POLYMERIZATION SHRINKAGE AND COMPRESSIVE STRENGTH OF MICROHYBRID DENTAL COMPOSITE

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[ENGINEERING OF BIOMATERIALS 153 (2019) 22]

Introduction

The UV light-activated composite resins are commonly used for hard teeth tissues restoration. The photopolymerization of such composites is accompanied by polymerization shrinkage which causes either marginal gaps or, in case of enduring adhesion, stress within the tooth or the restorative material. Polymeric shrinkage depends on many factors such as filler type and content, monomer system, polymerization characteristics, volume and cavity design, restorative procedure and light intensity used for photo activation [1-3]. The aim of the work was an investigation of the influence of direction of UV light irradiation on the polymerization shrinkage and compressive strength of micro hybrid dental composite.

Materials and Methods

Cylinder-shaped samples were made from UV light-activated micro hybrid composite Zmack comp (colour A2) produced by Zhermack. Composite is designed for anterior and posterior restorations. It is composed of dimethacrylate resin, triethyleneglycol dimethacrylate and the inorganic fillers (barium-aluminium-borosilicate glass, silicon dioxide, titanium oxide) with a weight content of 77%. The particles size of the fillers is from 0,04 to 5 μm. Samples were made in glass tubes with the internal diameter of 2 mm and the height of 6 mm. Material was applied in layers up to 3 mm and each layer was light-cured for 20 s with the use of Blue Luxcer (800-1000 mW/cm^2). Three variants of irradiation directions were used: (1) from the bottom and top, (2) form the right and left side, (3) combination of variants 1 and 2 (FIG. 1). For each curing variant at least 5 samples were made.

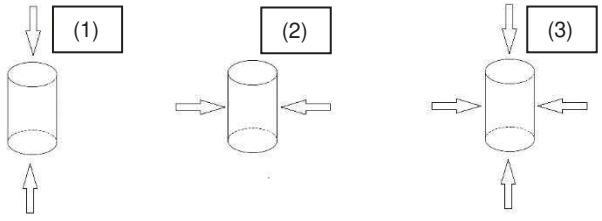

FIG. 1. Directions of specimens curing.

The polymerization shrinkage was calculated on the base of volume measurements according to the formula (1):

$$s = (1 - \frac{V_p}{V}) \cdot 100\% \qquad (1)$$

where: V_p is the volume of polymerized material and V is the volume of unpolymerized material.

The compression test was determined with the use of the MTS Insight 50 testing machine at a speed of 0,5 mm/min at a room temperature of 22±1°C. Registered force - displacement curves were recalculated into stress – strain curves and used for compressive strength (σ_c) and moduli (E_c) of elasticity calculations.

Results and Discussion

Tested composite belongs to the group of micro hybrid composites with high filler content which has an influence on polymerization shrinkage, since it leads, to a certain extent, to a reduction in monomer concentration. The shrinkage of the studied resin composites ranged from 1.17 to 2,35% depending on the direction of UV irradiation (TABLE 1). The highest value of volumetric shrinkage was for specimens irradiated from the bottom, top and two sides. Measured shrinkage of the tested composite is in the range of shrinkage of most dental materials with a range between 2 and 3% [4].

TABLE 1. The volumetric polymerization shrinkage.

	Irradiation directions		
	(1)	(2)	(3)
V [mm^3] ±SD	24,60 ±0,12	24,59 ±0,10	24,64 ±0,12
V_p [mm^3] ±SD	24,32 ±0,14	24,25 ±0,07	24,06 ±0,16
s [%] ±SD	1,17 ±0,13	1,36 ±0,18	2,35 ±0,32

Composites cured from the bottom and top (1) or form the right and left side (2) showed lower values of modulus of elasticity and compressive strength compared to composite cured from four sides (3) (TABLE 2). These results are correlated with the polymerization shrinkage and closer pacing of macromolecules for composite with higher shrinkage.

TABLE 2. The average values of maximum force (F_{max}), compressive strength (σ_c) and compressive modulus (E_c).

	Irradiation directions		
	(1)	(2)	(3)
F_{max} [N] ±SD	472,41 ±42,27	450,80 ±7,27	644,51 ±49,85
σ_c [MPa] ±SD	150,45 ±13,46	143,56 ±2,31	205,25 ±15,87
E_c [MPa] ±SD	7037 ±384	7034 ±580	9503 ±218

Conclusions

Dimensional stability of dental resin-composites is essential to the longevity and function of the restoration. Tested composite had quite high filler concentration. Higher filler content decreases the amount of resin in the composite, therefore polymerization shrinkage decreases.

References

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