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Dental composites: An overview

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Abstract

Composite materials are emerging as materials whose use is increasing day by day in all areas of our lives. The superior properties of composite materials compared to monolithic materials have played an important role in the preference of these materials in many important sectors such as defense, construction, space, aviation, automotive and health. There are different types of composite materials according to the matrix type, and the most widely used of them is polymer matrix composites. Polymer matrix composites have a great importance especially in the field of health due to the superior properties they offer. Polymer matrix composites used in dental fillings have an important place in this field due to their outstanding properties. In this study, polymer materials used in dental fillings, filling types and commercial polymer matrix composite products and their properties are presented.

Introduction

Polymer matrix composite dental filling materials are important repair materials used in the restoration of broken or decayed teeth in the anterior and posterior parts of the mouth. These composite materials are classified according to the rheological properties, the polymerization method in the application and the properties of the inert or reactive filling material in the matrix. While dental fillings that were polymerized by chemical methods were used in the past, dual systems that are polymerized with visible light and self-curing by both light and chemical methods are used today. While filling materials with large inorganic particles were initially used in composite dental filling materials, new generation inorganic filling materials have been developed due to the low mechanical properties and insufficient physical properties provided by these coarse particles. Hybrid composite filling materials have been developed by using finer particle size fillers, different particle size distributions and different inorganic material components in new generation composite fillers. The dimensional and structural development of the fillings used in dental composites is given in Fig.1. [1, 2].

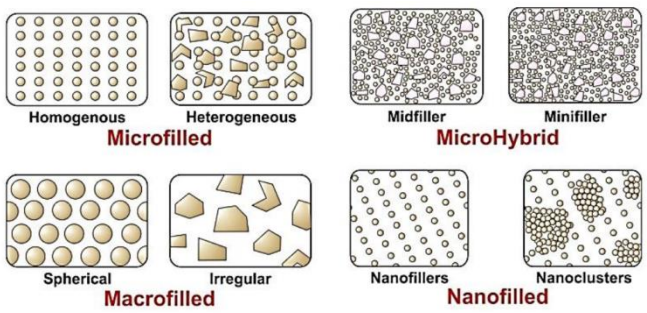
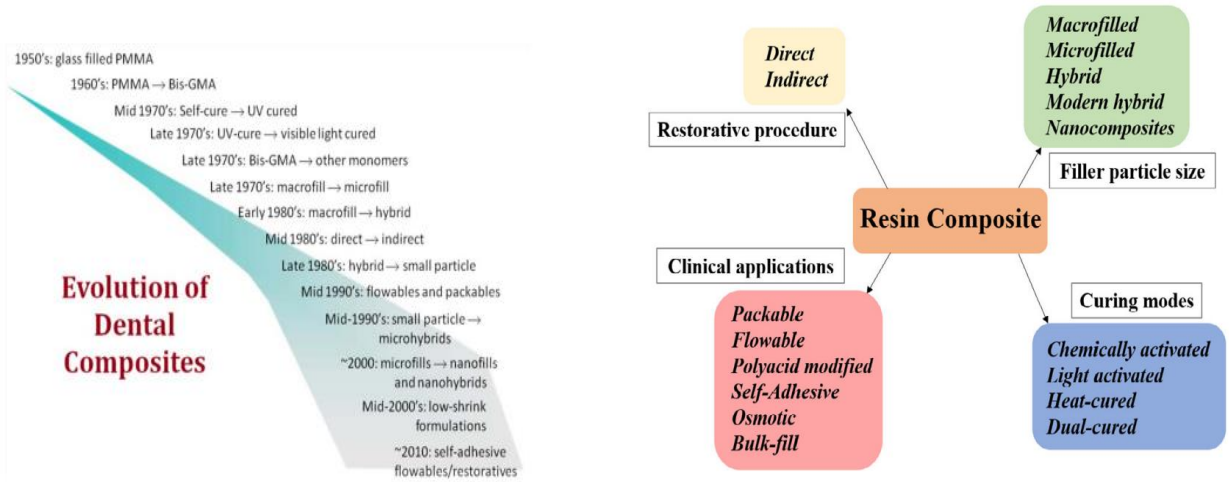


Fig. 1. The dimensional and structural development of the fillings used in dental composites [1]

In this way, many material properties such as color, gloss, abrasion, compression strength, impact resistance, hardness, excessive shrinkage and reduced stickiness in application, which are required and important in polymer matrix composite dental fillings, have been brought to the desired levels and new commercial products have been introduced to the market. Important studies on the development of new products in this field are still continuing and this field is still a very untouched field for our country. The composition and classification of resin-based dental composites have improved significantly since the materials were introduced to dentistry. (Fig. 2a,b) [2,3].



(a) (b)

Fig. 2 (a) Evoluation of Dental Composites,(**b**) The classification of dental resin composites [2, 3]

In this study, information about the development of composite dental filling materials and the materials used in this field will be given, and scientific studies in the literature on the physico-mechanical properties of commercial dental composites are presented.

Materials and Method

Composite dental filling material components can be examined under three headings: matrix materials used, inorganic filling phases and other auxiliary materials (Table 1).

Simply, the production process of dental composites is produced by using matrix materials, filling materials and auxiliary materials, by subjecting these materials to mixing and homogenization processes using ultrasonic systems and/or mechanical systems. The hardening of the obtained composite products is generally carried out by using LED or visible light systems of different power and duration. The physico-mechanical and biological properties of the composite product vary depending on the type and amount of matrix and filler phase used the size of the filler and the properties of auxiliary materials.

Table 1. Composite dental filling material components [4-7]

Matrix (Resin)	Fillers	Auxiliary materials
Bisphenol A-glycidyl methacrylate, Bis-GMA	Amorphous Silica	Coupling agent, 3-metakrilloxipropiltrimetoksisilan
Urethane di-methacrylate, UDMA	Hydroxyapatite	Photoinitiators, ethyl-4-(N,N - dimethylamino) benzoate (4EDMAB)
Tri-ethylene glycol di-methacrylate, TEGDMA	Zirconia	Photoinitiators, Camphorquinone (CQ)
Hydroxyethyl methacrylate (HEMA)	Aluminum silicate,	
Silorane	Barium (Ba), strontium (Sr), zirconium (Zr), and zinc glasses	
Addition-fragmentation monomer (AFM)	Borosilicate glass	
Aromatic urethane dimethacrylate (AUDMA)	ytterbium fluoride	
	lithium aluminum silicate	

Conclusion

The physico-mechanical properties (fracture toughness, flexural strength and modulus, compressive strength, volume shrinkage) of some dental composites currently available in the market are given in Fig. 3 (a-e). It has been observed that flexural strength values of dental composites vary between 95-170 MPa, flexural modulus values between 7.8-15 GPa, compressive strength values between 260-355 MPa, fracture toughness values between 1.4-2.3 $MPam^{1/2}$ and volumetric shrinkage values between 1.5-2.4%.

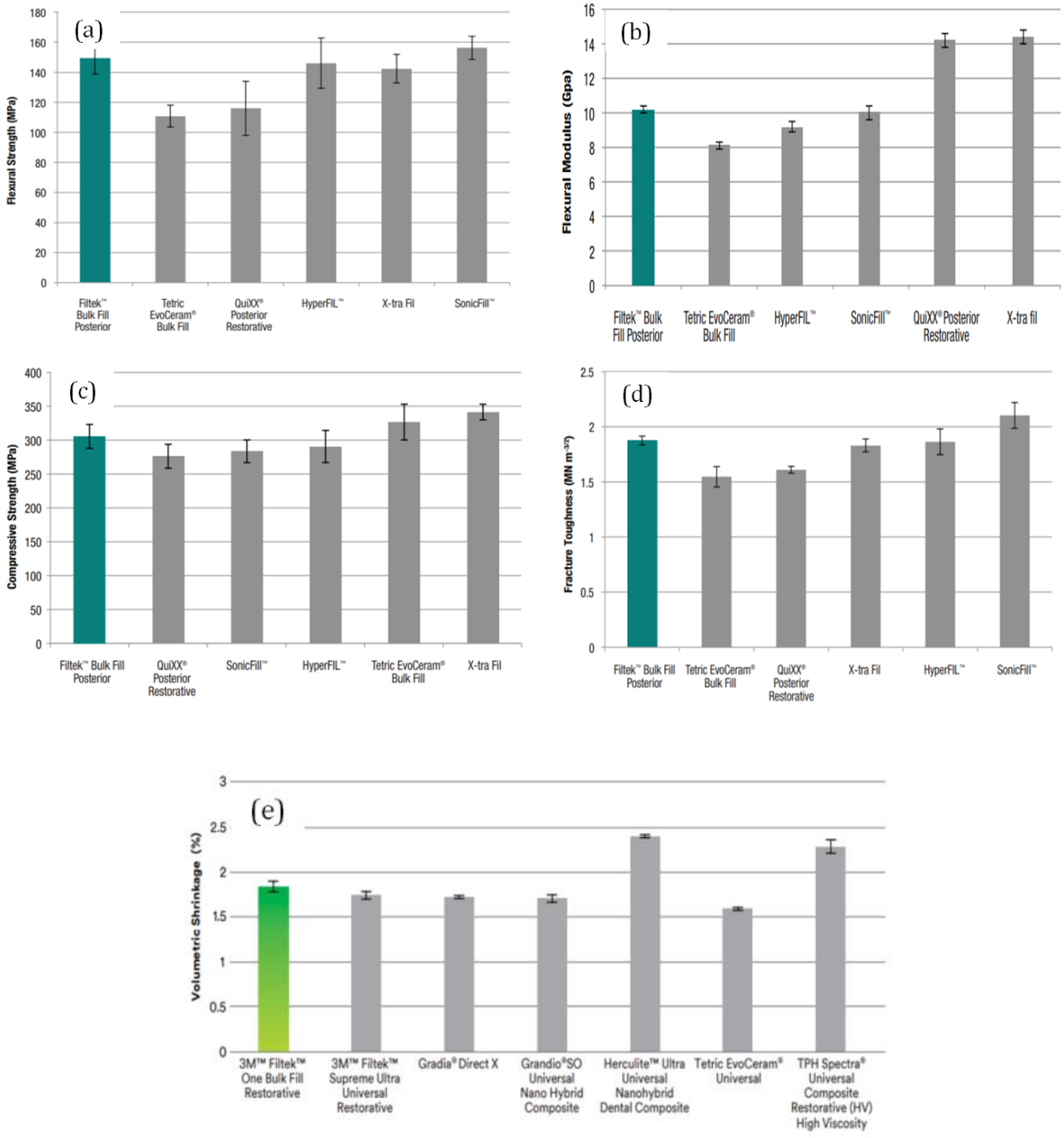


Fig. 3. The physico-mechanical properties of some commercial dental composites [7,8]

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