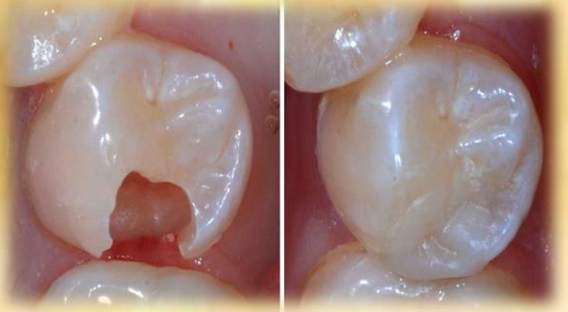

Good Morning



# Evolution of Posterior Composites



# CONTENTS

- Introduction
- Definition of composite
- Drawbacks of other direct restorations
- History
- Composition
- Classification
- Evolution of direct posterior composites

- Conventional composites
- Small particle composite resin
- Microfill composites
- Hybrid composites
- Compomer
- Giomer
- Fiber-reinforced composites
- Packable composites
- Ormocers

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- Anti-bacterial composites
- Nanocomposites
- Silorane based composites
- Bulk fill composites
- Self etch composites

# CONTENTS

# INTRODUCTION

- Tooth coloured restorative materials have increasingly been used to replace missing tooth structure and to modify tooth color and contour, thus enhancing facial esthetics.
- Dental composite have been considered acceptable restorative material for anterior teeth, for many years.
- Their improved mechanical properties, tooth color, matching ability and lack of metallic mercury have caused them to be promoted as an adjunct to or subsitute for dental amalgam in the restoration of posteriors also.

# INTRODUCTION

- Composite resins have made it possible to provide patients with highly conservative and esthetic restorations.
- During the last decade, average filler size was reduced drastically and submicrometer particle sized distribution of the fillers were used to optimize the filler load to improve the mechanical and wear characteristics.
- Hence, in addition to providing esthetics, the use of posterior resins has been noted to increase the fracture resistance of restoted teeth.

# DEFINITIONS

- The term **composite** refers to a three dimensional combination of atleast two chemically different materials with a distinct interface separating the components.

**According to Anusavice** : Dental composites are highly cross-linked polymeric materials reinforced by a dispersion of glass, crystalline, or resin filler particles and/or short fibers bound to the matrix by silane coupling agents.

**According to Skinners** : Composite is a compound composed of at least two different materials with properties which are superior or intermediate to those of an individual component.

# DRAWBACKS OF OTHER DIRECT RESTORATIONS

- **Dental amalgam -** mercury toxicity and lack of esthetics.
- **Silicate cements** were discouraged because of their poor strength, irritation to pulp tissue and brittleness.
- Self-curing acrylic resins showed poor physical properties like high polymerization shrinkage and coefficient of thermal expansion (CTE), lack of wear resistance, poor marginal seal, irritation to pulp and dimensional instability.

# HISTORY



| | |
|---|---|
| 1901 | Synthesis and polymerization of methyl methacrylate |
| 1930 | Use of PMMA as denture base resin |
| 1944 | First acrylic filling material |
| 1951 | Addition of inorganic fillers to direct filling materials |
| 1955 | Acid etch technique introduced by Buonocore |
| 1956 | Bowen investigated dimethacrylates (Bis-GMA) and silanized inorganic filler |
| 1962 | Introduction of silane coupling agents |

Textbook of operative dentistry – Nisha garg

# HISTORY



| | |
|---|---|
| 1964 | Marketing of Bis-GMA composites |
| 1968 | Development of polymeric coatings on fillers |
| 1973 | UV-cured dimethacrylate composite resins |
| 1976 | Introduction of microfilled composites |
| 1977 | Visible light cured dimethacrylate composite resins |
| 1980 | Posterior composites in views |
| 1990 | Improved composites and adhesive systems |

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# HISTORY



| | |
|---|---|
| 1996 | Development of flowable composites |
| 1997 | Development of packable composites |
| 1998 | Development of fiber reinforced, ion releasing composites and ormocers |
| 1999 | Single crystal modified composites |
| 2002 | Nanofilled composites |
| 2006 | Introduction of silorane based materials. |

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# An ideal composite resin for restoring posterior teeth should fulfill the following criteria:

- Wear similar to natural tooth structure or amalgam.
- Have no plastic deformation in function.
- Have a simple placement technique.
- Have minimum polymerization shrinkage.
- Have excellent marginal adaptation and sealing.
- Have a radiopacity similar to or greater than tooth structure for ease of radiographic evaluation.
- Be easy to finish and polish.
- Be esthetically pleasing.

**Ramya Raghu, Raghu Srinivasan. Optimizing tooth form with direct posterior composite restorations. *J Cons Dent* 2011;14(4):330-6**

# COMPOSITION

A resin composite is composed of :

- **Organic polymer matrix**
- **Filler particles**
- **Coupling agent**
- **Activator-Initiator system**
- **Inhibitors**
- **Coloring agents**
- **Optical modifiers**

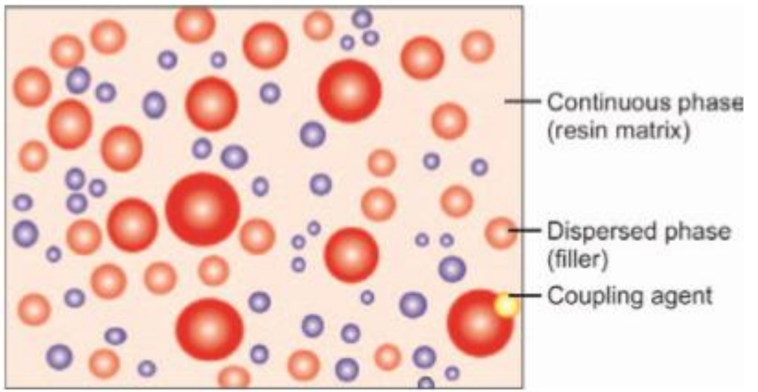



**Figure 17.1:** Schematic representation of different components of composite resin

# CLASSIFICATION OF RESIN-BASED COMPOSITES

- Accor
- Philip

**Table 15-1** Classification of Resin-Based Composites and Indications for Use

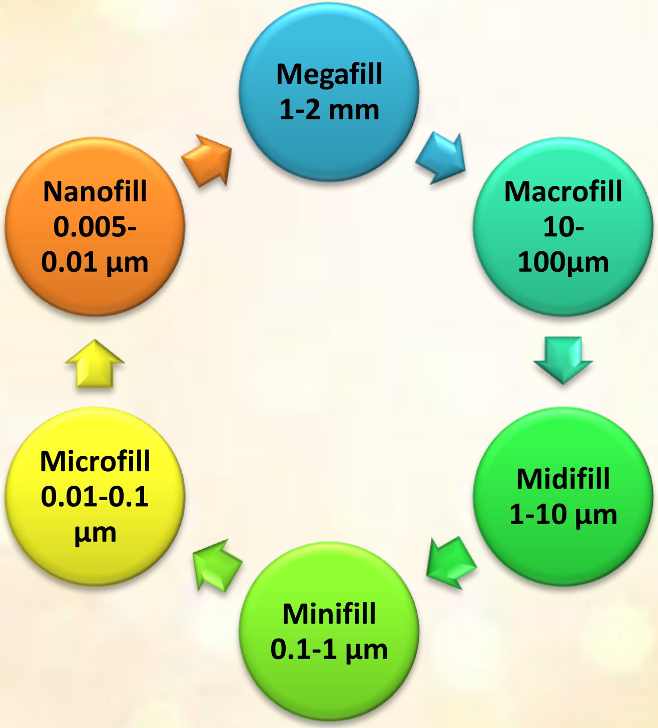
| Class of composite | Particle size | Clinical use |
|---|---|---|
| Traditional (large particle) | 1–50 µm glass | High-stress areas |
| Hybrid (large particle) | (1) 1–20 µm glass<br>(2) 0.04 µm silica | High-stress areas requiring improved polishability (Classes I, II, III, IV) |
| Hybrid (midifiller) | (1) 0.1–10 µm glass<br>(2) 0.04 µm silica | High stress areas requiring improved polishability (Classes III, IV) |
| Hybrid (minifiller/SPF) | (1) 0.1–2 µm glass<br>(2) 0.04 µm silica | Moderate stress areas requiring optimal polishability (Classes III, IV) |
| Packable hybrid | Midifiller/minifiller hybrid, but with lower filler fraction | Situations in which improved condensability is needed (Classes I, II) |
| Flowable hybrid | Midifiller hybrid, but with finer particle size distribution | Situations in which improved flow is needed and/or where access is difficult (Class II) |
| Homogeneous microfill | 0.04 µm silica | Low-stress and subgingival areas that require a high luster and polish |
| Heterogeneous microfill | (1) 0.04 µm silica<br>(2) Prepolymerized resin particles containing 0.04 µm silica | Low-stress and subgingival areas where reduced shrinkage is essential |

*SPF*, Small-particle filled.

Anusavice- 11th edition

# CLASSIFICATION OF RESIN-BASED COMPOSITES

- Classification according to Bayne and Heyman category particle size:



# Conventional composites

- Conventional compo ℅ to 80% inorganic filler by weight.
- The average particle the 1960s was approximately 8-12μm.
- **Advantage** - Physic s better than unfilled acrylic resins.
- **Disadvantages** - Rou ty, more wear, more prone to staining.

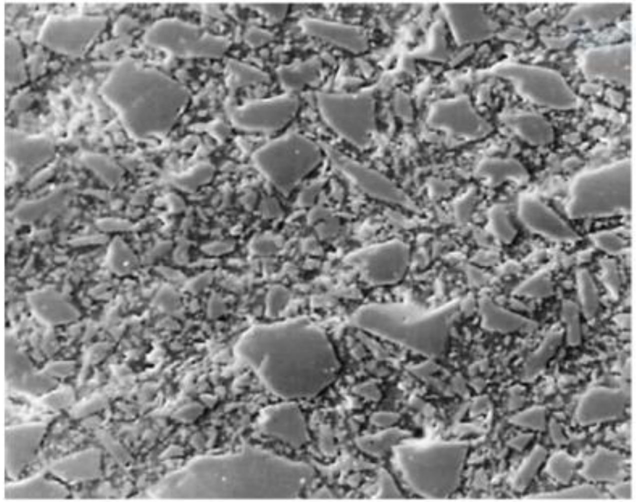


FIGURE 11-8 Scanning electron micrograph of polished surface of a conventional composite (×300).

Art and science of operative dentistry – Sturdvent's 5th edition.

# Small particle composite resins

- Average particle size of small particle composite resins ranges from **1 to 5 µm.**
- Filler content is 80% by weight and 65% by volume.
- It is used in stress bearing areas like Class I and II, large Class III and IV preparations.
- **Advantages** - **Superior polishing and texturing properties, good abrasion and wear resistance, lower coefficient of thermal expansion, decreased polymerization shrinkage, less water absorption, increased modulus of elasticity and compressive strength, good esthetic.**
- **Disadvantages** - Long-term durability of these composite resins is questionable due to presence of heavy metal glass fillers because these fillers are softer and prone to hydrolysis.

**Textbook of operative dentistry – Nisha garg**

# Microfill composites


- Introduced in late 1970's.
- Average diameter of filler particle size is **0.04 to 0.4µm.**
- Inorganic filler content of approximately **35% to 60% by weight.**
- **Advantages** - Highly polishable, good esthetic.
- **Disadvantages** -

**Poor mechanical properties due to more matrix content, poor color stability, low wear resistance, less modulus of elasticity and tensile strength, more water absorption, high coefficient of thermal expansion.**

**Art and science of operative dentistry – Sturdvent's 5th edition.**

# Hybrid composites

- Inorganic filler content of approximately **75% to 85% by weight.**
- Average particle size - **0.4-1µm**.
- **Advantages** - Availability in various colors, different degrees of opaqueness and translucency in different tones and fluorescence, excellent polishing and texturing properties, good abrasion and wear resistance, similar coefficient of thermal

**Disadvantages - Not appropriate for heavy stress bearing areas, not highly polishable as microfilled because of presence of larger filler particles in between smaller ones, loss of gloss occurs when exposed to tooth brushing with abrasive toothpaste.**

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Advantages - better polish and surface finish, easy handling, improved physical properties, good wear resistance.

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# COMPOMERS

- COMPosite + ionoMER = COMPOMER
- First introduced -**1993**
- **Composition**
  - Resin matrix – UDMA, Tetra carboxylic acid-HEMA, TEGDMA
  - Filler – strontium fluoride glass silicate (size : 0.2-1.6μm) (79% by weight)
  - Photoinitiator – camphoroquinone
  - Accelerator – dimethylamino benzoic acid ethyl ester
- **Applications**

  Class V and class II restorations

# COMPOMERS


Hytac Aplitip (3M)


Compoglass (Ivoclar)


Dyract AP (Dentsply)


Dyract Xtra (Dentsply)

F2000 Compomer (3M)

# COMPOMERS



## PROPERTIES

- Most properties are similar to conventional composites such as bond strength, fracture toughness, marginal adaptation, depth of cure and color matching.
- Fluoride releasing composite.
- Excellent handling.

## ADVANTAGES

- Ease of placement
- No mixing
- Easy to polish
- Good esthetics
- Less susceptible to dehydration
- Radiopaque

## DISADVANTAGES

- Require a bonding agent
- More marginal staining and chipping
- Limited fluoride release
- Microleakage more than resin modified glass ionomers
- Expansion of matrix due to water sorption
- Physical properties decrease with time.

# COMPOMERS

- Vishnurekha C et al compared the tensile bond strength and microleakage of conventional GIC, RMGIC and compomer and found that compomer showed highest tensile strength and RMGIC showed least microleakage among the three.

**Reasons :**

- Highest wt% of resin component in compomer and etching process for micromechanical retention→ better strength.
- **Auto cure resin in RMGIC and chemical bonding to tooth structure prevents microleakage.**

REKHA C, VARMA B. Comparative evaluation of tensile bond strength and microleakage of conventional glass ionomer cement, resin modified glass ionomer cement and compomer: An in vitro study. *Contemporary Clin Dent* 2012; 3(3): 282-287

# GIOMERS

- Introduced in early 1990s.
- Pre-reacted glass ionomer technology (PRG)

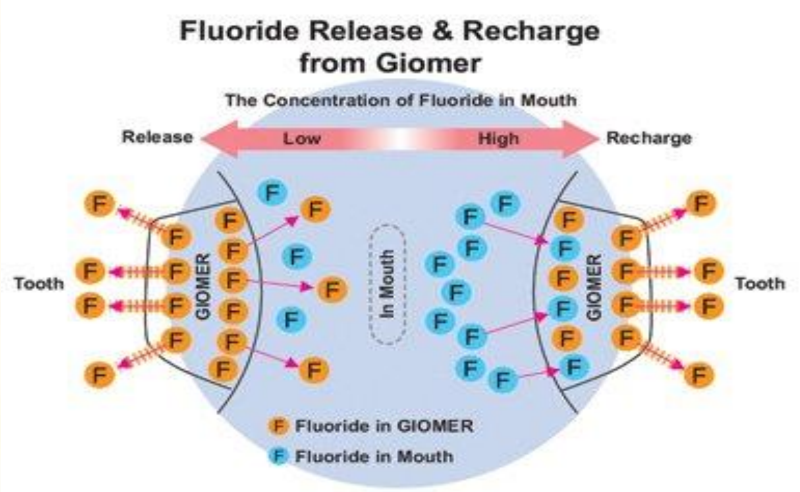
They are:

- S-PRG (Surface Pre - Reacted Glass Ionomer) marketed as BEAUTIFIL (shofu)
- F-PRG (Full Pre - Reacted Glass Ionomer) marketed as REACTMER (shofu)

# GIOMERS

## Properties

- Easier to polish than glass ionomers
- Optimum fluoride release
- Excellent aesthetics
- Better surface finish
- Chemical bonding to tooth structure
- Biocompatibility
- Sensitive to moisture and desiccation.



# GIOMERS

## INDICATIONS

- Restoration of root caries
- Non-carious cervical lesions
- Class V cavities
- Caries in deciduous teeth

## ADVANTAGES

- Flouride release
- Flouride recharge
- Biocompatible
- Excellent aesthetics
- Smooth finish line
- Excellent bonding
- Clinical stability and durability
- Better than microfilled composite

## LIMITATIONS

- Not as beneficial as GICs
- Hardness is less than composite
- Exhibits rapid & extensive expansion

# FIBER REINFORCED COMPOSITE

- In early 1990s, several different types of fiber reinforcement materials were introduced like Kevlar, carbon, glass, ultra-high molecular weight polyethylene (UHMWPE) and silane - treated glass .
- Fillers - glass or carbon fibers
- Excessive strength along direction of fibres
- Diameter- 5-10microns
- Length – 20-40microns

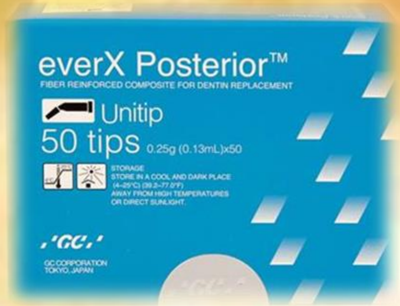
**FIBERS**

- Polyethylene,
- Glass,
- Polypropylene,
- Carbon or
- Aramid

Reinforcing component: provides stiffness and strength.

Surrounding matrix: supports the reinforcement and provides workability.

# FIBRE REINFORCED COMPOSITE




**CLINICAL APPLICATIONS**

- RESTORATIONS
- Tooth stability
- Treatment of missing teeth
- Post endodontics restorations
- Endodontic posts
- Repair of acrylic resin prosthesis

# FIBER-REINFORCED COMPOSITE

**Advantages**

- Low treatment costs
- Single visit immediate tooth replacement
- Readily repaired
- Suitable for young patients (developing dentin) and elderly (time saving).
- Metal free restorations
- Improved esthetics
- Can be produced in simple manner in laboratory without need for waxing, investing and casting
- Can frequently be used with minimal / no tooth preparation.
- Wear to opposing teeth much reduced in comparison to traditional PFM.

# FIBER-REINFORCED COMPOSITE

## Disadvantages

- Wear of overlying veneering composite esp... significant para...
- May... ridges.
- Excellent r... for adhesive t...
- Uncertain... o traditional t...

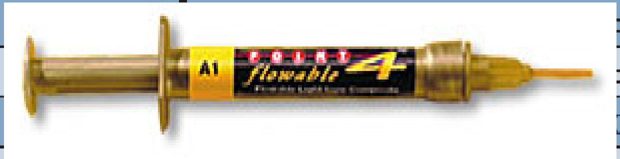



# FLOWABLE COMPOSITES

- Introduced in 1996.
- Reducing the filler content or by adding modifying agents like surfactants.
- Particle size similar to hybrid composite.
- Resin matrix- TEGDMA.
- Filler- silica
  - 0.02 - 0.05µ
  - 60% by weight
  - 41-53% by volume










| | |
|---|---|
| | Dentsply |
| Gradia Direct Flo | GC America |
| | Ivoclar |
| Tetric Flow | Ivoclar |
| | Southern Dental Industries |
| PermaFlo | Ultradent |

# FLOWABLE COMPOSITES

## *Properties*

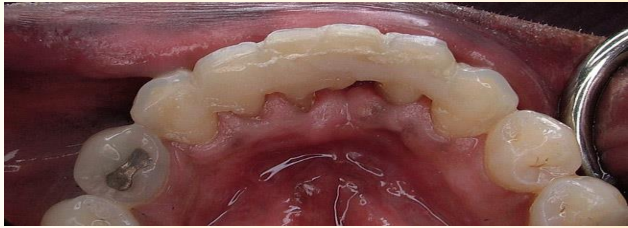
- Flow is increased
- Depth of cure is 6mm
- 56 to 70% filler by weight.
  - higher susceptibility to wear
  - a higher polymerization shrinkage
  - and lower flexural strength.
- Hence the use of these materials should be avoided in high stress areas.

# FLOWABLE COMPOSITES

**APPLICATIONS**

- Low stress bearing areas
- Repairing of restorations
- PRR
- Liners in proximal boxes
- Resurfacing worn composites or GIC
- Tunnel restorations
- Cementing agents
- Contraindicated in class I,II,IV areas

# FLOWABLE COMPOSITES



- pit and fissure sealants
- small, angular Class V abfraction lesions
- sealing ditched amalgam margins
- repair of small porcelain fractures in non-stress-bearing areas
- surfacing ribbon-reinforced composite resin splints
- repairing temporary restorations
- repair of crown margins
- repair of composite resin margins
- luting porcelain and composite resin veneers
- small Class III restorations

# FLOWABLE COMPOSITES

## ADVANTAGES

- Low viscosity
- Improved marginal adaptation
- High wettability of the tooth surface
- High depth of cure
- Penetration into every irregularity of preparation
- Eliminate air entrapment
- High flexibility,
- Radiopaque
- Availability in different colors
- Require minimally invasive tooth preparations
- For the pediatric patient to be used in narrow and deep pits and fissures.

## DISADVANTAGES

- More susceptible to wear in stress bearing areas
- Weaker mechanical properties
- More polymerization shrinkage and wear
- Sticks to the instrument, so difficult to smoothen the surface.

# FLOWABLE COMPOSITES



- Ja ... re (D ...

- highly filled flowable (G-aenial Universal Flow [GUF])
- two bulk-fill flowables (Surefil SDR Flow [SDR] and Venus Bulk fill [VBF]),
- bulk-fill nonflowable composite (Tetric N-Ceram Bulk fill [TBF])
- compared with two conventional composites (Tetric Flow [TF], Filtek Supreme Ultra [FS]).

- TF and GUF showed the highest linear polymerization shrinkage and GUF showed the highest polymerization shrinkage stress.
- Bulk-fill flowables (SDR and VBF) were properly cured in 4-mm bulk, but they shrank more than the conventional non-flowable composite.

Jang JH, Park SH, Hwang IN. Polymerization shrinkage and depth of cure of bulk-fill resin composites and highly filled flowable resin. *Oper Dent* 2015;40(2):172-80.

# PACKABLE COMPOSITE

- This new concept was developed by Dr. Lars Ehrnford of Sweden in 1996.
- Rather than incorporating the filler particles into the composite resin matrix, he devised a unique system by which the resin is incorporated into the fibrous ceramic filler network.
- It is based on the newly introduced concept **PRIMM.** (Polymer rigid inorganic matrix material).
- The fillers used
  - aluminium oxide and silicone dioxide glass particles
  - barium aluminium silicate
  - strontium glasses.


Synergy Compact (Coltene)


FILTEK P60 *(3M)*


Prodigy Condensable *(kerr)*


PYRAMID *(BISCO)*


ALERT *(Jeneric-Pentron)*


SOLITAIRE 2 *(Hereaus-Kulzer)*


SUREFIL *(LD Caulk)*


GLACIER *(Southern Dental Industries)*


HELIOMOLAR HB *(Ivoclar)*

# PACKABLE COMPOSITE

## INDICATIONS

- Indicated for stress-bearing areas .
- In class II restorations as they allow easier establishment of physiological contact points.

## ADVANTAGES

- Increased wear resistance .
- Condensability like silver amalgam restoration.
- Greater ease in achieving a good contact point.
- Produce better reproduction of occlusal anatomy.
- Deeper depth of cure.
- High flexural modulus.
- Decreased polymerization shrinkage.
- Reduced stickiness .

## DISADVANTAGES

- Difficulties in adaptation between one composite layer and another.
- Difficult handling
- Poor aesthetics in anterior teeth.

# PACKABLE COMPOSITE

- Uctasli MB et al (2004) evaluated the wear characteristics of flowables (Admira Flow, Filtek Flow, Tetric Flow) and packables (Admira, Filtek P60, Tetric HB) and found that
- Packables resulted in significantly lower wear than flowables.
- Before finishing - flowable composite materials showed a smoother surface.
- After finishing - similar surface textures were observed for packable & flowable composites .

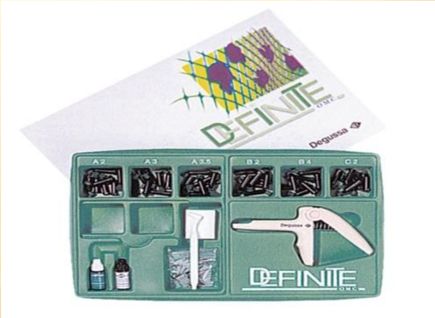
Uctalsi MB, Bala O, Gullu A. Surface roughness of flowable and packable composite resin materials after finishing with abrasive discs. *J Oral Rehab* 2004; (31):1197-1202

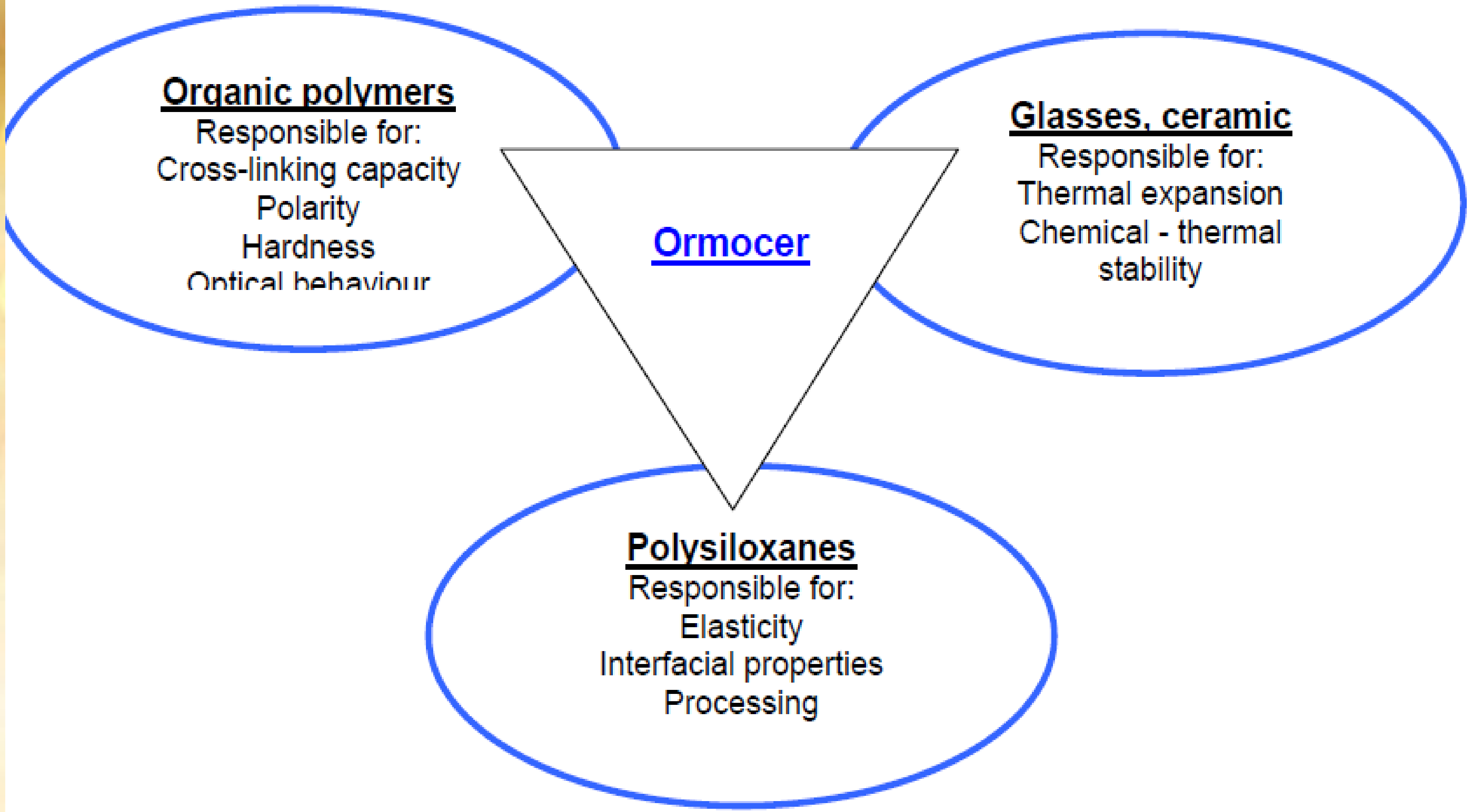
# ORMOCERS (ORGANICALLY MODIFIED CERAMICS)

- Introduced in 1998 (Fraunhofer Silicate Research Institute at Wurzburg, Germany ).
- ORMOCER is an organically modified non metallic inorganic composite material.
- It is three dimensionally cross-linked copolymer.

Composition

- Matrix : Ormocer, UDMA, Bis-GMA, TEGDMA
- Filler :Silica (0.7µm) (56 vol%)


Organic polymers
Responsible for:
Cross-linking capacity
Polarity
Hardness
Optical behaviour
Ormocer
Glasses, ceramic
Responsible for:
Thermal expansion
Chemical - thermal
stability
Polysiloxanes
Responsible for:
Elasticity
Interfacial properties
Processing

# ORMOCERS (ORGANICALLY MODIFIED CERAMICS)

## Advantages

- outstanding biocompatibility
- minimal shrinkage
- resistance to masticatory loading
- esthetics resembling natural teeth.
- Biocompatible
- CTE = natural tooth structure

## Indications

- Class I to V restorations
- Base in class I and II cavities
- Reconstruction of traumatically damaged anteriors
- Facetting of discoloured anteriors
- Correction of shape and shade for improved aesthetic appearance
- Locking, splinting of loose anteriors
- Repairing veneers, small enamel defects
- Extended fissure sealing
- Restoration of deciduous teeth
- Core build-up
- Composite inlays

# SMART COMPOSITES

- Introduced in 1998 under the name Ariston pHc (Vivadent).
- In smart composites the micron size sensor particles are embedded during manufacturing process into composite.
- These sensors interact with resin matrix and generate quantifiable anions.
- It releases fluoride, hydroxyl and calcium ions if the pH falls in the vicinity of the restoration.
- The fall in pH value is attributed to the deposition of plaque in that area.

# SMART COMPOSITES

- Composition :
  - Paste - Barium, Aluminium Fluoride and Silicate glass fillers with Silicon dioxide, Ytterbium trifluoride and Calcium silicate glass in dimethacrylate monomers.
  - Filler content - 80% by weight.
- The fluoride release from smart composites is higher than that of compomers but less than conventional glass ionomers.
- Alkaline glass fillers which inhibit the bacterial growth → prevent secondary caries.

# SMART COMPOSITES

- Stimuli response materials possess properties that may be considerably changed in a controlled fashion by external stimuli.
- Such stimuli may be for example changes of temperature, mechanical stress, pH, moisture, or electric or magnetic fields.
- Stimuli responsive dental composites may be quite useful for example for “release-on-command” of antimicrobial compounds or fluoride to fight microbes or secondary caries, respectively.

# SMART COMPOSITES

## ACP containing composite

- ACP composite materials release calcium and phosphate ions into oral cavity, providing supersaturating concentrations sufficient to trigger the apatite build-up.
- The introduction of reinforcing fillers to the ACP composite formulation has improved their **flexural strength and hardness,** while reducing the polymerization shrinkage and maintaining the **high degree of conversion.**
- Anticariogenic property.

Zrinka Tarle, Danijela Marović, Vlatko Pandurić. Contemporary concepts on composite materials. Rad Medical Sciences 2012;38 : 23-38

# ANTIBACTERIAL COMPOSITES

- Attempts have been made to develop antibacterial composites to prevent **secondary caries.**

**Chlorhexidine**

- shown antibacterial properties
- *Drawbacks*
  - Weakening of the physical properties of composites.
  - Release chemicals which show toxic affects.
  - Temporary antibacterial activity.
  - Shift in microorganisms and plaque to adjacent areas of the tooth.

# ANTIBACTERIAL COMPOSITES

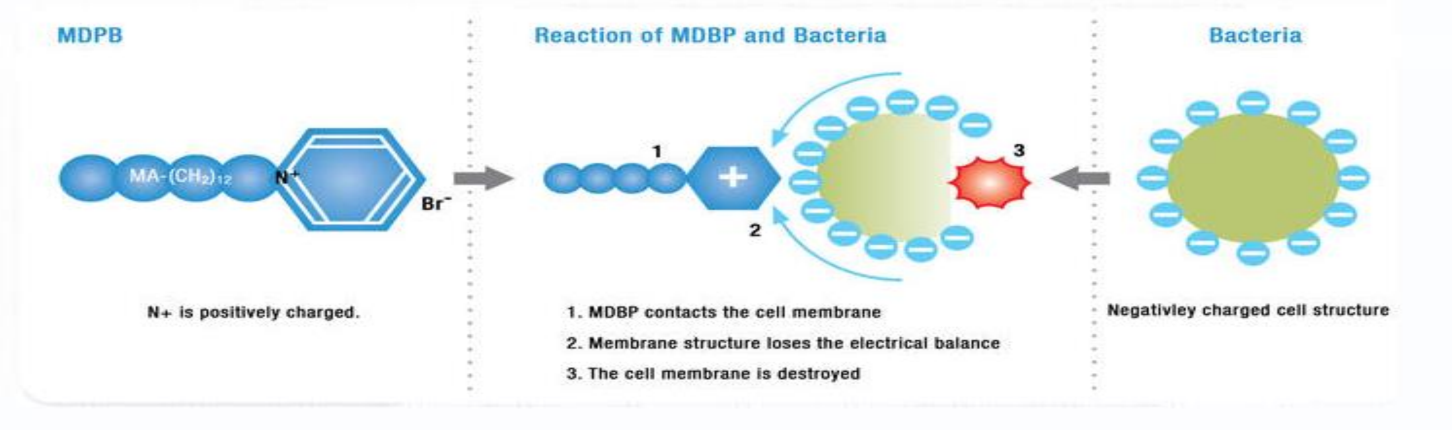

## Methacryloxydecyl Pyridinium Bromide

- By *Imazato et al in 1994*
- Combined antibacterial agent (hydroxydodecyl pyridinium bromide) with methacryl group.
- MDPB was synthesized from quaternary ammonium dicyclic pyridinium compound.
- Effective against bacterial species predominantly isolated from root caries, such as *Actinomyces* and *Candida albicans*.

# ANTIBACTERIAL COMPOSITES

## Mechanism of action:

- The anti bacterial property is due to direct contact with bacteria and not because of release of the anti bacterial compounds.
- These compounds cause structural damage to bacteria.



# ANTIBACTERIAL COMPOSITES

**Alkylated ammonium chloride**

- First tried by *Kim O et al in 2001*.
- The antimicrobial properties are enhanced.
- It was found that alkylated ammonium chloride derivatives with a greater chain length between the ammonium & acryl functional groups reduced some of the mechanical properties.

# ANTIBACTERIAL COMPOSITES

**Silver & titanium particles**

- First introduced by *Jandt KD et al in 2002*. *Yoshida K et al in 1999* added Novaron (N-5) & Amenitop (AM) into dental composites.
- They inhibited the growth of *S.mutans* during & after 6months.
- No or extremely less release of silver ions were noted for the composites.

# ANTIBACTERIAL COMPOSITES

**1% quartenary ammonium polyethylamine (PEI) nanoparticles**

- It was introduced by *Beyth N et al in 2006*.
- Mechanical properties are not much affected as there is no leaching of constituents.
- Its effect lasts for atleast a month.
- Advantages
  - Non volatility
  - Chemical stability
  - Low permeability through the skin - composite acts as a contact disinfectant

# ANTIBACTERIAL COMPOSITES

**Applications of antibacterial composites**

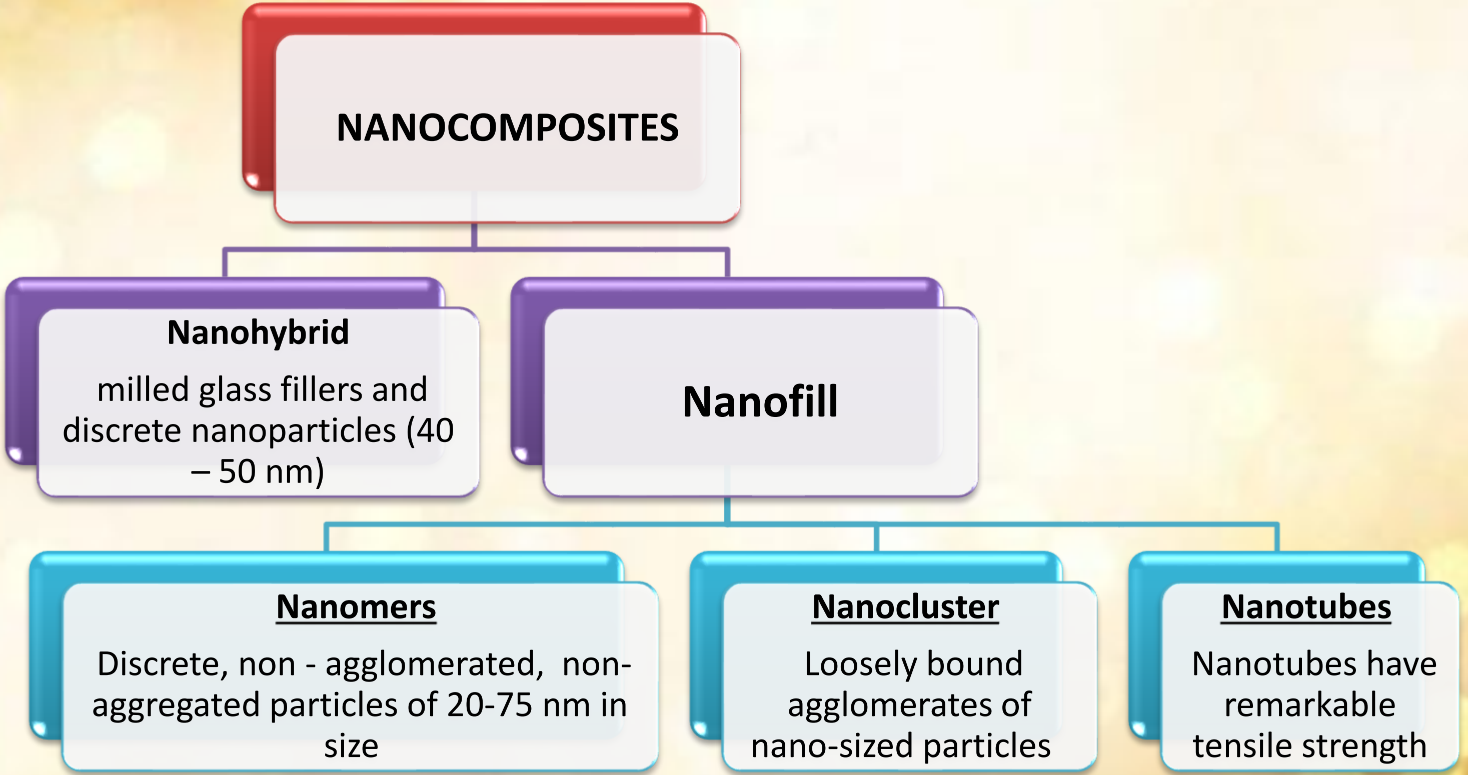
- Liners beneath  restorations or cements used to bond orthodontic brackets.

**Advantages**

- metallic nanoparticles might decrease the development  of recurrent caries.
- Increase the longevity of tooth restorations.
- effective in decreasing the formation  of bacterial biofilms.

# NANOCOMPOSITES

- Introduced into dentistry – early 1990s.



# NANOCOMPOSITES

- 2 types of nanocluster fillers.
  - Type 1 : zirconia-silica particles of 2-20 nm
  - Type 2 : nanocluster fillers, consists of crystals of size ranging from 70-75 nm
    - Silica particles were treated with 3-Methacryl oxypropyl trimethoxysilane (MPTS), as a coupling agent.
- With the use of nanofillers, filler levels could be as much as 90 - 95% by weight.

# NANOCOMPOSITES

**PROPERTIES**

- **Water sorption**: nanohybrid composites show less water sorption than nanofill composites.

- **Flexural strength** : Nanofill composites, which have higher filler loading, show greater flexural strength than nanohybrid composites.

# NANOCOMPOSITES



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- -sized primary particles in the nanoclusters
  nary
  sin.

# NANOCOMPOSITES

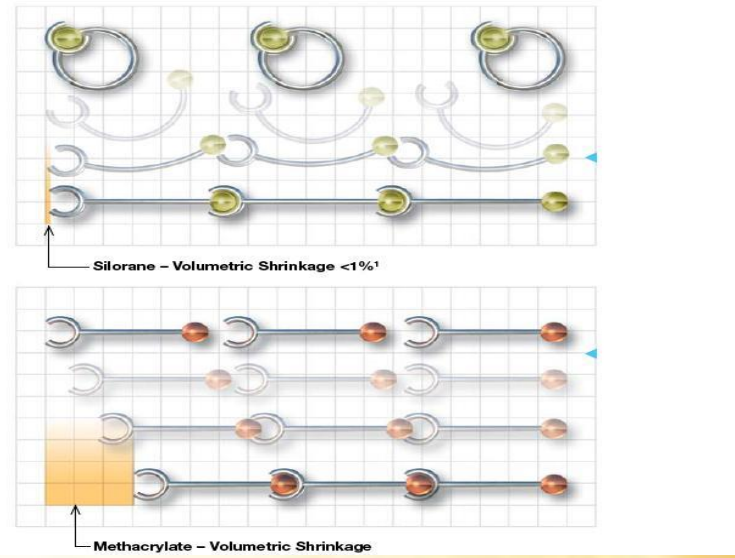
- Mahmoud (2008) evaluated and compared the 2-year clinical performance of an an ormocer-based composite (Admira); a nanohybrid resin composite (Tetric EvoCeram); a nanofill resin composite (Filtek Supreme) with that of a microhybrid resin composite (Tetric Ceram) in restorations of small occlusal cavities made in posterior teeth.
- After 2 years, the ormocer, nanohybrid, and nanofill composites showed acceptable clinical performance similar to that of the microhybrid resin composite.

Mahmoud SH, El-Embaby A, AbdAllah A, Hamama H. Two-year Clinical Evaluation of Ormocer, Nanohybrid and Nanofill Composite Restorative Systems in Posterior Teeth. *J Adhes Dent* 2008;10(4):315-322.

# LOW SHRINKAGE SILORANE BASED COMPOSITES

- Introduced in - 2007
- One of the most interesting approaches for the reduction of PS and PSS is silorane technology, currently commercially available as the composite material, the so-called "low-shrinkage" material.
- The novel matrix system is fundamentally different from methacrylate systems.
- Where methacrylate photopolymerization involves the conversion of C=C double bonds to single bonds, the silorane polymerization is based on the cationic ring-opening reaction.

# LOW SHRINKAGE SILORANE BASED COMPOSITES




- Combination of siloxane+ oxirane
- Hydrophobic in nature
- **INITIATING SYSTEM**
  - Camphroquinone
  - An iodonium salt
  - An electron donor-Filler-quartz—0.5 µm
  - Silane layer– prevent attack of acidic si-oH gr of quartz →prevents undesired initiation of cationic polymerization.

# LOW SHRINKAGE SILORANE BASED COMPOSITES


own man

n shrink


- Although the majority of the studies has shown that siloranes have lower PS and PSS than methacrylate-based resins, there are studies which reported the contrary.
- A significantly … tion reaction.

# LOW SHRINKAGE SILORANE BASED COMPOSITES

- Agrawal A (2015) stated that greater depth of cure was achieved in **silorane**-based posterior composite than in methacrylate-based posterior composite resins with a statistically significant difference.
- Shafeie (2015) stated that methacrylate- and **silorane**-based composites and nano-ionomer revealed a similar and good performance in terms of dentin marginal sealing, but not at the enamel margin.
- The additional selective enamel etching might improve enamel sealing for the three materials.

Shafiei F, Abouheydari M.Microleakage of Class V Methacrylate and Silorane-based Composites and Nano-ionomer Restorations in Fluorosed Teeth. *J Dent* 2015;16(2):100-105.

Agrawal A, Manwar N, Hegde S, Chandak M, Ikhar A, Patel A. Comparative evaluation of surface hardness and depth of cure of silorane and methacrylate-based posterior composite resins: An in vitro study. *J Conserv Dent* 2015;18(2):136-139

# BULK FILL COMPOSITES

- Introduced in 2009
- Indicated for use as a bulk-fill base (dentin replacement) beneath posterior composite restorations and can be bulk filled in layers up to 4 mm in depth.
- Because of their transparent nature and decreased percentage of filler particles, bulk fill flowables require a conventional composite material to be placed as the "enamel capping layer".
- Low viscosity – 62-65% filler content
- High viscosity – 72-85% filler content

# BULK FILL COMPOSITES


➢ Bulk fill composite materials must possess some important characteristics

**First**
- they must have low polymerization shrinkage stress to decrease micro leakage and counter  polymerization shrinkage, reducing stress by exhibiting some elasticity.

**Second**
- bulk fill composites should demonstrate an improved depth of cure, at least 4 mm, which is accomplished by being translucent and highly conducive to light transmission.

**Third**
- they should be more flowable to allow for easy cavity adaptation, including in cervical margins and existing boxes, and should be easy to dispense with minimal handling.“

**Fourth**
- they need excellent physical characteristics, such as great compressive strength and good wear.

# BULK FILL COMPOSITES

## HIGH VISCOSITY (PASTE/SCULPTABLE COMPOSITES)

- Tetric Evo Ceram Bulk Fill (Ivoclar Vivadent)
- X-tra Fil (VOCO)
- Sonic Fill (Kerr)

## LOW VISCOSITY ( BULK FILL FLOWABLES)

- Venus Bulk Fill (Heraeus – Kulzer)
- Surefil SDR Flow (Dentsply)
- X-tra Base (VOCO)
- Filtek Supreme XTE (3M ESPE)
- HyperFil DC™, Parkell, Inc.






**Table 1 Overview of the currently available bulk-fill composites**

| | Name<br>Manufacturer | Maximum layer thickness[1] | Capping layer | Available shades | Composition[2] | wt%/vol% |
|---|---|---|---|---|---|---|
| Flowable 'BASE' bulk-fill composites | Filtek Bulk Fill Flowable<br>3M ESPE; Seefeld, Germany | 4 mm | 2 mm required | Universal<br>A1<br>A2<br>A3 | Bis-GMA, UDMA, bis-EMA, Procrylat resin, ytterbium trifluoride, zirconia filler, silica | 65/43 |
| | Surefil SDR Flow<br>Dentsply; Konstanz, Germany | 4 mm | Required | Universal<br>A1<br>A2<br>A3 | Modified UDMA, ethoxylated bisphenol A dimethacrylate (EBPADMA), TEG-DMA, Ba-Al-F-B silicate glass, Sr-Al-F silicate glass, camphorquinone, photo-accelerator, BHT, UV stabilizer, titanium dioxide, iron oxide pigments, fluorescent agent | 68/45 |
| | Venus Bulk Fill<br>Heraeus Kulzer; Wehrheim, Germany | 4 mm | Required | Universal | Multifunctional methacrylate monomers (UDMA, EBPADMA), Ba-Al-F silicate glass, $YbF_3$, $SiO_2$ | 65/38 |
| | X-tra base<br>Voco; Cuxhaven, Germany | 4 mm | Required | Universal<br>A2 | Inorganic filler in a methacrylate matrix aliphatic dimethacrylate, bis-EMA | 75/61 |
| Paste-like 'FULL-BODY' bulk-fill composites | Filtek Bulk Fill Posterior[2]<br>3M ESPE | 5 mm | No | A1<br>A2<br>A3<br>B1<br>C2 | AUDMA, UDMA, 1,12-dodecane-DMA non-agglomerated/non-aggregated 20-nm silica filler, non-agglomerated/non-aggregated 4- to 11-nm zirconia filler, aggregated zirconia/silica cluster filler (comprised of 20-nm silica and 4- to 11-nm zirconia particles), ytterbium trifluoride filler consisting of agglomerate 100-nm particles | 77/59 |
| | QuiXfil, Quixx Posterior<br>Dentsply | 4 mm | No | Universal | UDMA, TEG-DMA, dimethacrylate and trimethacrylate resins, carboxylic acid, modified dimethacrylate resin, butylated hydroxy toluene (BHT), UV stabilizer, camphorquinone, ethyl-4-dimethylaminobenzoate, silanated strontium aluminum sodium fluoride phosphate silicate glass | 77/58 |
| | SonicFill<br>Kerr; Orange, CA, USA | 5 mm | No | A1<br>A2<br>A3<br>B1 | Bis-GMA, TEG-DMA, bis-EMA, barium glass, silicon dioxide | 86/66 |
| | SonicFill 2[3]<br>Kerr | 5 mm | No | A1<br>A2<br>A3<br>B1 | Bis-GMA, TEG-DMA, bis-EMA, zirconium oxide | - |
| | Tetric EvoCeram Bulk Fill, Tetric N-Ceram Bulk Fill<br>Ivoclar Vivadent; Schaan, Liechtenstein | 4 mm | No | IVA<br>IVB<br>IVW | Dimethacrylates (bis-GMA, bis-EMA, UDMA), barium glass, ytterbium trifluoride, mixed oxide and prepolymer, additives, catalysts, stabilizers, pigments | 81/61 |
| | X-tra fil<br>Voco | 4 mm | No | Universal | Inorganic filler in a methacrylate matrix (bis-GMA, UDMA, TEG-DMA) | 86/70 |

**Van Ende A, De Munck J, Lise DP, Van Meerbeek B.Bulk-Fill Composites: A Review of the Current Literature. *J Adhes Dent* 2017;19(2):95-109.**

# BULK FILL COMPOSITES

- Garcia D et al (2014) found that the polymerization shrinkage and depth of cure (>5mm) of two bulk fill flowable composites, SureFil SDR flow (SSF) (Dentsply) and Venus Bulk Fill (VBF) (Heraeus Kulzer) was significantly greater compared to a standard flowable, Filtek Supreme Ultra Flowable (FSUF) (3M/ESPE) (control), and a regular bulk composite that can be made flowable, SonicFill (SF) .
- The higher depth of cure of bulk fill flowables may be due to incorporation of more efficient initiator systems and higher translucency of composites.

Garcia D, Yaman P, Dennison J, Neiva G. Polymerization shrinkage and depth of cure of bulk fill flowable composite resins. *Oper Dent* 2014;39(4):441-8.

# BULK FILL COMPOSITES

- Le prince (2014) said that
- The mechanical properties such as elastic modulus, flexural strength, degree of conversion, microhardness of the **bulk-fill composites** were mostly lower compared with the conventional high viscosity material, and at best, comparable to the conventional flowable **composite**.
- Linear correlations of the mechanical properties investigated were poor with degree of conversion (0.09 < R < 0.41) and good with filler content.

Leprince JG, Palin WM, Vanacker J, Sabbagh J, Devaux J, Leloup G. Physico-mechanical characteristics of commercially available bulk-fill composites. *J Dent* 2014; 42(8):993-1000.

# SONIC ACTIVATED, BULK FILL COMPOSITE

- SonicFill (KERR)
- Contains rheological modifier that reacts to sonic energy from the handpiece and causes the viscosity to drop almost 90% during extrusion.
- Rapidly flow into the cavity, providing effortless placement and superior adaptation.
- Restoration placed precisely and efficiently without bubbles or voids.
- When the sonic energy is removed, the composite quickly returns to a non-slumping, sculptable state that is easy to handle and carve without being sticky.

# SONIC ACTIVATED, BULK FILL COMPOSITE

**Advantages**

# SELF ETCH COMPOSITES

- This variety of composites contain etchant, bonding agent & the restorative composite material in the same bottle.

Products-

- Vertise Flow *(Kerr Dental)*


- Fusio Liquid Dentin *(Pentron Clinical technologies)*

# SELF ETCH COMPOSITES

**Fusio Liquid Dentin (Pentron)**was introduced in may 2009.

- 4-META self adhesive flowable composite.
- Uses-
  - Small Class I, III, and V restorations
  - As a base liner for larger restorations
  - As a pit-and-fissure sealant
- It is available in vita shades A1, A2, A3, and B1.
- Filler load : 65% wt (1.2μ size)
- Shrinkage : 2.94%

# SELF ETCH COMPOSITES

**Vertise Flow** was introduced in January 2010

- Uses-
  - Small Class I and Class II restorations
  - Liner for large Class I and Class II restorations
  - Pit-and-fissure sealant, and for porcelain repair
- Available in XL, A1, A2, A3, A3.5, B1, B2, universal opaque, and translucent shades.
- Incorporates Optibond technology ( self etch adhesive -7$^{th}$ gen)
- High bond strength & high mechanical strength

# INDIRECT COMPOSITE SYSTEM

- They were introduced in an effort to address the disadvantages, including technique sensitivity, anatomic form, polymerization shrinkage, wear & interproximal contacts, of the direct adhesive restorations.
- In spite of the proven success & improved materials, indirect composites are not as successful as the direct bonded restorations due to extra chair side time & the added cost.

# INDIRECT COMPOSITE SYSTEM



Advantages

- Control of polymerization shrinkage
- Enhanced physical properties - *viscoelastic stability, decreased internal flow and increased creep resistance to occlusal stresses at oral temperatures.*
- Contacts and contours are better created
- Better control over marginal adaptation.

Disadvantages

- Increased cost
- Technique sensitivity
- Difficulty in Resin-to-resin bonding: *Laboratory processed resins are highly cross-linked, therefore very few double bonds remain available for chemical adhesion of the composite cement*
- Moisture control cannot be maintained.

# INDIRECT COMPOSITE SYSTEM

**I GENERATION**

- They were introduced in early 1980's.
- ***SR Isosit inlay system-***
  - They were first reported in 1983 & was made commercially available in 1986. It is homogenously filled containing 55% by weight of radiolucent colloidal silica plus 20% radiopaque lanthanium fluoride.
- ***Coltene Brilliant***
  - This inco osite containing 78.5% by

# INDIRECT COMPOSITE SYSTEM

- *Visio-Gem (ESPE)*
  - Initially they were introduced as anterior composites but later expanded to be used as indirect inlays.
- *Concept (Ivoclar)*
  - It is a highly filled microfill composite, which is heat & pressure polymerized. It has superior esthetics & excellent resistance to wear.
- These first generation materials have low flexural strength, low modulus of elasticity & low resistance to wear & abrasion.
- It was due to low filler load & high matrix load.

# INDIRECT COMPOSITE SYSTEM

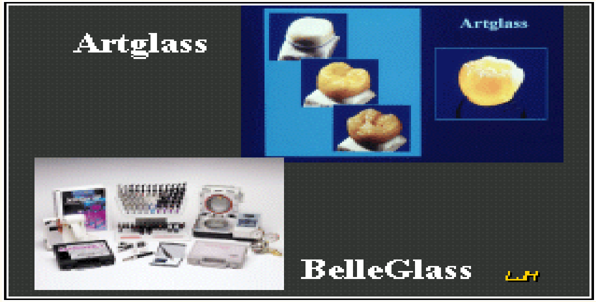
## II GENERATION

- They were introduced in mid 1990's.
- These materials incorporated ceramic fillers with mean particle sizes of less than 1µ diameter, silanised & with a narrow distribution.
- The filler is commonly barium silica.
- They have a high filler load (70-80% by weight & 50-60% by volume) & they have a lower resin content.(about 33% by volume).

# INDIRECT COMPOSITE SYSTEM

These new materials included

- Artglass (Heraeus-Kulzer),
- BelleGlass HP (Kerr),
- Targis (Ivoclar),
- Colombus (Cendres et Métaux)
- Sinfony (ESPE)
- Sculpture/FibreKor
- Gradia
- Herculite XR & XRV (Kerr)





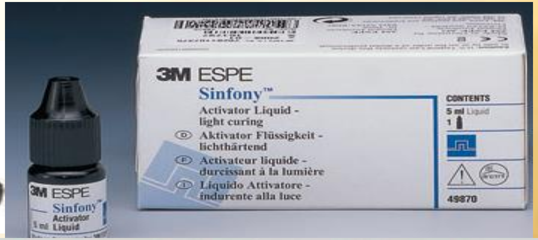




Table 1a: Details of lab processed indirect fiber composites

| Name | Composition | Types / architecture | Processing method |
|---|---|---|---|
| Vectris Launched in 1996 by Ivoclar | Matrix- BisGMA and TEGDMA(24- 39 Wt %) decandioldimethacrylate UDMA - 0.3&0.1wt%. preimpregnated E &R glass - 60Wt% for pontic and around 45-50% for the other materials. | Frame, Single, and Pontic. Single and Frame are glass-fibre woven E fibers.(Mesh) VectrisPontic – unidirectional R glass-fibres (Unidirectional) | Initial polymerization -1 min with light curing unit final polymerization -light and heat curing unit (Targis power) for 25 minutes. |
| FiberKor (Jeneric/Pentron) | S-glass fibers(60%) in 100% bis-GMA matrix | FibreKor 2K strips contain 2,000 individual fibers, FibreKor4K strips contain 4,000 fibres and FibreKor 16K strips contain 16,000 fibres. (Unidirectional) | Initial polymerization -light cuirng unit (alpha lightI)for 1minute followed by light-heat curing for 15 minute in(alpha lightII) 45 |
| EverStick net (Stick tech Ltd) | E-glass fibers impregnated with PMMA. | Mesh type glass fibers | The wetting of fibers is done with stick resin and polymerization as for fiberKor. |

Nandini S. Indirect resin composites. *J Cons Dent* 2010;13(4):184-94.

Table 1b: Details of directly processed fiber composites

| Name | Composition | Fiber arcitecture | Processing method |
|---|---|---|---|
| Ribbond (Ribbond) | Polyethylene | Lenoweave (cross link stitch weave) | Chair side impregnation required |
| Connect (Kerr) | Gas plasma treated woven polyethylene fibers. | Braid | Preimpregnated |
| Splint It (jeneric/pentron) | Glass<br>Glass<br>polyethylene | Unidirectional<br>Weave<br>Weave | Preimpregnated |
| Everstick (Stick Tech Ltd) | Glass | Unidirectional | Preimpregnated |
| Fiberflex Biocomp | Kevlar | Unidirectional | Chair side impregnation required |
| Glaspan (glaspan) | Glass | Braid | Chair side impregnation required |
| DVA fibers (dental/Ventures) | Polyethylene | Unidirectional | Chair side impregnation required |
| Fiber-splint (polydentiainc) | Glass | Weave | Chair side impregnation required |

Nandini S. Indirect resin composites. *J Cons Dent* 2010;13(4):184-94.

Table 2: Details of second generation IRC

| Brand name | Composition | Polymerization | Key points |
|---|---|---|---|
| Artglass Launched in 1995 By Heraeusl-Kulzer | Filler- 70wt% filler of bariumsilicate glass of 0.7μ. Matrix- 30wt% organic resin. Additional to conventional bifunctional molecules, Artglass contains four to six functional groups which provides the opportunity for more double-bond conversions | Photo-cured in a special unit using a xenon stroboscopic light (UniXS, Heraeus/ Kulzer). The system emits 4.5 watts as usable luminous power, while the emission range is between 320 and 500 nanometers. The high intensity is emitted for only 20 milliseconds, followed by 80 milliseconds of darkness. This type of light exposure increases polymerization potential. The short excitation time followed by a longer period of nonexposure allows the already cured resin molecules to partially relax, and more of the nonreactive double-bond carbon groups are made available for reaction . | Can be used to fabricate inlay, onlays and crowns with/without metal substrate (ranges from nickel-chromium to gold-based metals). Bonding to the metal substrate is achieved by applying an acrylonitrile copolymer (Kevloc), a flexible copolymer, to the metal surface before placing and curing the restorative material |


Nandini S. Indirect resin composites. *J Cons Dent* 2010;13(4):184-94.

| Brand name | Composition | Polymerization | Key points |
|---|---|---|---|
| Belleglass HP introduced by Belle de St. Claire in 1996 | Filler-Silanatedmicrohybrid fillers of 0.6 μ. Base and surface composites are available which are used on dentin and enamel respectively. Five different shades of enamel composites are available. The base composite has barium glass fillers (78.7% wt and 65% volume) Surface material has borosilicate fillers which provide enhanced optical characteristics are used (74%wt and 63% volume). Resin matrix of dentin -bis-GMA, whereas, for enamel - a combination of a hydrocarbon saturated methacrylate diurethane of TEGDMA & aliphatic dimethacrylate. | Uses two different curing units. This gives the advantage of incremental buildup and resembles the natural tooth with the hard, translucent, enamel covering the more opaque and softer dentin, able to absorb the stresses. The base composite is light cured, with a conventional light cuirng unit which stabilizes the restoration during build up and reserves unreactive surfaces for bonding. The surface composite is heat cured. The polymerization is carried by heating in an oven at 140°C at 80 psi for 20 minutes. The atmosphere is maintained oxygen free and under nitrogen gas pressure . | The reduction in size of the filler improves the polishability and smoothness of the material. Newer composite like "Foundation" has been modified to have a filler diameter of 30 μ in the base composite, which will allow for further reduction in polymerization shrinkage9. |

Nandini S. Indirect resin composites. *J Cons Dent* 2010;13(4):184-94.

| Brand name | Composition | Polymerization | Key points |
| --- | --- | --- | --- |
| Sinfony Introduced by 3M ESPE | Fillers - ultra-fine glass or glass-ceramic powders Pyrogenic silica is also used as a microfiller. It is a form of amorphous silicon dioxide with a primary particle diameter of < 0.05 μm, produced in an oxy-hydrogen gas flame. Matrix-polyfunctional methacrylate monomers. | The proprietary system consists of two polymerising units (Visio alpha, Visio beta).the Visio alpha is equipped with a halogen lamp whereas the Visio beta is equipped with four fluorescent tubes. The polymerization wavelength ranges from 400-550nm. The polymerization mode for alpha source is 15 seconds whereas that of beta source is 40°C for 15minutes[47,48] The other non proprietary unit used is Hyper LII which is a high – intensity polymerization unit equipped with two metal halide lamps. The wavelength is in the range of 250-600nm and with an intensity of 150W for 60 seconds[48]. Polymerization of this material with two different light sources improves the property[7] | Used for full veneering of fixed and removable prostheses on metal frameworks, for inlays / onlays, individual crowns, glass fibre reinforced bridges and for the customization of prefabricated teeth. Pyrogenic silica has large surface area (up to 350 m2/g) and have therefore a thickening effect. They are used to control the rheological properties of the composite. The microfiller particles can insert themselves into the gaps between the macrofillers. |

Nandini S. Indirect resin composites. *J Cons Dent* 2010;13(4):184-94.

| Brand name | Composition | Polymerization | Key points |
|---|---|---|---|
| Targis Launched in 1996 by Ivoclar Vivadent | [ceromer] filler- 77wt% , trimodal and has barium glass of particle size of 1µ. Spheroid silica filler -0.25 µ and colloidal silica – 0.015-0.05 µ. Matrix- conventional monomers. | Targis is coated with glycerin gel (Targis Gel) to prevent formation of oxygen-inhibited surface layer and placed in the curing unit Targis Power (IvoclarVivadent) for the following cycle: light emission in the first 10 min along with increase of temperature to 95°C for 25mins, and cooling for 5 min. | Targis is a veneering composite material. The material can be without framework material, to fabricate adhesive inlays/onlays/ veneers and anterior crowns. In addition, Targis is suitable for veneering metal frameworks. |


Nandini S. Indirect resin composites. *J Cons Dent* 2010;13(4):184-94.

| Brand name | Composition | Polymerization | Key points |
|---|---|---|---|
| SR Adoro (Ivoclar Vivadent) | The dentin and enamel materials constitute the main components. components of this system include SR Link (to bond to metal frame work), a liner, dentin material, stains, incisal material and Opaquer. SR Link comprises a monomer that contains a highly hydrophobic aliphatic hydrocarbon chain and a phosphoric ester with a methacrylate function. Matrix-of dentin and incisal material consists of UDMA instead of Bis GMA and TEGDMA and the copolymer filler load is about 63% by weight. A copolymer is produced by grinding a microfilled composite into particles of approximately 10-30 μm and later incorporated into inorganic microfillers. Upon polymerization, the copolymers become completely integrated into the composite and a homogeneous composite with a high loading of inorganic microfillers is obtained. The liner has 49% by weight barium glass filler particles. |  | Targis system has continuously been revised and the, application could now be defined for SR Adoro The phosphoric acid group of the molecule is a strong acid, which reacts with the metal or the metal oxide, forming a phosphate. The phosphates form a passivating layer on the metal surface. After the metal oxide reaction has been completed, the layer becomes very inert. The methacrylate group of the phosphoric acid reacts with the monomer components of SR Link, forming a copolymer and thereby providing a bond to the veneering resin. |

Nandini S. Indirect resin composites. *J Cons Dent* 2010;13(4):184-94.

| Brand name | Composition | Polymerization | Key points |
|---|---|---|---|
| Solidex Introduced by Shofu | Light cured indirect ceramic polymer system. Filler -53 vol% of 1μ silicon dioxide and aluminium oxide inorganic fillers and ceramic microfilaments, Matrix-25 wt % co-polymers of multi-functional resins and 22% conventional resins/ light-initiators. It is available as metal primers, cervical, incisal, body, opaque and translucent shades. | The additional light polymerization is done with Solidilite system which is equipped with 4 halogen lamps for fast curing for a curing time of 1~5 minutes at a wavelength of 420-480 nm and temperature of 55 °C. Sublitecuring system is designed for initial or short polymerization during build-up without removing the restoration from the model. | |


Nandini S. Indirect resin composites. *J Cons Dent* 2010;13(4):184-94.

| Brand name | Composition | Polymerization | Key points |
|---|---|---|---|
| Paradigm MZ100 (3M ESPE) | 85 wt% ultrafine zirconia-silica ceramic particles that reinforce a highly crosslinked polymeric matrix. The polymer matrix consists of bisGMA and TEGDMA and a ternary initiator system. The particles have a spherical shape, and an average particle size of 0.6 micrometer. This contrasts sharply with milled glass fillers in conventional hybrid composites. | Made from Z100 restorative material under optimized process conditions that assure thorough cure and a high degree of crosslinking. Paradigm MZ100 blocks are made in two cylindrical sizes, 10 and 14; these correspond to the CEREC sizes. | Alternative to porcelain blocks for CEREC restorations. The ultrafine zirconia-silica filler particles are synthesized by a patented sol-gel process that results in a unique structure of nanocrystalline zirconia dispersed in amorphous silica. |
| Vita ZetaLC (Vita Zahnfabrik) | Matrix -Bis GMA, UDMA, TEGDMA Fillers. –multiphase feldspar frits and silicon dioxide (44.3 wt%) | Additional light curing can be done with Dentacolor XS curing unit at circa 40°C at wavelength of 350-500nm | Used for the full and partial veneering of crowns, and as long-term temporary metal-free restorations. nano-sized fi llers that ensure high translucency due to natural refraction. |
| Pearleste E2 (Tokuyama Dental Corp) | Bis-MPEPP, TEGDMA, UDMA, Filler-SilicaZirconia(0.04μ), Silica –titania (0.08μ) | Pearlcure light –high pressure mercury lamp 150W*1, 350-550nm for 120S. Pearlcure heat- heat oven 15 min under atmospheric pressure. | |
| Estenia C&B (Kuraray) | Matrix– UDMA, Filler –alumina ultrafine filler, glass filler (92wt%) | Secondary Light cure – Alpha II for 5 min Secondary heat cure – KL 100at 110°C for 15 minutes[35]. | |
| Gradia (GC Corp) | Matrix- UDMA, Filler – silica powder, silicate glass powder, prepolymerised filler (75wt%)[36] | Secondary Light cure – Alpha II for 5 min | |

Nandini S. Indirect resin composites. *J Cons Dent* 2010;13(4):184-94.

# CONCLUSION

- Now a days, composites have unquestionably acquired a prominent place among filling materials employed in direct posterior restorative techniques.
- To overcome the shortcomings of traditional composites, various techniques and advances have been tried and developed.
- Yet every new change has its own drawbacks and composites are not yet able to guarantee excellent results.
- Thus, the knowledge of various advancements is necessary to be able to decide which material is ideal for a particular clinical situation.

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Thank you