamel

Sealing of the filling





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FLOWABLES

Flowables indications

Filling of minicavities, pit and fissure sealing, tunnel

- Reparations
- Splinting
- Marginal adaptation
- Tratament of infractions
- Block out of undercuts

Flowables

- Less amount of filler
- Higher polymarization shrinkage
- Lower modulus of elasticity
- Lower polymerization stress

1. *generation nízký obsah plniva, malá mechanická odolnost*
2. *generation: nanoparticles –hihger amount of filler*

Flowables indications

Filling of minicavities, pit and fissure sealing, tunnel

- Reparations
- Splinting
- Marginal adaptation
- Tratament of infractions
- Block out of undercuts

Bulk fill

Application in bulks, deep polymerization (4 – 5mm)

Heterogenous group

1. Flowables – SDR Flow (Dentsply), Venus Bulk Fill (Hereaus Kulzer), X-tra fill (VOCO), Filtek Bulk Fill (3M ESPE).
2. Packable composites (Tetric EvoCeram Bulk Fill (Ivoclar –Vivadent) a QuiXfill (Dentsply).
3. Sonic Fill (KaVo) – sonic activated composite

Sonic Fill

Sonic activation – materials become Flowable.

Bulk fill

- More translucent
- More fotoiniciators
- Combination of materials (flowable bulk fill + hybrid vomposite
- Packable composite + flowable on the borrom
- Sonic fill – combination with other materials is not necessary but useful.

Bulk fill

- The problem of polymerization stress is not solved completely.
- Thinner layers than 4 mm recommended.