PHYSICOCHEMICAL PROPERTIES OF THE SURFACE OF LIGHT-CURED DENTAL COMPOSITES AFTER THEIR MODIFICATION WITH LIQUID RUBBER

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Introduction

There are many ways to improve the mechanical properties of light cured dental composites, including the use of spherical-shaped reinforcement particles [1], whiskers [2], or glass fibers [3]. Increasing the fracture toughness of composites is also possible due to the modification of matrix resins by introducing liquid rubber [4-6]. The presence of liquid rubber in the matrix of these composites, in addition to reducing shrinkage and improving mechanical properties, can also positively affect the hydrophobic and biological properties by changing the surface condition [7]. This work aims to assess the contact angle and surface free energy of two types of commercial composites (flow and condensable) before and after modification of their matrix with liquid rubber.

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 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 the addition of 5% by weight (of resin) of a liquid methacrylate-terminated polybutadiene 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. The measurement of the contact angle Θ and surface free energy (SFE) γ_S was carried out on a DSA30 goniometer (Kruss) using ultra high-quality water (UHQ, PureLab, Vivendi Water) and diiodomethane (Sigma Aldrich) as polar and non-polar liquid, respectively. The liquids were dosed at 4 µL (water) and 1.5 µL (diiodomethane). The smaller volume of diiodomethane was due to the relatively large surface area occupied by the drop concerning the sample surface. The samples were tested 24 hours after polymerization (dry stored) as well as after 24 hours of incubation in distilled water as simulations of the oral environment to evaluate changes in surface properties under the influence of the aqueous environment. Results were statistically analyzed using Statistica software (TIBCO Software Inc.).

Results and Discussion

The values of SEF for the tested materials before and after incubation in water, along with marked statistically significant differences, are presented in FIG. 1. There was a statistically significant reduction in SEP in the case of composite FM compared to F, from the value of 49.33 to 48.42 mJ/m^2. Composite B achieved a higher SEP value compared to F, similar to the BM and FM composites, which indicates the effect of more reinforcement. For composite BM the values were lower than for composite B, however, the differences did not show statistical significance. Incubation in water statistically significantly decreased the values of surface free energy in all cases of the tested materials. Importantly, in all cases of the tested composites, the dispersion component has a decisive share in the size of the surface free energy, which means a higher adhesive affinity for non-polar substances. In the case of the FM composite, the value of this component decreased by 32% compared to the F composite. In the case of the BM composite, an increase in the polar component value was obtained.

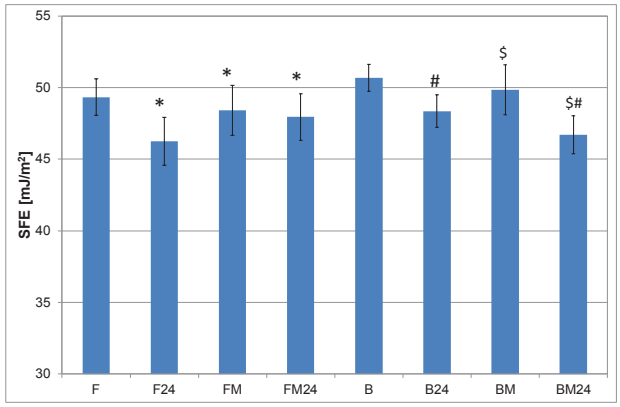

FIG. 1. SFE measurement results for materials immediately after polymerization and after 24 hours of incubation in distilled water. The symbols (*) indicate statistically significant differences against material F, (#) - against material B, $ - statistically significant difference between materials BM and BM24.

Conclusions

Modification of dental composites with liquid rubber favors their hydrophobicity and lowers the value of the surface free energy. It is particularly important in terms of reducing the possibility of colonization of such modified fillings by bacteria

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References

[1] Kim K., Ong J., Okuno O., J. Prosthet. Dent. 87 (1992) 642–649.
[2] Xu H. H. K., Quinn J. B., Smith D. T., Giuseppetti A. A., Eichmiller F. C., Dent. Mater. 19 (2003) 359–367.
[3] Elbishari H., Satterthwaite J., Silikas N., Int. J. Mol. Sci. 12 (2011) 5330–5338.
[4] Lee V. A., Cardenas H. L., Rawls H. R., J. Biomed. Mater. Res. - Part B Appl. Biomater. 94 (2010) 447–454.
[5] Kerby R. E., Tiba A., Knobloch L. A., Schricker S. R., Tiba O., J. Oral Rehabil. 30 (2003) 780–784.
[6] Matsukawa S., Hayakawa T., Nemoto K., Dent. Mater. 10 (1994) 343–346.
[7] Deb S., Braden M., Bonfield W., Biomaterials 16 (1995) 1095–1100.
[8] Pionteck J., Müller Y., Häußler L., Macromol. Symp. 306–307 (2011) 126–140.