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Rheological Properties of Unfilled and Filled Mixtures of Bis-GMA and TEGDMA

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INTRODUCTION: The purpose of this study was to investigate the complex viscoelastic properties of unfilled and filled mixtures of Bis-GMA and TEGDMA in order to understand how both the organic and inorganic fractions influence their particular behaviour [1].

METHODS: Unfilled Bis-GMA/TEGDMA mixtures were prepared with ratios 100/0, 80/20, 70/30, 60/40, 50/50, 40/60 and 0/100 wt%.

Filled experimental composites were prepared using a Bis-GMA/TEGDMA 50/50 mixture (wt/wt) filled at 60% with silanized dental glass as macrofiller and partially hydrophobic silica as microfiller, respectively 57/3, 55/5 and 52/8 wt%.

Rheological measurements were performed using ARES (TA instruments, New Castle, DE, USA) and RheoStress 300 (Thermo Electron Corporation, Karlsruhe, Germany) rheometers. Parameters evaluated for the unfilled mixtures were the stress (τ) and viscosity (η) as a function of shear rate, and for the filled mixtures, storage modulus (G'), loss modulus (G'') and complex viscosity (η^*) as a function of frequency (ω) and time.

RESULTS: Unfilled samples all exhibit Newtonian behaviour, their viscosity remaining constant whatever the shear rate. Fig. 1 shows the viscosity of the mixtures in relation with the TEGDMA content (wt%).

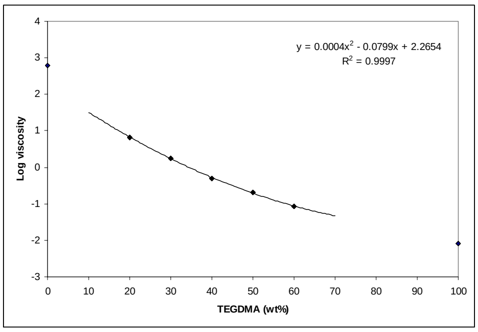

Fig. 1: Viscosity of Bis-GMA/TEGDMA mixtures as a function of composition.

Filled mixtures appeared to be non-Newtonian, highly structured fluids. The complex viscosity at various frequencies is shown in Fig. 2. All the samples exhibit shear-thinning behaviour, i.e. the viscosity decreases with increasing frequency. The viscosity does not reach a plateau at low frequencies, which is typical of yield behaviour. Their thixotropy is presented in Fig. 3. We show the recovery of the complex viscosity at 0.1 rad/s after the materials have undergone pre-shear at 10 s^{-1} for 300s. This treatment is enough to destroy their internal structure. Overshoot was observed with the 8% microfiller sample.

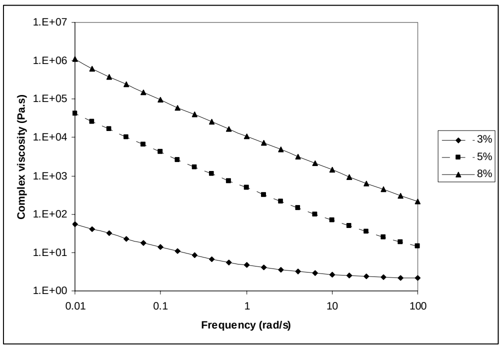

Fig. 2: Complex viscosity as a function of the frequency in relation with the microfiller content (3%-5%-8%).

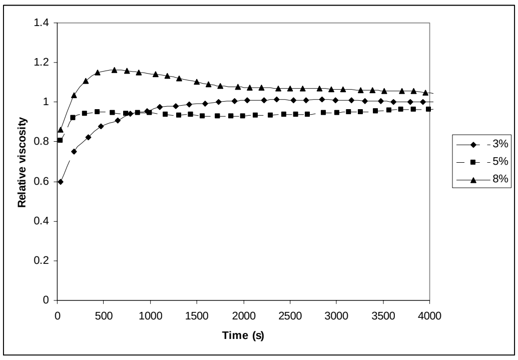

Fig. 3: Recovery of initial viscosity versus time after severe destructuration of the materials.

DISCUSSION & CONCLUSIONS: From the above results, it can be concluded that the complex rheological behaviour of resin composites is due to the inorganic fraction. The nature, morphology and loading of fillers play a huge role in the final viscoelastic characteristics of the materials. Further studies on filler surface treatments and arrangement in the organic matrix are to be conducted.

REFERENCES: [1] Barnes H. A., Hutton J. F., Walters K. (1989) Rheology of Suspensions in *An Introduction to Rheology*, 1st ed., Amsterdam, Elsevier, pp 115-37.

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