European Cells and Materials Vol. 13. Suppl. 1, 2007 (page 20) ISSN 1473-2262

Influence of Curing Mode upon Polymerization Contraction Kinetics of Resin Composites

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INTRODUCTION

Polymerization shrinkage is an inherent occurrence because monomer molecules get closer by exchanging van der Waals spaces for covalent bond spaces. The major drawback is the formation of a tooth-restoration interfacial gap. So, decreasing stress-strain behavior and volume changes of restoration polymers remains a current challenge. This study investigated the influence of the curing mode on the polymerization contraction of three resin composites.

METHODS

Three samples of three resin composites [Filtek P60 (P60), Filtek Flow (FLO) and Admira (ADM)] were light-cured using a LED unit (Elipar Freelight 2) for 20s and 40s in continuous mode and for 20s in exponential mode (5s of ramped activation and 15s with a maximum power). Curing contraction and kinetics were measured for a total duration of 360s using the deflected-disk technique according to the Watts and Cash method [1].

RESULTS

Resulting data are displayed in Tables 1 and 2. According to the Kruskal-Wallis tests, and whatever the curing mode, P60 showed significantly the lowest contraction, and FLO the highest. Remarkably, among all the materials tested there was no significant difference between the 20s and 40s continuous curing mode. In the exponential mode, all the materials displayed the highest final curing shrinkage. For the first three-second period, the polymerization contraction was slower in the exponential mode than in the continuous mode and the polymerization rate was higher for all the materials during the 3-10 second period in the exponential mode. From the 20th second, the curing rate was identical whatever the curing mode.

Table 1. Polymerization shrinkage means (%vol.)

Material	Curing mode	Shrinkage means % (SD)
ADM	Led 20s	2.62 (0.04) ^{a}
	Led 40s	2.56 (0.05) ^{a}
	Led exp	2.77 (0.03) ^{b}
P60	Led 20s	1,73 (0,03) ^{c}
	Led 40s	1.77 (0.03) ^{c}
	Led exp	2.00 (0.01) ^{d}
FLO	Led 20s	3.89 (0.03) ^{e}
	Led 40s	3.90 (0.02) ^{e}
	Led exp	3.98 (0.05) ^{f}
Results with the same superscript letter are not different		

Table 2. Polymerization shrinkage kinetics rate (vol%.s^{-1}).

Material	Curing mode	Polymerization kinetics (vol%.s^{-1}) between: 0-3s	3-10s	10-20s	20-40s	40-60s
ADM	Led 20s	0.281	0.131	0.041	0.011	0.004
	Led 40s	0.294	0.118	0.036	0.012	0.005
	Led exp	0.167	0.182	0.048	0.013	0.004
P60	Led 20s	0.210	0.077	0.025	0.007	0.003
	Led 40s	0.202	0.081	0.025	0.008	0.004
	Led exp	0.083	0.145	0.035	0.009	0.003
FLO	Led 20s	0.228	0.251	0.084	0.017	0.005
	Led 40s	0.249	0.241	0.075	0.020	0.007
	Led exp	0.067	0.294	0.103	0.021	0.006

DISCUSSION & CONCLUSIONS

Curing contraction and polymerization rate depend on the composite composition: monomer type, size and viscosity; filler type and amount; photoinitiator amount [2]. Because of a lower filler quantity, FLO has a lower viscosity, and its shrinkage is higher than that of P60 or ADM. ADM contains much more TEGDMA than P60 and its shrinkage is higher than P60. Besides, the curing mode is an important parameter: Use of a high intensity LED cure unit in continuous mode leads to fast formation of a rigid network, which rapidly decreases the capacity of the monomers to flow. The ramped activation decreases the polymerization rate and allows a molecular rearrangement taking away the gel point. Such a phenomenon entails a decrease in the strain-stress behavior, which potentially diminishes interfacial failures. [3]. It seems possible to reach a clinical compromise between the curing shrinkage and the reduction of internal stresses in the resin composites by choosing a curing mode in accordance with the polymers used. Moreover, for a material thickness of 1.64mm (which is the thickness of the experimental disks) a continuous light activation for 20s is quite sufficient to obtain the terminal conversion rate of the resin composites tested.

REFERENCES:

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