

Contemporary aesthetic restorative dental composite materials

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ABSTRACT

Purpose: This is a review paper that gives an insight into the most popular group of aesthetic dental materials - dental composite materials. This article describes the historical background, the main features of this group of materials, the categorization of the materials in relation to clinical applications and the polymerization process.

Design/methodology/approach: This review is based on the contemporary scientific literature most relevant to the topic. The literature search has been made in Elsevier - Science Direct.

Findings: Light-curing dental composites exhibit some resemblance to the construction of the hard tissues of the tooth. They also consist of two basic components. These are: an organic matrix and an inorganic filler. The third component, which is regularly added, is so-called "binding agent". According to the composition of the materials they make a good choice for aesthetic restoration in natural dentition.

Practical implications: In the clinical observations there are many complications resulting from inadequate polymerization of composite materials. This may be the result of poor quality of curing lights of a very low intensity, too long distance between the tip of the lamp and the surface of the material or improper exposure time

Originality/value: Dental composite materials are the only group of dental materials in which these features are combined together, ensuring naturally looking final effect of the restoration. Easy handling of the dental composite materials together with effective polymerization process with portable light units make these materials a good choice for clinical use.

Keywords: Dental materials; Composite material; Polymerization; Restorative dentistry

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MATERIALS

1. Historical background

The problem of tooth caries is still very common. Tooth decay is still the most common disease of the stomatognathic system. This is why a very rapid development of materials used in restorative dentistry is observed [1,2]. The first material used for filling tooth cavities was silicate cement. It was developed in the 19th century. It consisted of two components: a powder containing powdered aluminum-silicon glass particles, and fluid containing phosphoric acid in its composition. The advantage of this material was the possibility to choose the right color and the right translucency of the filling. Silicate cement had, however, a number of shortcomings, which include among others: long curing time and high solubility in the saliva present in oral cavity [1,2].

Another material commonly used in restorative dentistry was dental amalgam, which is an alloy of mercury with other metals, mainly used in dentistry with additions of silver and copper. It had many advantages, such as good mechanical properties and physicochemical properties, high stability and good marginal integrity. In addition to these indisputable advantages of the amalgam it had some disadvantages. The presence of mercury caused the metallic color determining unsatisfactory aesthetics and a high thermal conductivity, resulting in tissue sensitivity to changes in oral temperature [1,3].

2. The advent of composite dental materials

The development of composite materials began in the '40s of the twentieth century in Germany by synthesizing a molecule of PMMA (polymethyl methacrylate). In the '50s, research works began on the creation of composite materials by adding inorganic fillers. In 1955 the phenomenon of increase in adhesion was discovered by using enamel etching with acid, which allowed the initiation of the development of so called "adhesive dentistry". The breakthrough was to replace the resin based on PMMA by synthesized by Bowen and Cobb bis-GMA resin [1-3]. It contained dimethacrylates with long chain polymer, which was mixed with inorganic filler particles. Composite materials, in contrast to amalgam, mimic the natural tooth color. They were, however, worse than an amalgam in mechanical properties. In order to improve the mechanical strength of composite materials changes in the resin composition were introduced [1,2].

In the curing process of composite materials used in direct restorations of dental hard tissues, it was necessary to

initiate the polymerization process. In cold plastic materials – historically older – to correct the polymerization it was necessary to mix the recommended proportions of ingredients known as a base and a catalyst [1,2]. At the end of the '60s the first light-cured composite materials were introduced to the market and today they are the most commonly used materials in restorative dentistry [1,2].

In the '80s hybrid materials were launched to the dental market. They combine the features of materials with macro- and microfillers. Their modifications in the form of microhybrid materials have been recognized as universal composites used in the art of dentistry up to date.

The use of the polymerization light with a specific spectrum allowed to eliminate limits on direct filling modeling and composite materials began to be available in a "ready for direct use" form [1,2]. For this reason, composite materials are currently used primarily in the immediate reconstruction of damaged or lost hard dental tissues. They are used also for fixing elements of orthodontic appliances and cementing permanent prosthetic restorations [4,5]. Due to their aesthetic and stable properties, they are also used in cosmetic restorations of the tooth hard tissues.

Light-curing dental composites exhibit some resemblance to the construction of the hard tissues of the tooth. They also consist of two basic components. These are: an organic matrix and an inorganic filler. The third component, which is regularly added, is so-called "binding agent" [1,2].

The organic matrix constitutes approx. 20-30% of the composite material by volume. The main component contains the polymer matrix monomers. These compounds are multifunctional dimethacrylates corresponding to the cross-linking and improving the mechanical and physical properties of the fillings. In terms of the function and chemical properties there are two groups of monomers: basic (also called oligomers) and comonomers [1,2,6].

The basic monomers include:

- Bis-GMA – methacrylate, bisphenol A (Fig. 1);
- Bis-EMA – ethoxylated bisphenol A dimethacrylate;
- UDMA – dimethacrylate urethane (Fig. 2).

Modern monomers currently used in composite materials, allow to obtain even better characteristics of these materials [1,2,6]. Most of the materials used in dentistry comprise Bis-GMA resin in their composition. They have many benefits, such as high molecular weight, rapid hardening and less shrinkage. Their adhesion to the tooth corresponds to the hydroxyl groups contained in the molecule. Because of the large viscosity of the Bis-GMA resin, it is necessary to use diluting agents in the composition of composite materials.

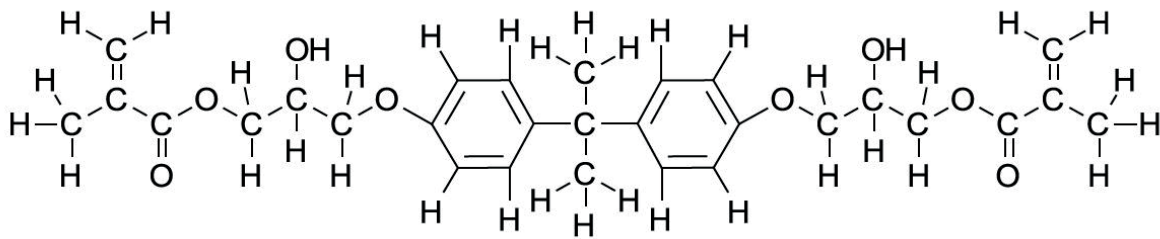


Fig. 1. The molecular structure of Bis-GMA [7]

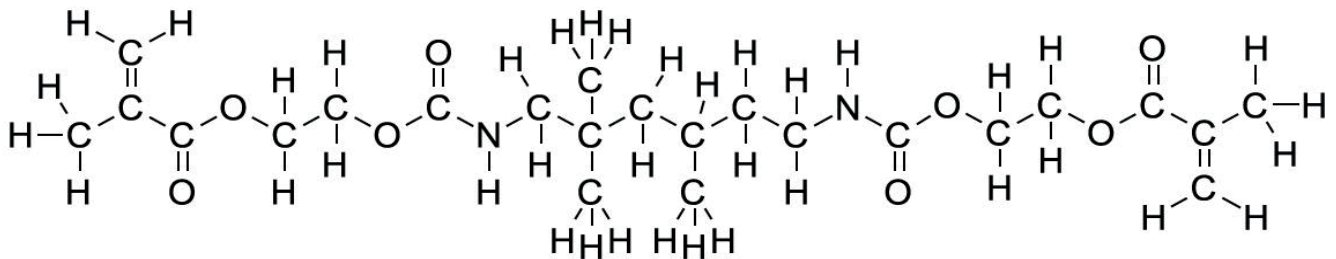


Fig. 2. The molecular structure of UDMA [8]

Some materials contain monomers which are a modification of the Bis-GMA resin. The changes in that part of the Bis-GMA molecule (2,2-bis [4- (2-hydroxy-3-metakrylooksypropoksy) phenyl] propane), are replaced by aliphatic or aromatic urethane dimethacrylates, which allows for improved efficiency of polymerization light, less water-holding capacity and greater rigidity. Suitable monomers for the composite materials are compounds having at least two double bonds. In the incomplete conversion of double bonds during polymerization such monomers may be incorporated into the polymer network with at least one of the two double bonds. It has been shown that the conversion of the double bonds has a direct influence on the final shape of the polymer network, and consequently - also on many properties of dental composites.

Another, more widely used basic monomer is UDMA. This name refers to the number of monomers containing methacrylate groups and urethane linkages. UDMA has a lower viscosity and higher degree of conversion than the Bis-GMA monomer [1,2,4]. By using UDMA (1,6-bis (2-ethoxy metakrylooksy-carbonylamino) -2,4,4-trimethylhexane) it is possible to eliminate the harmful release of free molecules of bisphenol A, which is a decomposition product of Bis-GMA. One of the monomers of UDMA is the reaction product of hydroxyethyl methacrylate, 2-(HEMA) with 2,4,4-trimethylhexa-1,6-

diizotiol. In the manufacturing process of composite materials UDMA may be used alone or in combination with Bis-GMA and TEGDMA comonomer (Fig. 3).

A second group of monomers - comonomers - consists of the compounds of lower molecular weight in comparison to the basic monomers. They are responsible for regulating the viscosity of the resin filler material (act as the basic monomers of the disperse phase). The commonly used monomers include: HEMA (2-hydroxyethyl methacrylate), EGDMA (ethylene dimethacrylate monoglicol) (Fig. 4), DEGDM (diethylene glycol dimethacrylate) and TEGDMA (triglikolu ethylene dimethacrylate) [1,7,9]. The use of comonomers makes the material more resistant mechanically and reduces the thermal expansion and shrinkage. The comonomers also contribute to reducing the water sorption of the polymer. By using a diluent monomer, it is possible to obtain the desired consistence of the material, which allows for the introduction of an appropriate amount of an inorganic filler.

In order to improve the physicochemical properties and mechanical properties of composite materials many modifications of the chemical composition of the individual material components are made.

Composite materials with a polymer matrix based on siloranes (Fig. 5) are considered to be the most promising for the development of dental materials. Siloranes are composed of cyclic siloxane scaffold, imparting

hydrophobic properties and cycloaliphatic oxirane group linked through organic alkene directly to the silicon atoms. This type of chemical structure is responsible for the low value of the polymerization shrinkage. The process of the polymerization of photoreactive siloranes is mainly based on the opening of oxirane rings and follows a cationic mechanism. Silorane based composites contain a ternary photoinitiator system, consisting of camphorquinone, a cationic photoinitiator in the form of an iodonium salt, and electron donor.

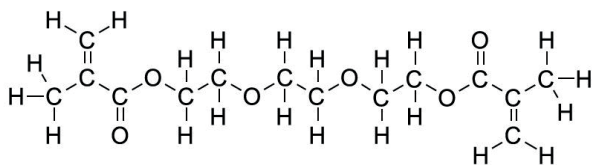


Fig. 3. The molecular structure of TEGDMA [7]

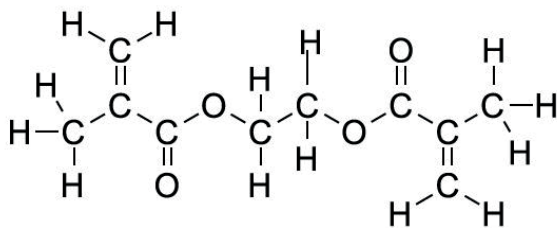


Fig. 4. The molecular structure of EGDMA [9]

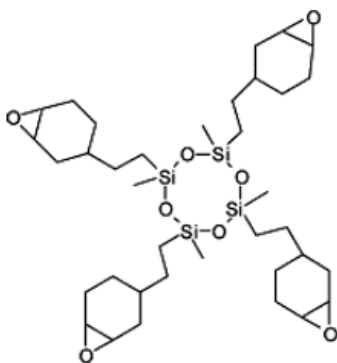


Fig. 5. The molecular structure of a silorane particle [10]

The role of a constant component of composite materials - the ceramic filler - is to ensure high mechanical properties: the compressive strength and the bending resistance, the reduction of polymerization shrinkage, improvement of the appearance and translucency of the filling. In the past, quartz crystal were used as a filler -

currently the glass and colloidal silica are used for this purpose [1,2,10]. The presence of fillers containing elements with high atomic weight (barium, strontium, ytterbium, zirconium, hafnium, tantalum) makes it possible to obtain a good radiographic contrast on the X-rays. It facilitates correct diagnosis of the fillings on the radiograms. The filler content in the composite material also affects a significant effect on its resistance to abrasion.

Better dispersion of the filler particles in the composite material is achieved through a process of silanization. It is the coverage of filler particles with a monolayer of a silicon compound containing double bonds. This compound gives a strong, stable connection making it possible to combine the two phases: organic and inorganic of the composite material [1,11,12]. Effective silanization reduces the degree of degradation of the composite material and protects the surfaces of the fillers against fractures. It also influences the transfer of compression from a flexible matrix phase to the more rigid filler. With improved silanisation process, the resin wets filler particles more effectively. This in turn allows the introduction more filler phase into the composite material. By varying the proportion of fillers in relation to the organic phase, silanization can significantly increase the strength of the composite. Composite materials with the filler subjected to silanisation process are characterized by better mechanical performance, less abrasion and greater resistance to water sorption. The stronger the connection matrix-filler, the better the performance achieved in the composite strength tests [2,11,12].

The composites, in addition to the basic polymer and filler particles, also include other chemical components (stabilizers, photoinitiators, antioxidants and dyes). The function of these compounds is to modify the physical properties of the polymer material in order to obtain the desired properties.

Chemicals used in the materials added to initiate the polymerization reaction are known as photoinitiators. They are sensitive to certain light spectrum, but always it is within the visible light range. Good color of the composite dental materials is achieved by adding suitable colorants - inorganic oxides may be added in small amounts to the polymer composite, whereby it is possible to accurately match the color of the filling to the natural tooth color [1,2,12].

3. Categories of dental composite materials

Taking into account the size of the filler particles, composite materials have been divided into four basic

groups [2,12]: macromolecular, microparticulate, hybrid and the nanoparticle materials.

Macromolecular materials are first composite materials that have a particle size of up to up to 100 μm . They are characterized by the highest hardness, low shrinkage, and low coefficient of thermal expansion. They contain an average of 55% of inorganic macrofiller as powdered quartz (SiO_2), glass (aluminum, sodium, silicon) or irregularly shaped ceramic enriched with a small amount of fumed silicas improving reolitic properties and anti-sedimentation of the filler [1,12]. Micromolecular composite materials comprise only 25% of the filler and have a lower hardness and a higher abrasion. They are mostly useful for fillings in the front teeth, can be well polished and are more resistant to discoloration. Two groups of this material can be distinguished [1,12]:

- a) homogeneous micromolecular materials having a particle size of 0.04-0.1 μm , containing a small amount of particles of the inorganic filler (35-55%) as an amorphous silica; generally they are cured by heat;
- b) inhomogeneous prepolymerized micromolecular composites consisting of complexes of microfillers present in different forms:
 - granular (1-200 μm) – contain the grounded, prepolymerized organic-inorganic grit with irregular shape;
 - ductile iron (20-30 μm) – have a spherical filler (obtained from the suspension polymerization);
 - agglomerates (1-25 μm) – containing complexes (agglomerates) of pyrolytic silica suspended in the homogeneous, uncured material.

Composite hybrid materials have an intermediate structure between traditional and microfiller materials. The share of the inorganic phase in the composite is the highest and is in a weight ratio of 78-90% and a volume - an average of 64%, with 10-15% of amorphous SiO_2 , and the rest containing the macrofiller. They use more noble species of glass (boron, strontium, silicon, zirconium). These materials contain particles of the macrofiller of a size 0.5-8 μm and submicron filler size of 0.14-0.007 μm . Depending on the size of the filler they can be divided into a number of subgroups of the materials derived from this category [1,12]:

- a) macrohybrid filler having a size of up to 10 μm ;
- b) hybrid intermediates, wherein the filler has a size 1-5 μm ;
- c) hybrid low molecular size filler to 3 microns;
- d) microhybrid, the size of the filler is less than 1 μm ;
- e) nanohybrid containing particles with sizes 0.005-0.3 μm .

Hybrid composites are characterized by high mechanical strength, good and permanent aesthetics and high resistance to abrasion. This is due to filling with colloidal silica binder improving microhardness of the

matrix, which prevents chipping of the macrofiller. This in turn leads to a better adhesion and marginal integrity. These parameters of hybrid composites made that they are now the most commonly used materials to fill cavities in all classes according to Black.

Long-term development of dental composite materials allowed for achieving good filling materials that differ significantly with their properties [1,2]. Today, the essential way of curing composite materials is the polymerization process initiated with light. With the increase of the light intensity and exposure time, the degree of conversion of composite materials and their hardness, compressive strength and abrasion resistance increased [13,14].

4. Polymerization

The polymerization is a reaction by which the chemical compound of a low molecular weight, called a monomer or a mixture of several of these compounds react with themselves until all the free functional groups get into the reaction. This reaction generates molecules of a molecular weight many times larger than the substrate to form a polymer. Most of the composite materials are cross-linked by of free radical additive polymerization and belongs to the group of so-called "chain growth" polymers.

The polymerization time and depth of cure of the composite material depends on the intensity and the possibility of penetration of the light into the mass of the material. After about 10 minutes of exposure composites are cured at about 75%, and further crosslinking process takes up to 24 hours. The polymerization reaction does not occur at 100% of the volume of the material. The whole volume of the composite is never cross-linked and even in the cured material there is a certain content of unpolymerized monomers. This phenomenon affects the mechanical strength of the polymerized resin, as well as dimensional stability of the final filling (migration and leaching of unpolymerized monomer) [1,2].

The polymerization is an exothermic reaction, which means that it is accompanied by the release of a certain amount of energy in the form of the heat. In the case of exceeding the tolerance of the pulp associated with an increase in temperature during exposure, the patient may feel pain or this can even lead to irreversible changes in the tissues of the tooth.

Polymerization reaction of materials based on derivatives of acrylic is accompanied by some volume shrinkage, which is considered as one of the main causes of treatment failure [1,2,12].

In the hopes of creating substances that do not contract during polymerization there have been a lot of research work on certain types of resins [1,2,8,10,12]. As a result, the polymerization shrinkage can lead to formation of cracks occurring at the border of the marginal bond of the restoration of the tooth tissues, which can lead to the phenomenon of bacterial microleakage creating so called "secondary caries" [1,15].

5. Mechanical properties of dental composite materials

The composite materials can be characterized using a number of mechanical parameters. The most important mechanical properties of the composite material – largely determining the quality of the filling are hardness, compressive strength, fatigue resistance, abrasion resistance and impact strength [1,2].

The hardness is one of the most important features related to the susceptibility or resistance to deformation of the surface, crushing or scratching by an external force. In the case of composite materials, its value depends on many factors such as the composition of the organic matrix, the nature and content of the filler and the degree of conversion of the resin. The hardness of the composite is less than the hardness of the enamel. Macromolecular materials show slightly higher hardness when compared to micromolecular materials, which is associated with lower filler content. The degree of hardness is also affected by a combination of filler particles in relation to the polymer matrix. Determination of the hardness of composite materials is considered to be an indirect method permitting evaluation of the degree of conversion of the composite materials. The surface of the composite material is always softer than the layers lying deeper. This involves a higher content of organic particles and inhibitory effects of oxygen on the polymerization process [3-5].

The strength of the composite materials consists of resistance to tension and compression. Insufficient tensile stress is one of the causes of damage to the composite fillings. Tensile strength is dependent on the ductility of the matrix and on the distance from each of the filler particles. The highest tensile strength is characteristic of hybrid materials – 51.7-66.8 MPa. This value is comparable to the tensile strength of dentin, which is 5.7 MPa. Composite materials with a microfiller have tensile strength of about 30-56 MPa, and composite materials with macrofiller – 35-50 MPa. The mechanical resistance of composite materials is comparable to the tensile resistance of the amalgam, which is 60 MPa [6-8].

The compressive strength of the enamel and dentine is 400 MPa and 300 MPa, respectively. Microfiller composites exhibit low resistance to compression – 190-260 MPa. Some of the more traditional composites are more resistant (250-300 MPa) and the highest compressive strength that is comparable with the tooth structure, are characteristic of the hybrid composites – 300-450 MPa. Good polymerization of the material reduces the possibility of damage when a filling is exposed to occlusal forces [9,10,16-18].

The compressive strength of composite material increases linearly with the increase of the volume occupied by the filler in the composite. Compressive strength and flexural strength of microfiller composite materials is approximately 50% lower than the strength of hybrid composites [1,2]. The modulus of elasticity is referred to stiffness of the composite materials. It is also dependent on the filler content and increases with increasing the volume of the filler. Modulus of elasticity is clinically important in sites, in which there are significant forces bite.

The modulus of elasticity is a measure of the stiffness of the material. It depends on the nature of the particles of the organic phase and the rigidity of a coupling matrix filler. The higher the modulus of elasticity, the higher the deformation resistance of the material. Significant differences between the value of the coefficient of elasticity of materials and tooth structure can lead to deformation and fracture susceptibility of the material [9,11].

Susceptibility to abrasion of the composite materials should be comparable with enamel abrasion. Such abrasion is achieved by adding glass particles, barium or zinc. Too big and too hard particles may lead to premature wear of opposing tooth enamel [9].

Clinical use of the materials revealed roughened surfaces of the material by abrasion of the die, loss of filler particles, filler particles fractures or matrix with exposure of air bubbles [9, 11].

By definition, the friction is rubbing one surface against the other and the mechanical resistance is a process that occurs when the surface is exposed to the mechanical action of another surface or chemically active substance, which can contribute to the progressive removal of material from the surface by mechanical or chemical factors [1,16]. The abrasion of the tooth acts in a continuous and gradual manner, especially in the molar teeth. Hence, the tribology – the science dealing with the mechanisms of friction and wear of interacting surfaces that are moving relative to each other – this is an important area also for the development of dentistry and focuses the attention of many researchers [9-12].

Use of SiO₂ filler with a grain size of 0.1-0.5 μm in the composite materials strongly diminishes susceptibility to wear and makes it possible to obtain the composite surface with a very good gloss. Thus, composite materials with a microfiller have greater wear resistance due to a more homogenous structure and a high surface smoothness [2,16,17]. Attrition process is related to non-homogeneity across the surface of the material and the small distances between the filler particles that create a protective environment for the polymer matrix.

Macrofiller composite materials have low resistance to abrasion due to the effect of wiping of the resin that surrounds the large filler particles and the loss of block polymers [1,2]. Materials containing a filler made of micro and macromolecules, or hybrid composites, exhibit very high wear resistance. They are characterized by increased density and consistency of the organic and aqueous phases. Because of these properties of hybrid materials they are the materials of choice for filling cavities in posterior teeth [1,2,18].

Impact strength is a measure of the fragility of the material defined by the work they need to do to withstand a dynamic fracture. Composite materials used in restorative dentistry and reconstructive procedures change their mechanical properties according to the methods and techniques of polymerization. Properties of the composite material are largely dependent on the formation of the polymer network [1,2,19]. The degree of conversion of the composite materials is dependent on the chemical composition of the substrate (mainly the amount and the nature of the monomers and initiators) and the filler content. The polymerization conditions are also very important and influence the temperature of the composite material during this process [1,13,29,20].

In case of insufficient exposure and incomplete conversion, the residual monomers are generated during the polymerization process. These monomers, together with the photoinitiator molecules, may come into saliva, causing allergic reactions. This causes an increase in the number of bacteria in the area of the filling and leads to the occurrence of secondary caries [15,21].

The presence of camphorochinon as a light-photoinitiator material allows for the highest degree of conversion of the resin [17,22]. The materials vary in the degree of conversion. This is caused by the difference in chemical composition and, in particular, the amount of amine, which together with camphorochinon form the light absorbing complexes. Amine complexes of camphorquinone and other active ingredients added to the composite spectrum shift activated photoinitiator in the range which are not in the spectra of a light-emitting diode and plasma.

As a result of this phenomenon, incomplete polymerization of the composite material may occur. The efficiency of the polymerization, and thereby the degree of conversion, depends mainly on the exposure time and the light intensity [17,22].

The physicochemical and mechanical properties of composite materials are influenced by the degree of conversion. The increase in the degree of conversion increases the value of the hardness and stiffness of the composite material. This also increases its resistance to fracture, modulus of elasticity and wear resistance [23].

The degree of polymerization of the materials is not only affected by changes in its composition and its consistency. Great impact on beneficial changes in the polymerization process of the materials has the development of systems for the light induced polymerization. New technologies facilitate the use of curing light units. This process is also affected by changes in the techniques of polymerization.

Continuous polymerization or continuous cure is the irradiation of the materials in the time indicated by the manufacturer – 20, 40, 60 seconds. The time can be modified in terms of energy input. The process of continuous polymerization can be applied in four ways:

- light of constant intensity (uniform continuous cure);
- low-light and high intensity (step cure);
- light of increasing intensity (ramp cure);
- light of a very large single dose of energy (high energy pulse cure).

Over time, a two-stage irradiation has been introduced, known as intermittent polymerization (discontinuous cure). The most common method of polymerization is pulse polymerization (pulse delay), which consists of a two-stage energy supply. This method uses a lamp of polymerization which is controlled by the intensity of emitted light and the exposure time.

The most commonly used polymerization technique today is a technique called "soft start". In this technique the polymerized material is exposed at the initial stage by 10 seconds to the light of 100 mW/cm², and the light intensity is increased to the maximum (depending on the type of lamp to 500-800 mW/cm²) by the rest of the curing time [7,24].

To obtain the desired properties of the fillings made of composite light-cured dental materials, an appropriate material and a proper way of its exposure to the light must be applied. It takes into account the setting characteristics of the light, the distance of the light source from the surface of the material and the direction of irradiation to the material [1,2,18].

Produced light units for curing composite dental materials may vary under many parameters, such as the light source, the amount of heat dissipation, the quality and type of optical elements and the presence of the voltage stabilizer. The effectiveness of the polymerization process is of paramount importance. It is influenced by the wavelength of the emitted light by the lamp and the light intensity. Nowadays the most popular light units for curing dental composite materials are halogen lamps, blue light-emitting diodes, argon lasers and plasma units [24,25].

Halogen lamps have a built-in filter that stops harmful waves producing heat. The simplest cure lamps make it possible to choose only the exposure time. Today, lamps with built-in control light intensity are more and more popular.

The wavelength of the light emitted by halogen lamps is between approx. 360 nm to approx. 560 nm, and the peak of its intensity is in the range of 400-500 nm. The power of currently produced halogen lamps is 700-800 mW/cm², although there are also lamps whose power exceeds 1500 mW/cm². In these devices light bulbs with increased power have been used (250 W and 340 W).

Devices using light emitting diodes produce blue light. There are many research works comparing the properties of halogen lamps to LED lamps [24-26]. Spectrum of LED units is better suited to the currently used photoinitiators. LED units consume less energy and are produced in a more ergonomic wireless versions. Minimal heat emission reduces the risk of overheating the pulp.

Increasingly used are plasma units in which the light source is an electric arc. They exhibit very high power, about 1320 mW/cm², while the power of halogen lamps is on average 700 mW/cm² [24,27]. This allows for a significant reduction in exposure time, because – as has been shown – polymerization of composite material can be achieved in 3 s. The effectiveness of the polymerization process can be compared to polymerization with a halogen lamp during 40 seconds. High intensity light can cause severe volume shrinkage leading to the formation of marginal gap and a negative growth of the temperature harmful to the tooth pulp. Some filling materials with less reactive monomers, requiring longer exposure to light benefit from using a plasma lamp during the polymerization process [24].

Argon lasers produce energy at a wavelength of 480-514 nm, which causes rapid progress of polymerization of composite materials [24]. The smaller temperature rise during irradiation causes a decrease in the risk of overheating the pulp. The hardened materials using argon lasers show lower values of polymerization shrinkage.

Good polymerization of the material reduces the risk of damage while the filling is exposed to occlusal forces.

The hardness of the material, its abrasion resistance and compressive strength dramatically affect the quality of the filling. The degree of hardness is one of the most important features for providing wear resistance. On the other hand, the dental composite materials that are too hard can cause excessive wear of opposing teeth [1,2,14].

In the clinical observations there are many complications resulting from inadequate polymerization of composite materials. This may be the result of poor quality of curing lights of a very low intensity, too long distance between the tip of the lamp and the surface of the material or improper exposure time [24].

6. Conclusions

Composite materials are widely used in contemporary dentistry. These materials show good mechanical properties that are very important for clinical features of dental filling, especially at sites exposed to high occlusal load. Aesthetic demands of patients can be met only by use of the restorative materials that mimic the features of natural teeth. These features include the color, the shade, translucency and opacity. Dental composite materials are the only group of dental materials in which these features are combined together, ensuring naturally looking final effect of the restoration. Easy handling of the dental composite materials together with effective polymerization process with portable light units make these materials a good choice for clinical use.

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