POLYMERIZATION SHRINKAGE OF NEW DENTAL COMPOSITES MODIFIED WITH LIQUID RUBBER

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Introduction

Light cured resin based composites (RBC) are used in dentistry from the 1970's. Their matrix is usually a mixture of dimethacrylate resins, while the reinforcement is ceramic particles. These components are supplemented by inhibitors, stabilizers, initiators, pigments etc., guaranteeing obtaining the desired functional and aesthetic features. Despite significant achievements in the field of modern dental composites, the problem of shrinkage still occurs, causing consequences in the form of marginal fissure, inflammation and secondary caries. The main factors that have a significant impact on shrinkage are the content and type of inorganic filler in the composite, the molecular weight and the degree of conversion of the monomer system [1]. In work [2], modification of the resin matrix was proposed through the use of bicyclic compounds (e.g. spiro orthoesters) in ring-opening polymerization. Liquid rubber has the effect of reducing polymerization shrinkage of epoxy resin [3]. However, despite attempts to toughening dimethacrylate resins contained liquid rubber [4,5], there are no such reports on changes in polymerization shrinkage of RBC.

Materials and Methods

Two commercial composites: Flow-Art and Boston (Arkona) was used for modification and testing. The matrix was a mixture of dimethacrylate resins: Bis-GMA, TEGDMA, UDMA and EBADMA. Composition of the mixture was completed by the addition of photoinitiator, stabilizer and inhibitor. Both types of composites contained the same ceramic filler which was a mixture of Ba-Al-B-Si glass, pyrogenic silica and titanium dioxide. The flow type composite contained 60% ceramics by weight of polymer matrix, while packable composites contained 78% wt. of reinforcement. The exact amounts of ingredients and their composition were patented by the manufacturer (Arkona). The modification of RBC's was made by addition of 5% by weight (of resin) of a liquid poly(acrylonitrile-co-butadiene) copolymer Hypro® 2000X168LC VTB (CVC Thermoset Specialties, USA). The following material designations were adopted: F – Flow Art, B – Boston and FM and BM – modified F and B composites, respectively.

Polymerization shrinkage measurements were carried out using the own method using computed microtomography (Skyscan 1174, Bruker microCT) [6]. A sample of the material was applied to a pin with diameter of 5 mm made of PTFE. During the scan, the pin with the material rotated in the half-angle range with a 9° step, 20 images were taken with a resolution of 6.6 μm. Immediately after scan polymerization was performed using the LED lamp of intensity 1350 mW/cm^2. The second scan with the same settings was done after 2 minutes from polymerization. The volumetric shrinkage was calculated as the ratio of the difference between uncured and cured material volume to uncured composite volume. Each composite was measured 10 times and results were statistically analyzed using Statistica software (TIBCO Software Inc.).

Results and Discussion

Result of shrinkage measurements were presented in FIG. 1. Modification of the matrix of composites with liquid rubber significantly reduced the level of volumetric shrinkage for both flow and condensable materials. Material F showed a shrinkage of 3.96% ± 0.41, while modification with liquid rubber allowed to reduce this value by over 6%. Similarly, in the case of material B, for which the measured polymerization shrinkage was 2.87% ± 0.28, after modification its value decreased by over 10%. According to work [7] the reactive rubber can be partly embedded in the crosslinked resin phase, which has reduced shrinkage. A possible explanation is the increasing content of carboxyl groups, which can catalyze the formation of ether reducing the network density.

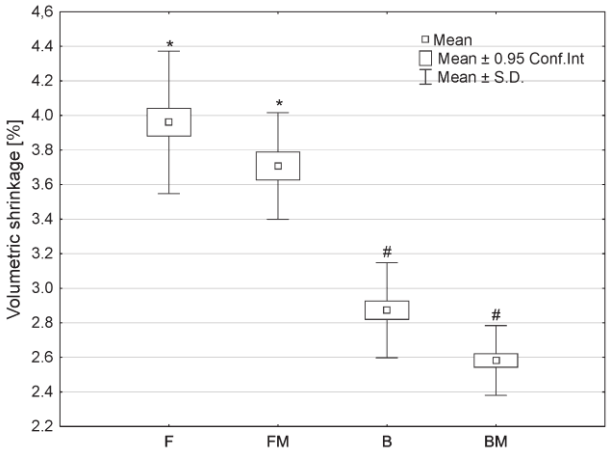

FIG. 1. Volumetric shrinkage of tested composites. Symbols (*) and (#) denotes significant differences between F / FM and B / BM composites, respectively.

Conclusions

Modification of dental composites with liquid rubber enables significant reduction of polymerization shrinkage. Addition of 5% by weight (of resin) resulted in decreasing of shrinkage by 6% for the Flow Art composite and 10% for the Boston condensable composite.

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