Restorative dentistry – aesthetics I.

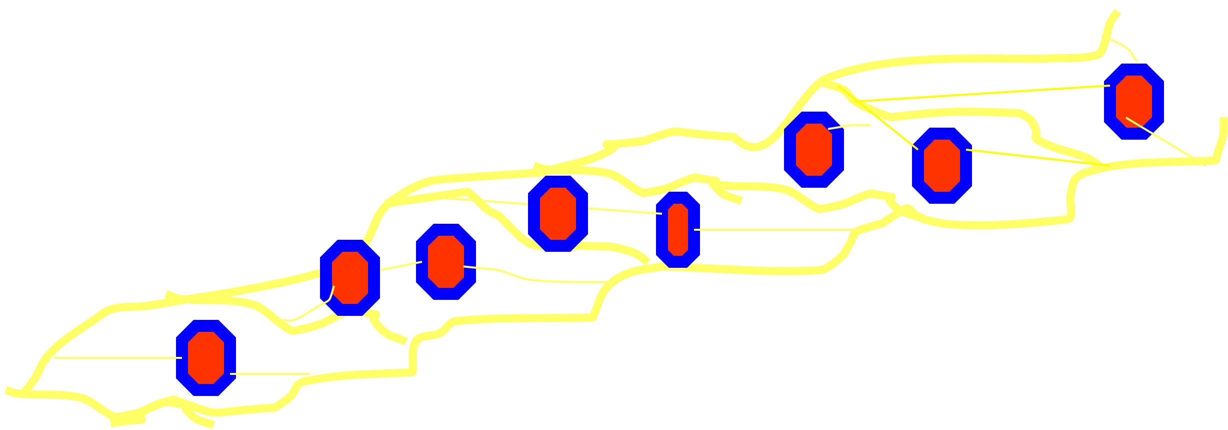
Contemporary trends

- 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 <u>**- matrix**</u>

- 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.

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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

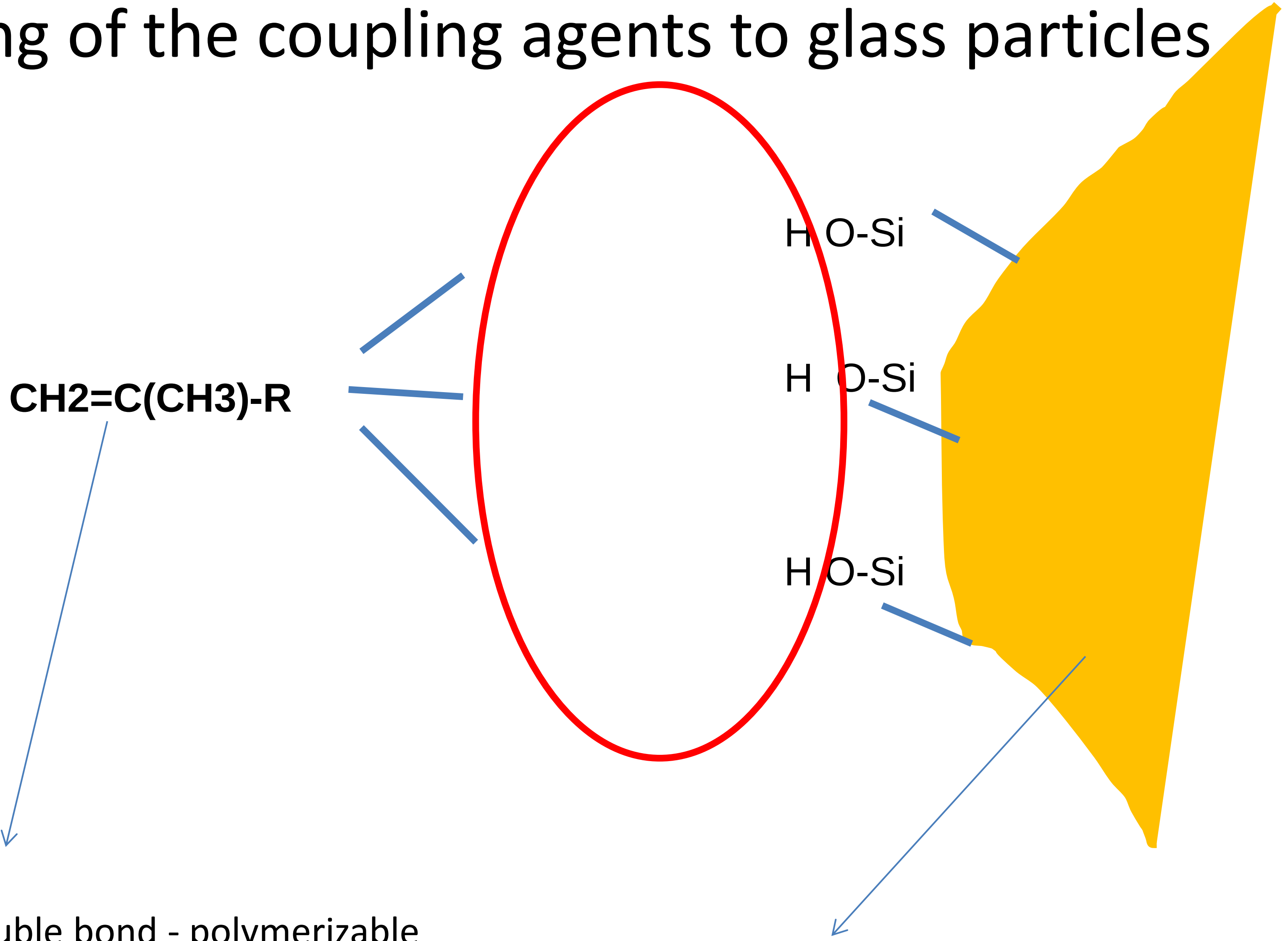
- Macro particles + microparticles+ prepolymer

- macroparticles + microparticles + prepolymer + nanoparticles

Coupling agent

G -methacryloxypropyltrimetoxysilan (A 174)

Binding of the coupling agents to glass particles



Double bond - polymerizable

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

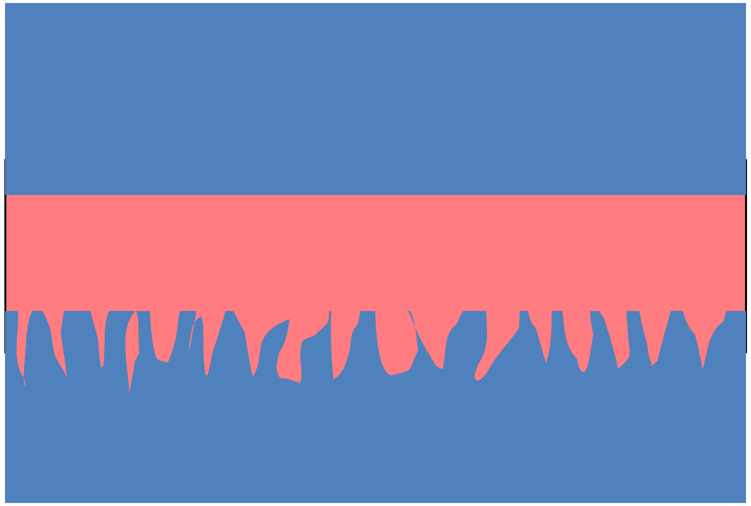
Adhesion

- **Mechanic**
- **Specific**

Adhesion

Mechanic

Irregulartiies of the surface



Adhesion

- **Specific**

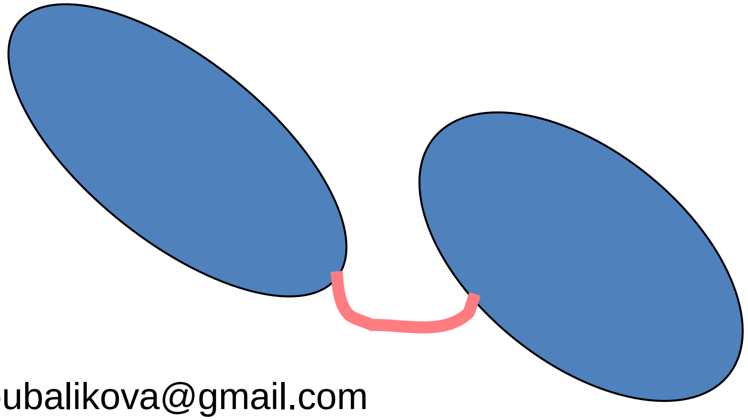
Physical

Chemical

Adhesion

- **Specific**

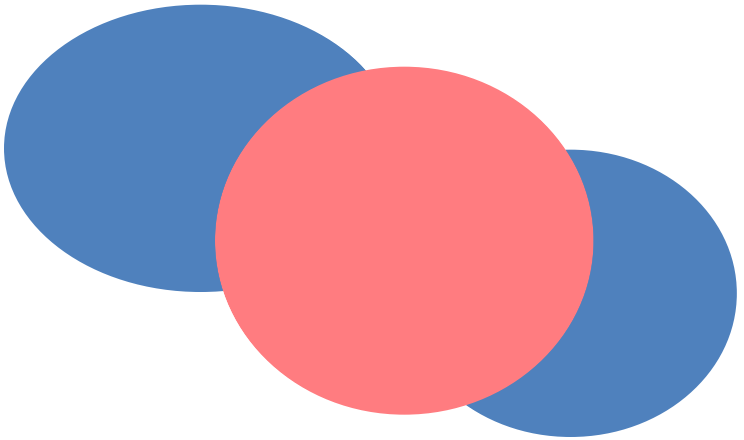
Physical – intermolecular forces - Van der Waals, hydrogenium bridges



Adhesion

- **Specific**

Chemical



Adhesion

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

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Adhesive preparation of surfaces

- Creates irregularities
- Increases surface energy

Adhesion of dental materials

Composites - micromechanical

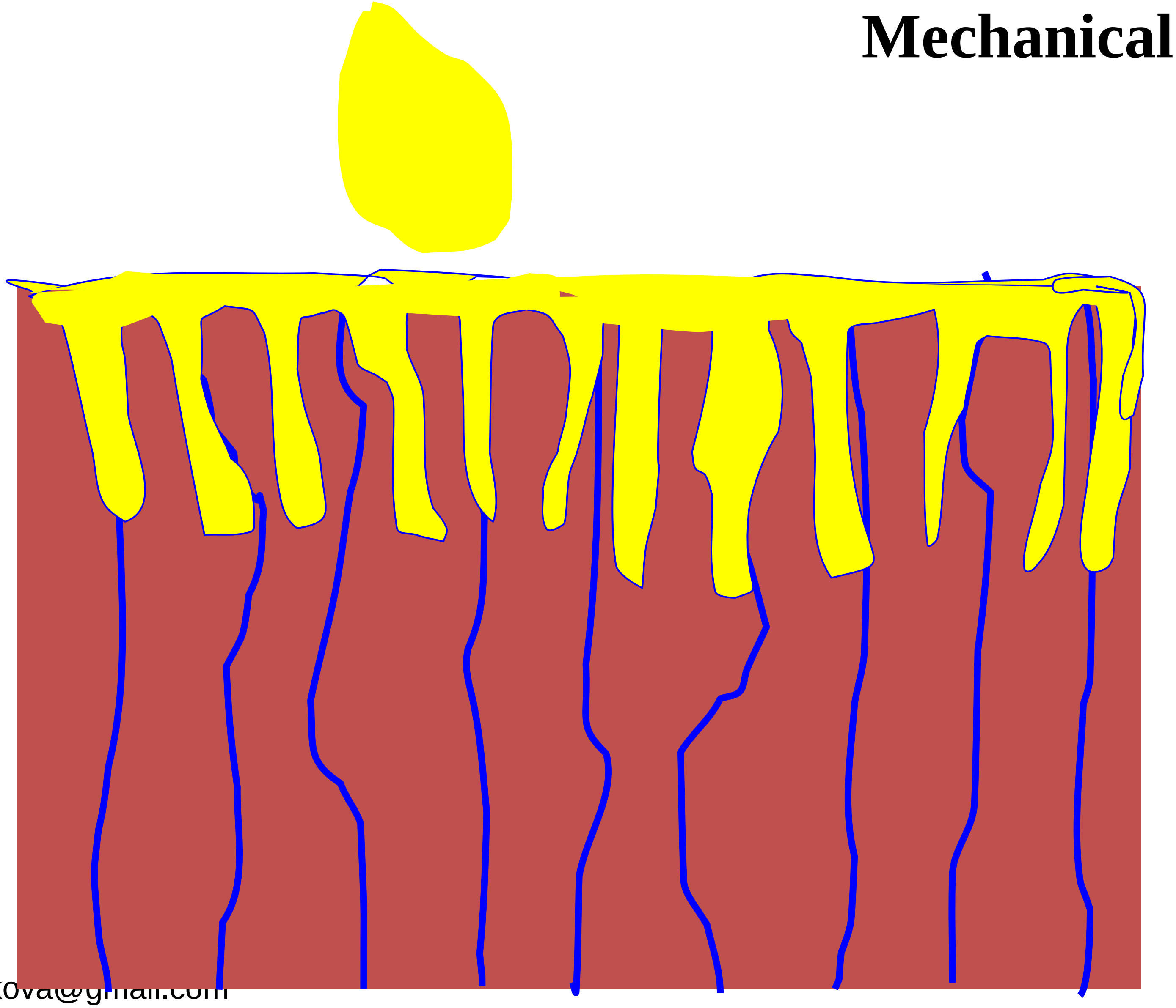
Adhesives – micromechanical, specific

Glassionomers - specific

Composits

Connection to enamel

Mechanical



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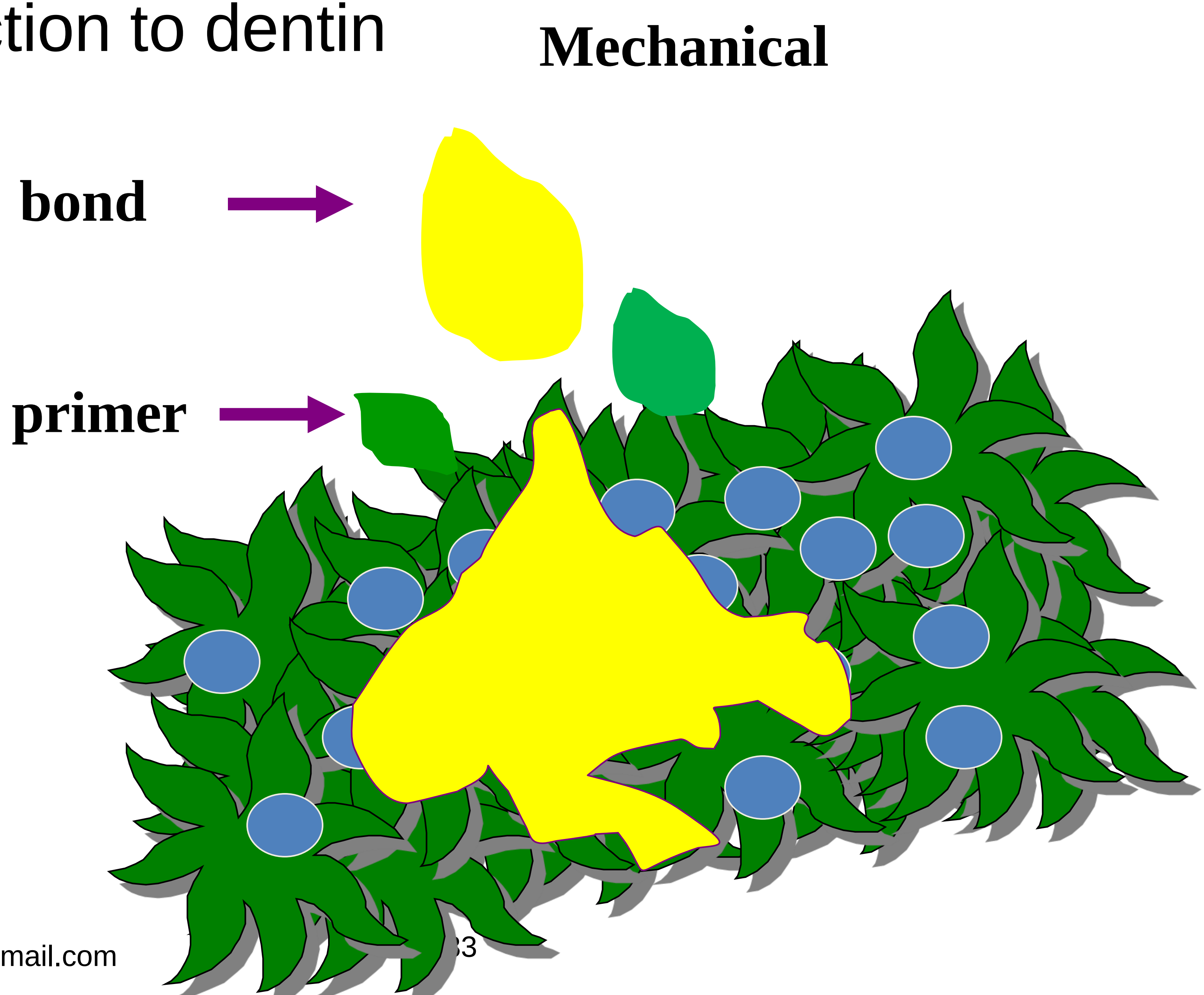
Adhesion to dentin

Dentin:

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

Connection to dentin



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

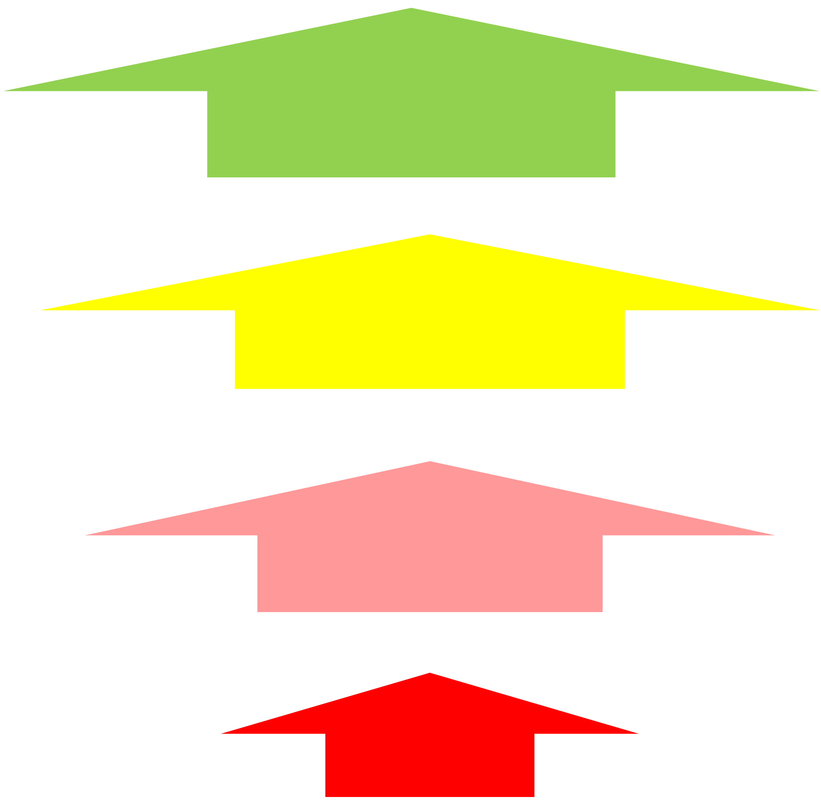
6th Generation: (late 1990’s – 2000)

- 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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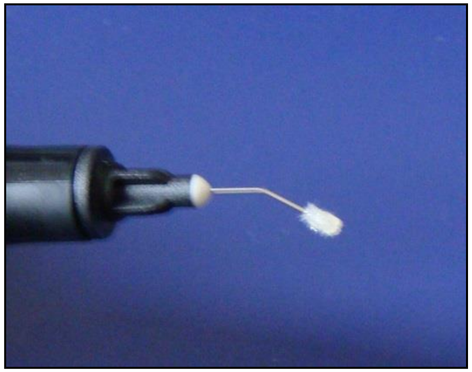

Adhesives – classification acc to clinical steps

<table>
<tr><td>3- ERA</td><td>Acid etching</td><td>Washing</td><td>Priming</td><td>Bonding</td></tr>
<tr><td>2- ERA</td><td>Acid etching</td><td>Washing</td><td colspan="2">Priming a bonding</td></tr>
<tr><td>2- SEA</td><td colspan="3">Selfetching priming</td><td>Bonding</td></tr>
<tr><td>1- SEA</td><td colspan="4">Selfetching bonding</td></tr>
</table>

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Adhesives

- Acid etching technique
- Selfetching adhesive systems

Adhesives

- Acid etching technique

Etching

Washing

Priming Bonding

Adhesives

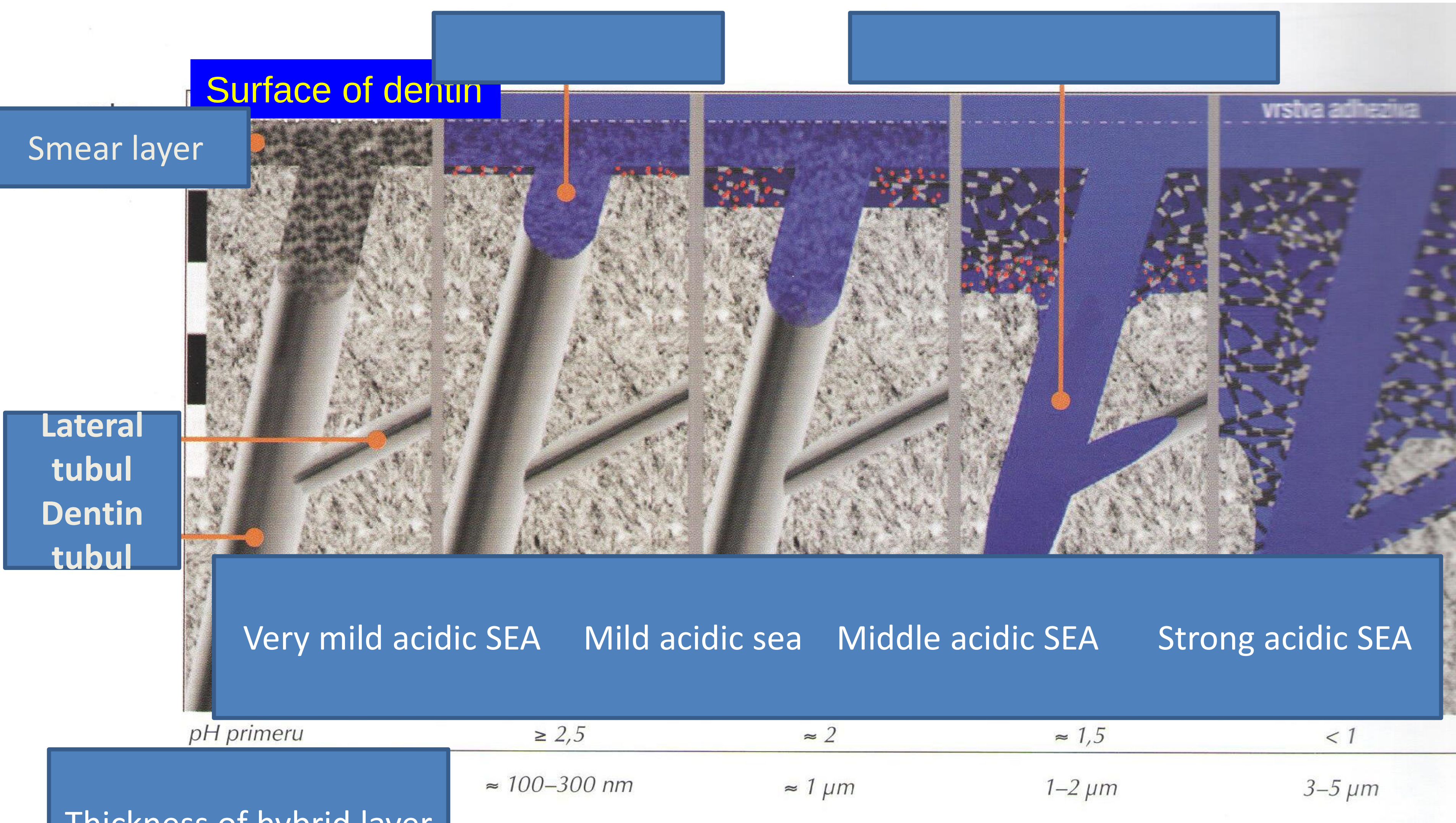
- Selfetching adhesive systems

Priming

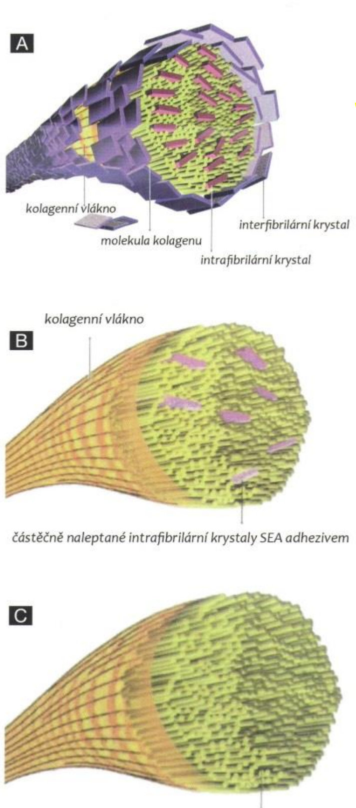
Bonding

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

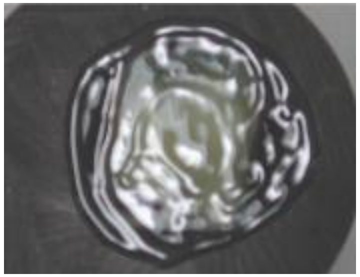
Active – rubbing with microbrush (SEA, dentin)

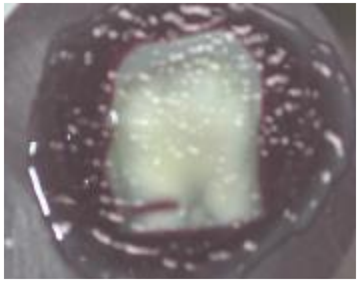
Passive – without any rubbing (ERA, enamel)

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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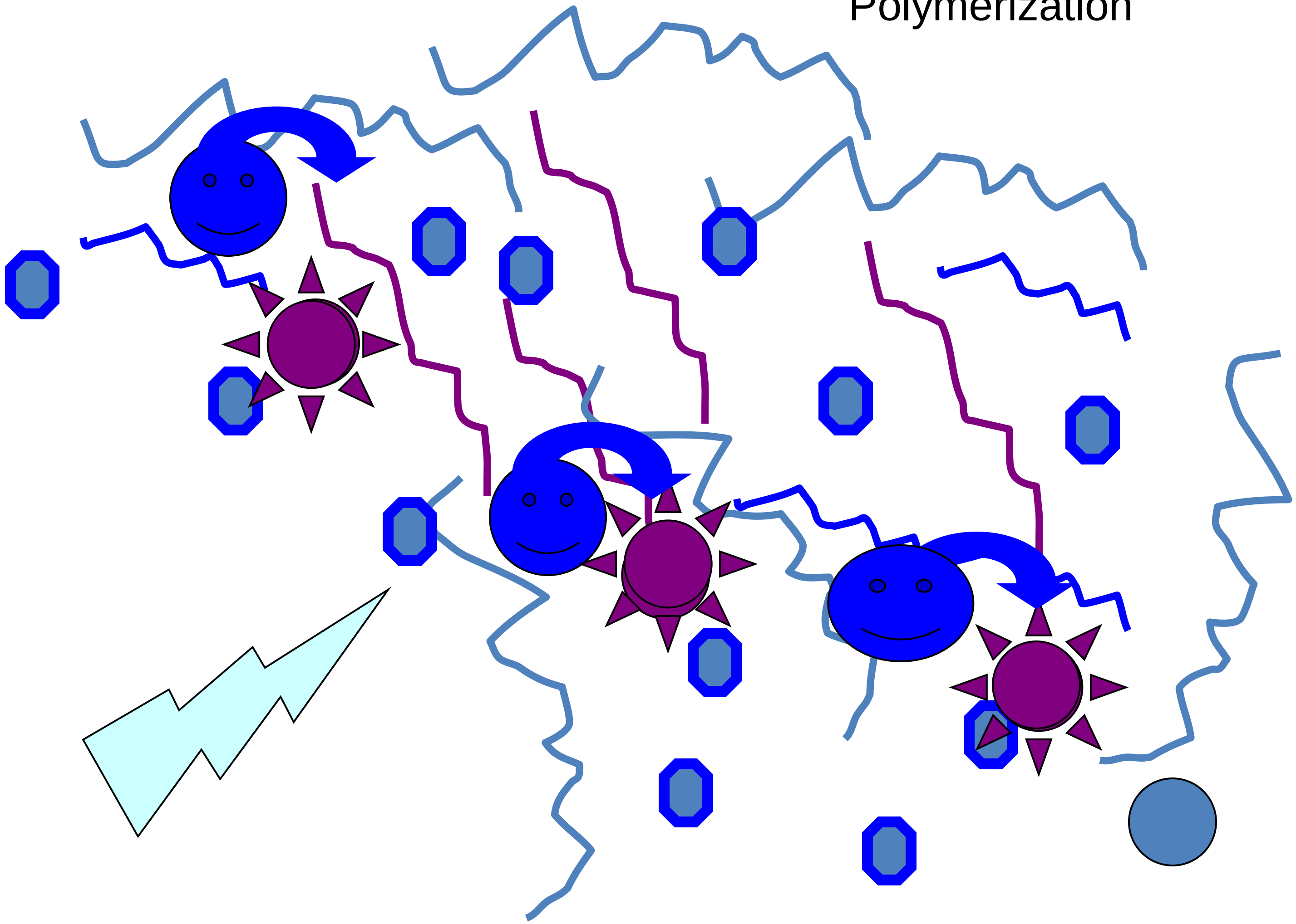
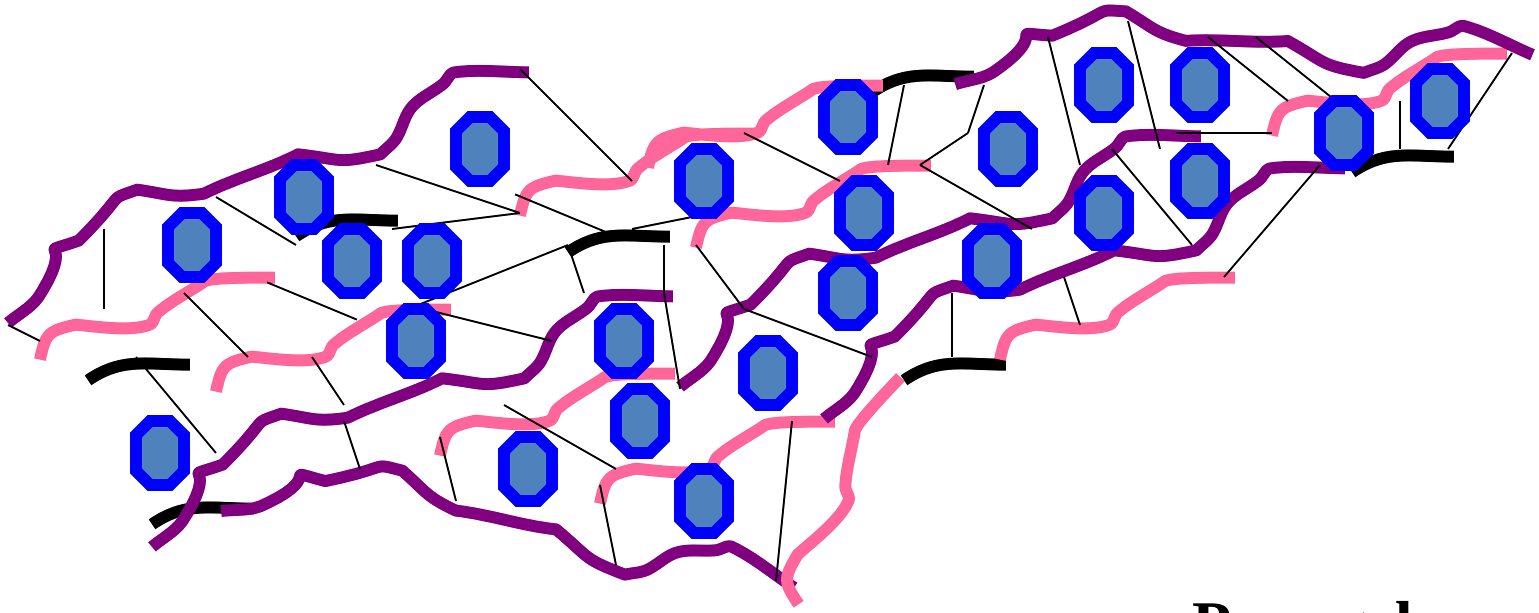
Polymerization



Polymer network



Pre –gel
Gel
Post -gel

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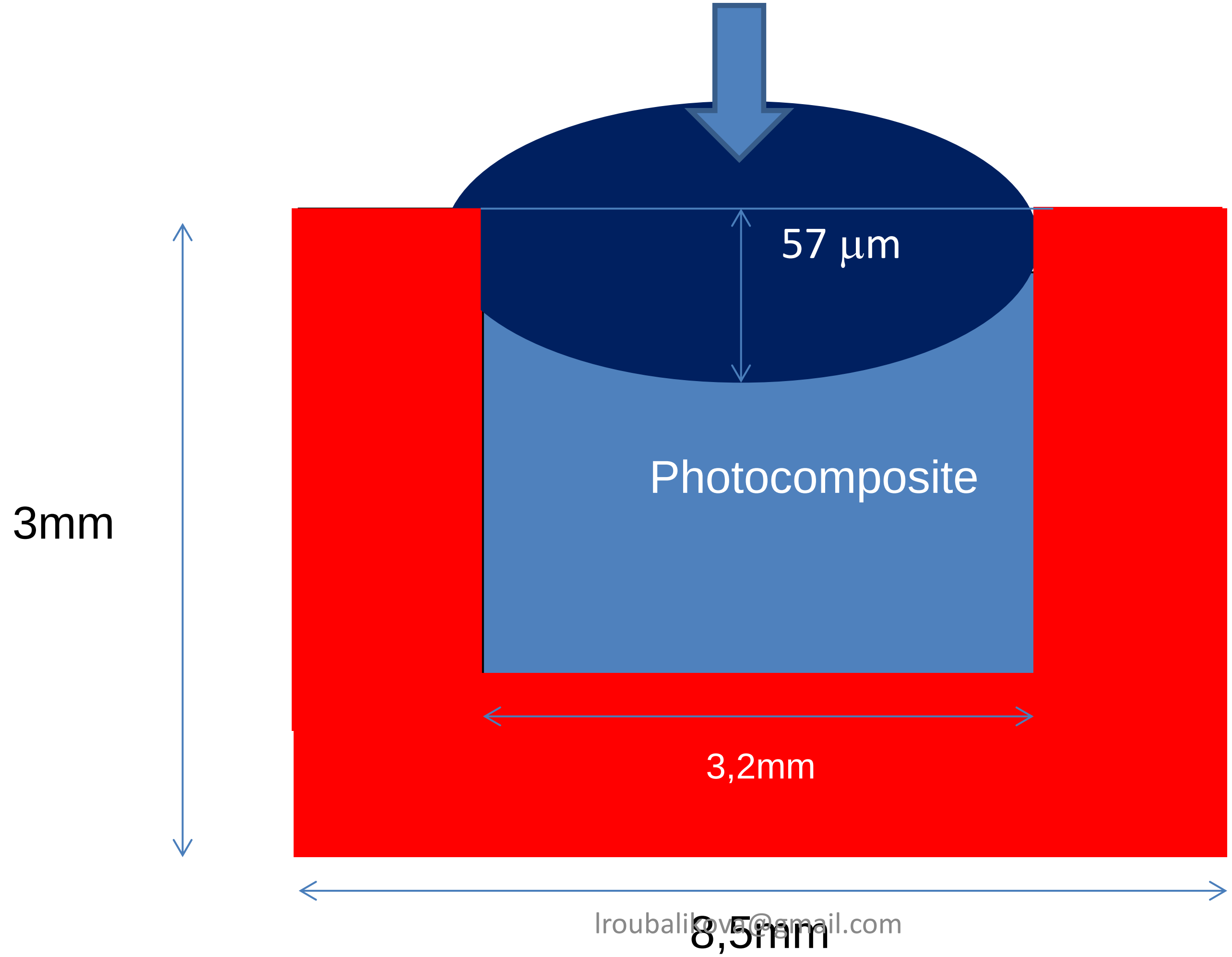
Byung, Suh
Principles of adhesion dentistry
2013



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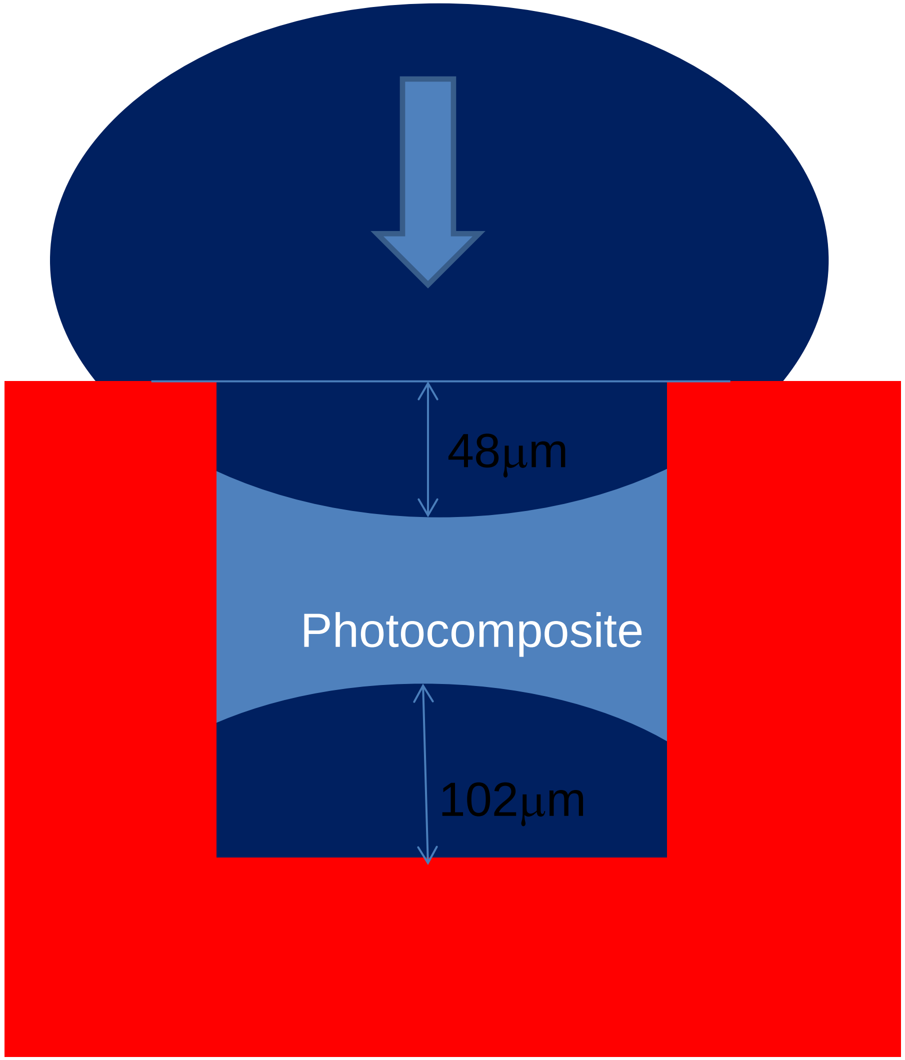
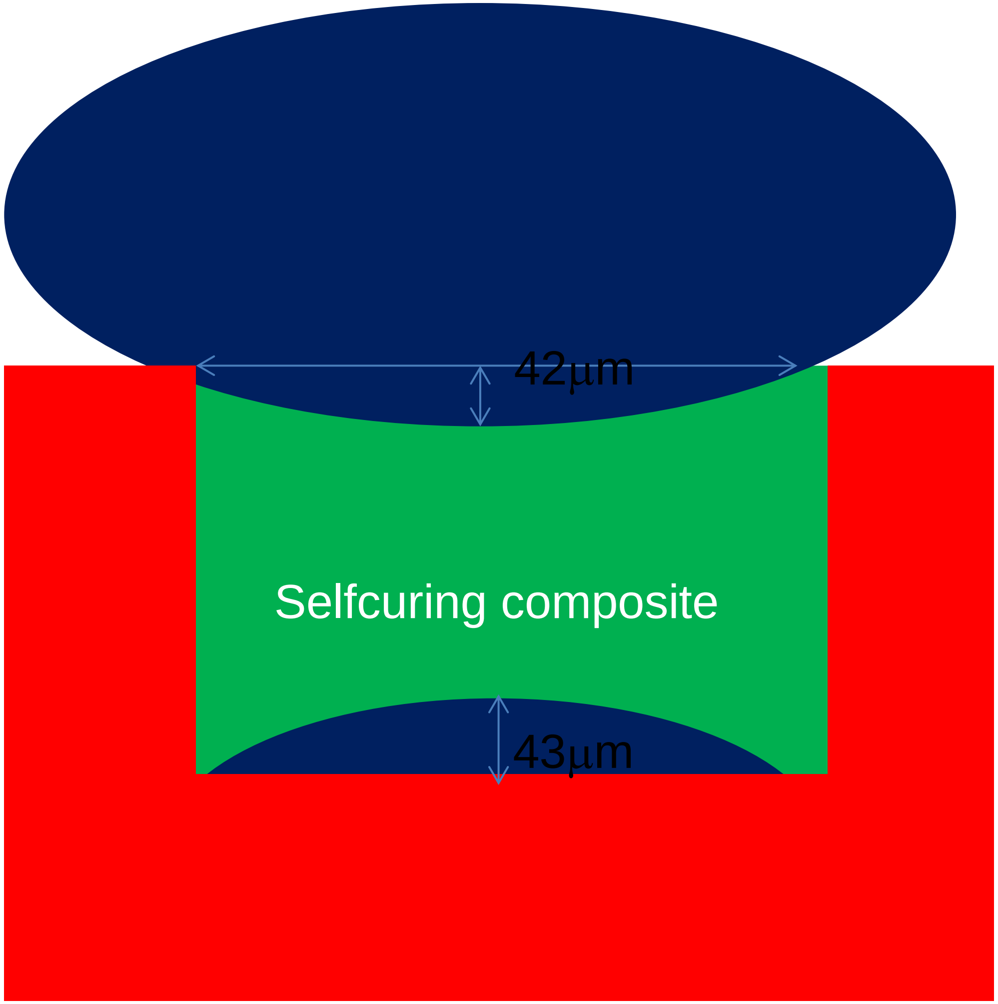
Polymerization strain and stress



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

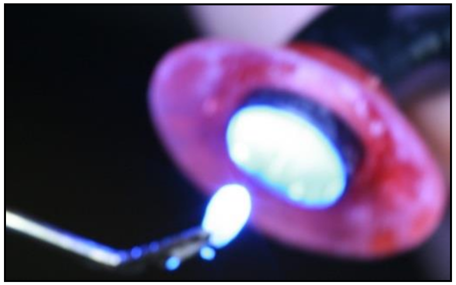
- Material is not soft, polymerization continues, due to polymerization shrinkage the polymerization stres occurs – forces on bonded surfaces can cause gaps or cracks.

- 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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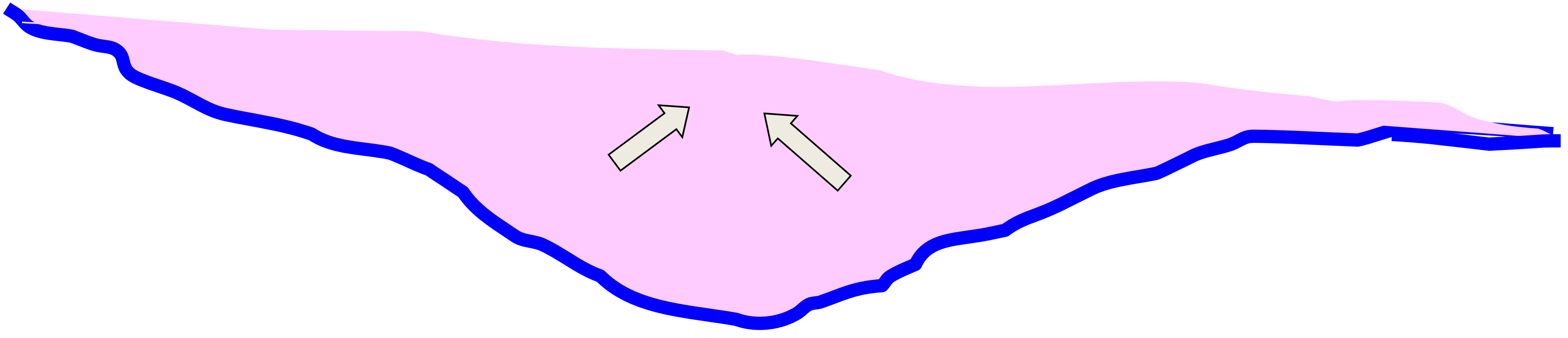
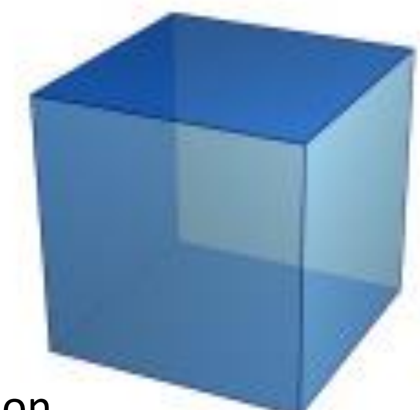
C – factor (Configuration factor)

Surface of adhesion/free surface of the filling



1/1 and less is optimal

5



2

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

1

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*

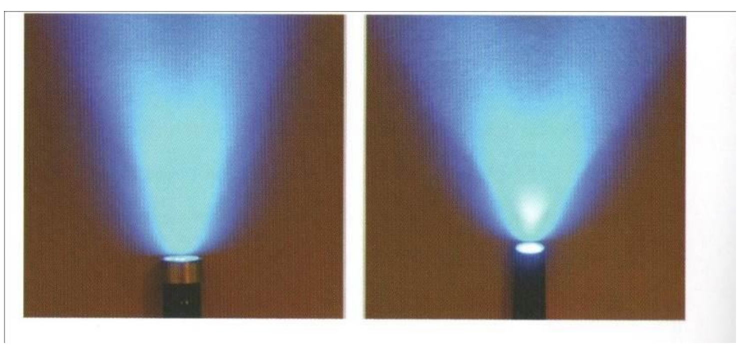
Soft start

Continuos increasing to 750 mW/cm² 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.

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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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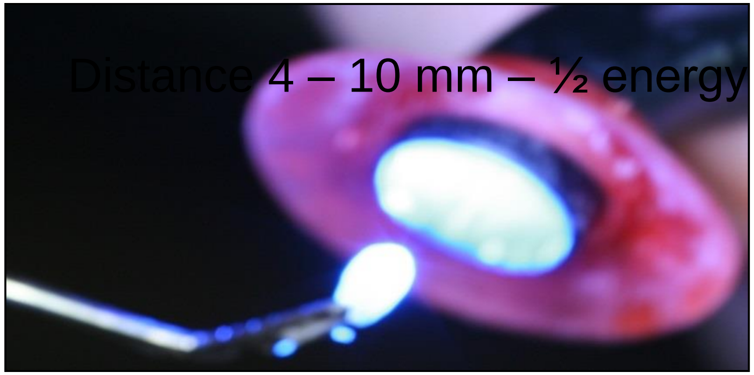
Time of polymerization

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



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

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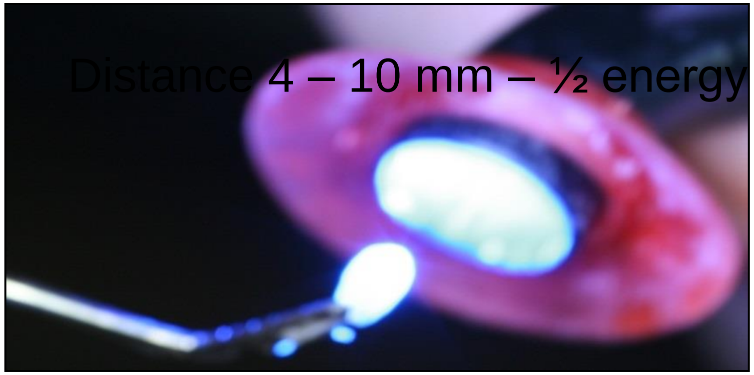
Time of polymerization

- 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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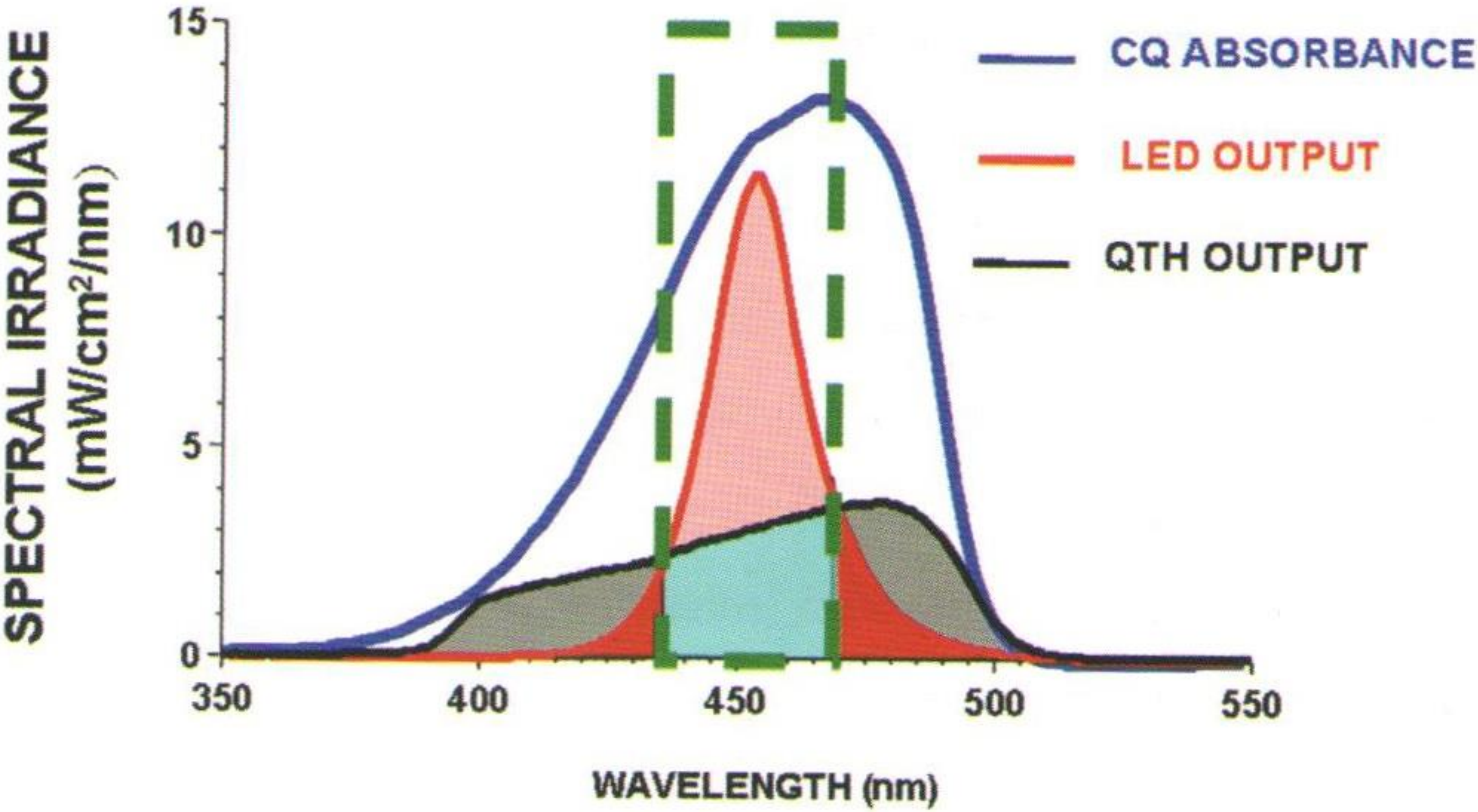
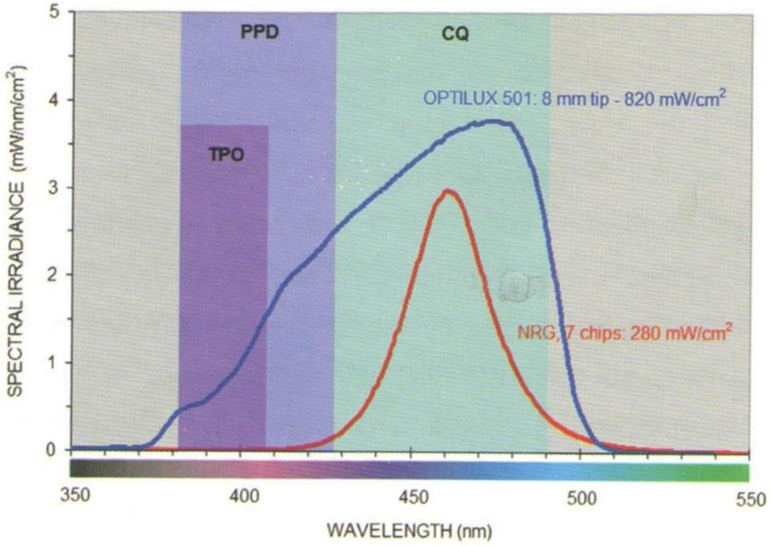
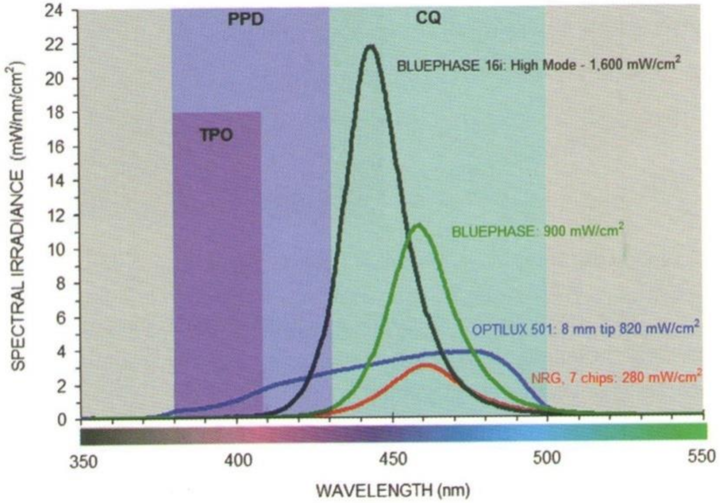
ABSORPTIVE REGION THAN FROM QTH LIGHT

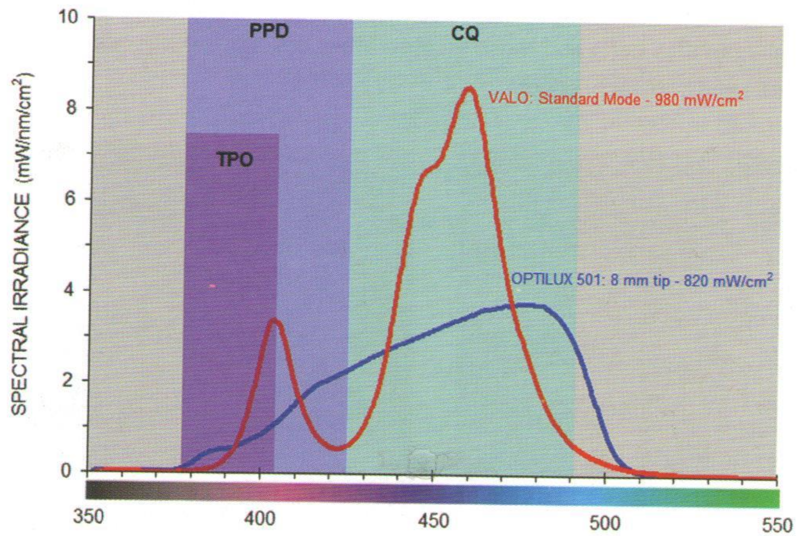




PPD
CQ
TPO
OPTILUX 501: 8 mm tip - 820 mW/cm2
NRG, 7 chips: 280 mW/cm2
SPECTRAL IRRADIANCE (mW/nm/cm2)
WAVELENGTH (nm)

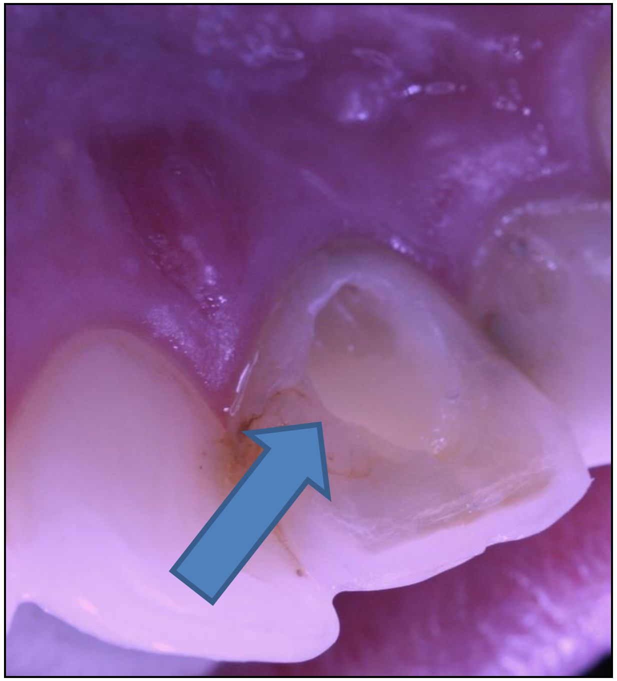


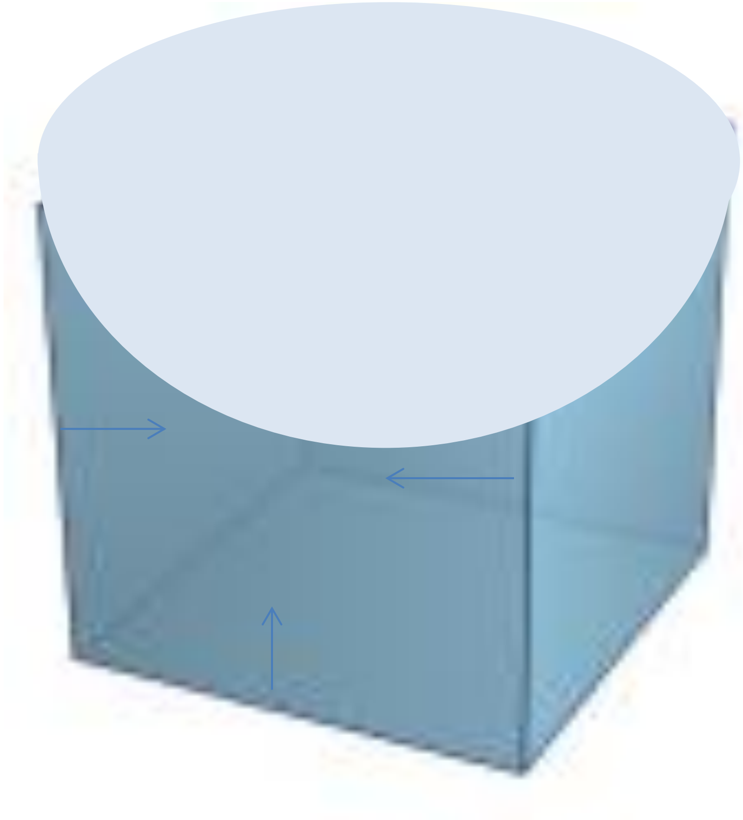
PPD
CQ
TPO
BLUEPHASE 16i: High Mode - 1,600 mW/cm2
BLUEPHASE: 900 mW/cm2
OPTILUX 501: 8 mm tip 820 mW/cm2
NRG, 7 chips: 280 mW/cm2
SPECTRAL IRRADIANCE (mW/nm/cm2)
WAVELENGTH (nm)



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



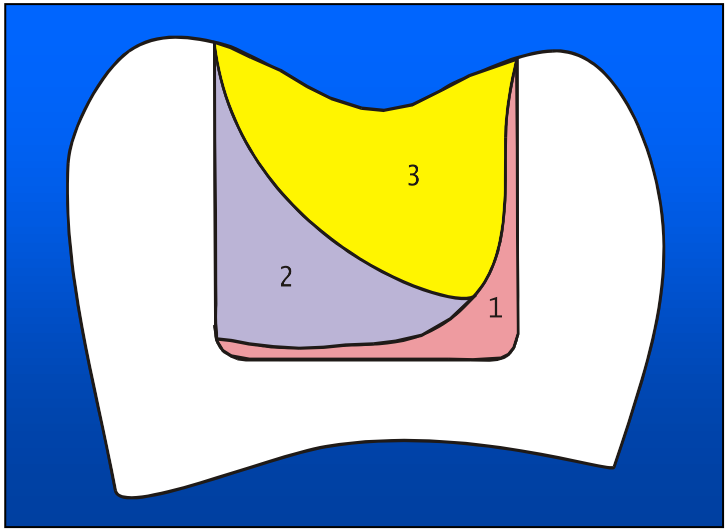


GAP in dentin, cracks in enamel

Working with layers

- Incremental technique

Flowable +thin layers



Free surface – as big as possible in each layer

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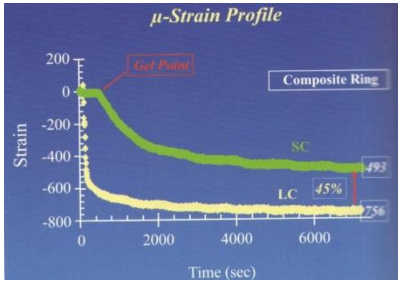
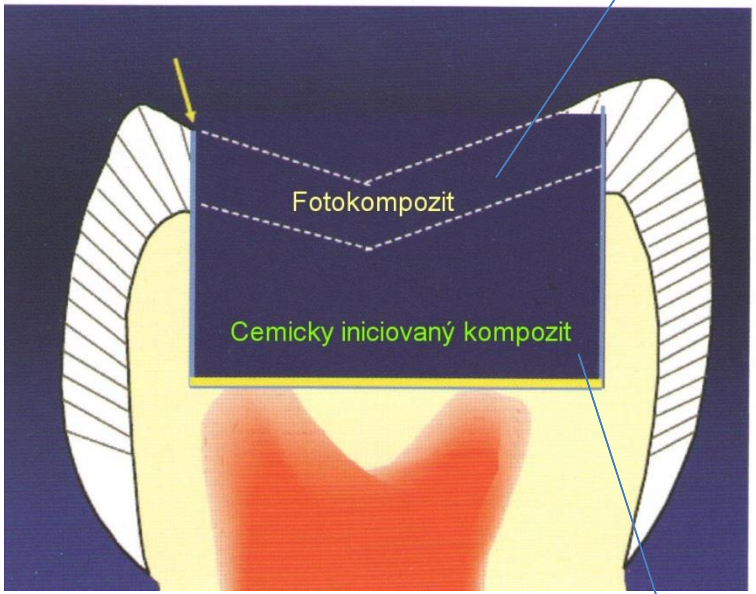
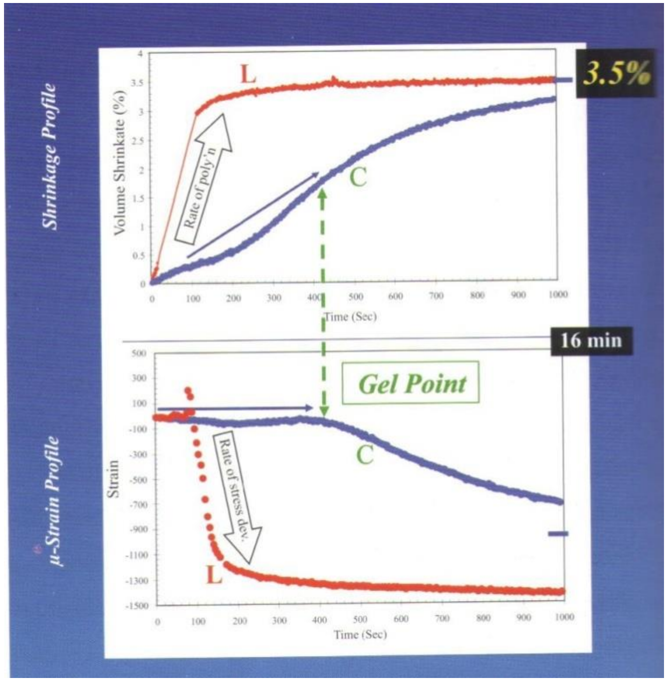
COMBINATION OF MATERIALS



Light curing composite



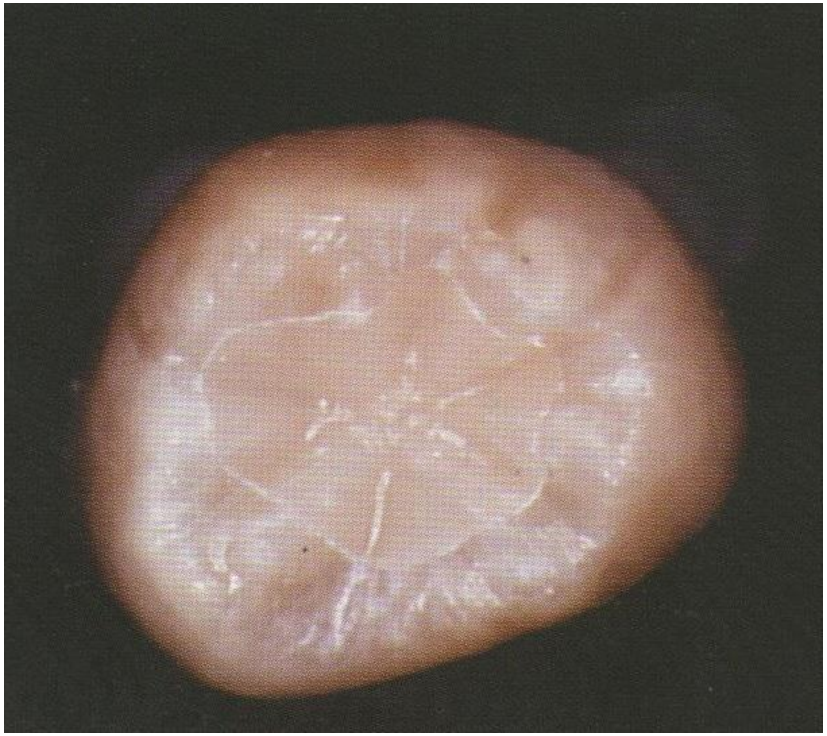


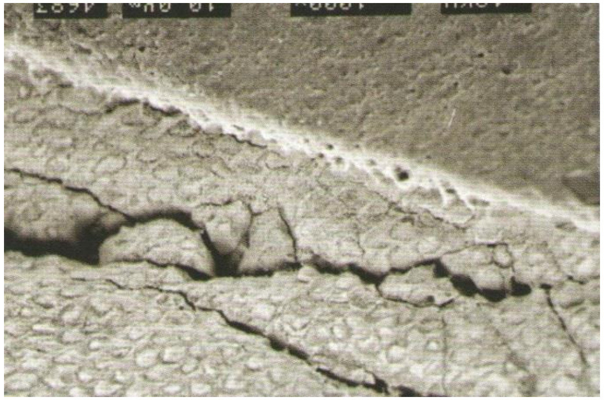
Selfcuring composite

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.