Study of the thixotropic behaviour of flowable resin composites: analysis of the destructuration-restructuration process

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INTRODUCTION: The purpose of this study was to investigate the mechanism of the destructuration-restructuration process of thixotropic experimental flowable composites and to determine whether it had an influence on the final mechanical properties of the polymerized materials.

METHODS: Experimental resin composites were prepared using a Bis-GMA/TEGDMA 50/50 mixture (wt%/wt%) filled at 60% with silanized dental glass as a macrofiller and partially hydrophobic silica as a microfiller, in the proportions 60/0, 57/3, 55/5, 52/8 and 50/10 wt%. A photoinitiation system, a camphorquinone/amine mixture (50/50 wt%), was added to the composites in the proportion of 1%.

Samples were prepared in moulds of 25mm x 2mm x 2mm as specified in ISO specification 4049 [1]. Composites were heavily destructured (by forcing them through the application tip of a syringe) before being placed in the moulds, and were polymerized after a resting time of 0min, 3min or 90min. A last group of sample was polymerized without prior destructuration as a control. Four samples were prepared in each group.

Samples were then placed in a 3-point setup bending at a rate of 0.75mm/min until fracture occurred in order to measure their elastic moduli and their flexural strengths. Statistical analysis was performed using a two-way ANOVA and post hoc Scheffe's tests at $p<0.05$.

To analyse the modifications in the microscopic structure of the materials after deformation and during restructuration, samples were sliced using a microtome and Transmission-Electron Microscopy (TEM) micrographs were taken for each sample.

RESULTS: Statistical analysis performed on the results obtained for the elastic moduli and those obtained for the flexural strengths of the samples showed an influence of the delay before polymerization as well as an influence of the ratio between macrofillers and microfillers. Elastic moduli of the materials tested are shown in Table 1.

Table 1. Elastic moduli of the materials tested versus the time elapsed between destructuration and photopolymerization.

%micro-fillers	0min	3min	90min	∞
0	6.25(1.39)	7.30(0.69)	4.83(1.42)	8.13(0.70)
3	6.38(0.44)	7.65(0.39)	8.00(1.48)	8.20(1.83)
5	6.28(0.81)	7.63(0.56)	7.63(0.30)	7.78(0.30)
8	6.70(0.46)	4.48(0.51)	6.93(0.46)	7.14(0.45)
10	6.18(0.17)	6.93(0.38)	6.28(0.79)	8.37(0.29)

TEM micrographs showed no difference in the microscopic structures between samples that were destructured and samples that were not. Figure 2 shows the sample with 5% of microfillers, both in the rest state and immediately after deformation.

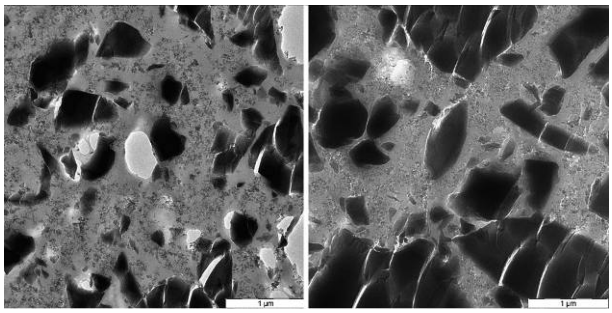

Fig. 2: Microscopic structure of the composite with 5% of microfillers in rest state (left) and immediately after destructuration, (right).

DISCUSSION & CONCLUSIONS: From the results above, it appears that the thixotropic behaviour of resin composites does not seem to be linked to filler particle movements but to more complex factors (including hydrogen bonds involving filler particles). The time elapsed between destructuration of the materials and their photopolymerization has an influence on their final mechanical properties.

REFERENCES: [1] International Organisation for Standardization. Specification of dentistry – resin-based filling materials. ISO-4049, 1988.

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