Composite Restorations

Esthetic dentistry has shown much advancement in materials and technology since the last century. Materials which have been used for esthetic restorations are silicate cement, glass ionomer, acrylic resins, composites and fused porcelain. R Bowen, in 1962 developed a polymeric dental restorative material reinforced with silica particles used as fillers. These materials were called 'composites'. Nowadays, composite resins are considered as an economical and esthetic alternative to other direct and indirect restorative materials.

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

Composites are basically modified methacrylates or acrylates with other ingredients to produce different structures and properties. Since methacrylate shrinks on polymerization, to counter the effect of shrinkage, the inorganic inert filler particles of similar refractive index are added.

Composition of Dental composites:

1. Organic matrix or organic phase: It represents the backbone of composite resin system.

2. Filler or dispersed phase: Commonly used fillers are silicon dioxide and boron silicates, they used to:

a. Reduce the coefficient of thermal expansion.
b. Reduce polymerization shrinkage.
c. Increase abrasion resistance.
d. Decrease water sorption.
e. Increase tensile and compressive strengths.
f. Increase fracture toughness.

3. An organosilane or coupling agent: Bonding of filler and resin matrix.

4. Activator-initiator system: Activate the polymerization of composites.

5. Inhibitors: Inhibit the free radical generated by spontaneous polymerization of the monomers.

6. Coloring agents: Used to produce different shades of composites.

7. Ultraviolet absorbers: Added to prevent discoloration. They act like a "sunscreen" to composites.

Advantages:

1. Conservation of tooth structure.
2. Esthetically acceptable, and it can be repaired rather than replaced.
3. Mechanical bonding to tooth structure.
4. Low thermal conductivity.
5. Immediate finishing and polishing.
6. No galvanism.
7. Low microleakage.

Disadvantages:

1. Polymerization shrinkage.
2. Time consuming.
3. Expensive.
4. Technique sensitive.
5. Low wear resistance.

INDICATIONS:

1. Class I, II, III, VI, V, and VI tooth cavity preparations.
2. Esthetic Improvement Procedures: For Example: Laminates, Partial and full veneers, diastema closure, and treatment of tooth discolorations.
3. Erosion or abrasion defects.
4. Hypoplastic or other defects.
5. Core build up.
6. Luting cement.
7. To repair the fractured ceramic crowns.

CONTRAINDICATIONS:

1. Difficult moisture control.
2. Heavy occlusal stresses.
3. Class V lesions.
4. High caries susceptibility and poor oral hygiene.
5. Subgingival or root caries.

Types:

1. Macrofilled Composite Resin/Conventional/Traditional:

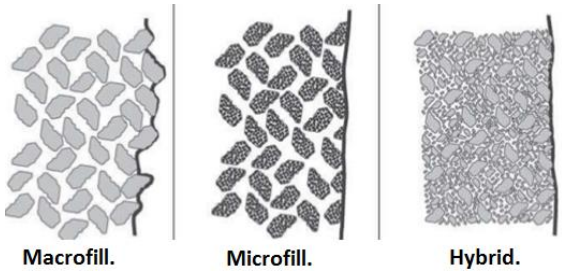
These were developed during early 1970s. Average particle size of macrofill composite resins ranges from 8–12 mm. Filler content is approximately 60–65% by weight. It exhibits a rough surface texture because of the relatively large size and extreme hardness of the filler particles. Due to roughness, discoloration and wearing of occlusal contact areas and plaque accumulation take place quickly than other types of composites.

Advantage:

Physical and mechanical performance is better than unfilled acrylic resins.

Disadvantages:

1. Rough surface finish.
2. Poor polishability.
3. More wear.
4. More prone to staining.



2. Small Particle Composite Resins:

Small particle composites have better surface smoothness than traditional composites. Average particle size of small particle composite resins ranges from 1 to 5 um. The small particle size results in smooth polished surface which is resistant to plaque, debris and stains. Filler content is 80% by weight and 65% by volume. Fillers used are heavy metal glasses like lithium, barium, zirconium and quartz. It is used in stress bearing areas like Class I and II, large Class III and IV preparations.

Advantages:

1. Superior polishing and texturing properties.
2. Good abrasion and wear resistance.
3. Lower coefficient of thermal expansion.
4. Decreased polymerization shrinkage.
5. Less water absorption.
6. Increased modulus of elasticity and compressive strength.
7. 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.

3. Microfilled Composites Resins:

Microfilled composites were introduced in the early 1980s. Average particle size ranges from 0.04 to 0.4 micrometer. Filler content is 30 to 40% by weight. Small particle size results in smooth polished surface which is resistant to plaque, debris and stains. But because of less filler content, physical properties are inferior. Microfilled composites have low modulus of elasticity and high polishability, excellent translucency however, they exhibit low fracture toughness and increased marginal breakdown. They are indicated for the restoration of anterior teeth and cervical abfraction lesions.

Advantages:

1. Highly polishable.
2. Good esthetic.

Disadvantages:

1 Poor mechanical properties due to more matrix content.
2. Poor color stability.
3. Low wear resistance.
4. Less modulus of elasticity and tensile strength.
5. More water absorption.
6. High coefficient of thermal expansion.

4. Hybrid Composite Resins:

Hybrid composites are named so because they are made up of polymer groups (organic phase) reinforced by an inorganic phase. Hybrid composites are composed of glasses of different compositions and sizes, with particle size diameter of less than 2 µm and containing 0.04 µm sized fumed silica. Filler content in these composites is 75 to 80% by weight. This mixture of fillers is responsible for their physical properties similar to those of conventional composites with the advantage of smooth surface texture.

Advantages:

1. Availability in various colors.
2. Different degrees of opaqueness and translucency in different tones and fluorescence.
3. Excellent polishing and texturing properties.
4. Good abrasion and wear resistance.
5. Similar coefficient of thermal expansion to tooth structures.
7. Decreased polymerization shrinkage.
8. Less water absorption.

Disadvantages:

1. Not appropriate for heavy stress bearing areas.
2. Not highly polishable as microfilled because of presence of larger filler particles in between smaller ones.
3. Loss of gloss occurs when exposed to tooth-brushing with abrasive toothpaste.

Two new generations of hybrid composite resins are:

a. Nanofill and nanohybrids composites.
b. Microhybrids composites.

RECENT ADVANCES:

1. Flowable composite resin:

Flowable composites were introduced in dentistry in late 1996. Filler content is 60% by weight with particle size ranging from 0.02 to 0.05 µm. Low filler loading is responsible for decreased viscosity of composites, which allows them to be injected into small preparations, this makes them a good choice for pit and fissure restorations. But incorporation of lower filler content results in poor mechanical properties of these composites than conventional composites.

2. Condensable (packable) composites:

Condensable/packable composites have improved mechanical properties and handling characteristics. Main basis of packable composites is Polymer Rigid Inorganic Matrix Material (PRIMM). Here components are resin and ceramic inorganic fillers which are incorporated in silanated network of ceramic fibers.

3. Giomers:

Giomer is hybrid of words "glass ionomers" and "composite". Giomers have properties of both glass ionomers (Fluoride release, fluoride recharge) and resin composite (excellent esthetics, easy polishability, biocompatibility). Giomers are very much similar to compomers and composite materials in that they are light activated and require the use of bonding agent for adhesion to tooth structure.

4. Compomers:

Compomers provide combined advantages of composites (term 'Comp' in their name) and glass ionomer ('Omers' in their name). They are available in single paste, light enable material in syringe or compules. It's fluoride release ability is greater than composite resins but less than glass ionomer systems. Adhesion to tooth structure is by micromechanical means and requires acid etching and use of primer/adhesive.

5. Ormocers:

ORMOCER is an organically modified nonmetallic inorganic composite material. They are more biocompatible than conventional composites and have higher bond strength and high compressive (410 MPa) strength.

6. Antibacterial/ion releasing composites:

Since composites show more tendency for plaque and bacteria accumulation in comparison to enamel, attempts have been made to develop caries resistant antibacterial composites. For this, following have been tried to incorporate in the composites:
Chlorhexidine, Methacryloyloxydecyl Pyridinium Bromide (MDPB), and silver.

7. Expanded matrix resins composites:

Composites show polymerization shrinkage on curing which can result in marginal leakage, postoperative sensitivity and secondary caries. Therefore, slight expansion of the composite during polymerization is desired to reduce these effects. For this, Spiro orthocarbonates (SOCs) are added in composites because they expand on polymerization. Epoxy resins contract 3.4 percent and SOCs expand 3.6 percent. Both are mixed to achieve desired expansion.

8. Smart Composite:

Smart composites work based on the recently introduced alkaline glass fillers which inhibit the bacterial growth and thereby reduce formation of secondary caries. In smart composite, micron size sensor particles are embedded during manufacturing process into composite. These sensors interact with resin matrix and generate quantifiable ions like fluoride, hydroxyl and calcium ions if the pH falls in the vicinity of the restoration. Fall in pH occurs because of plaque deposition in that area.

Reference:

Textbook of operative dentistry. Nisha Garg and Amit Garg. (2015).