2682 Thermal Effects on Photopolymerization Stress Development

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Objectives: Curing dental resins at elevated temperatures can dramatically accelerate the exothermic photopolymerization process. This study was conducted to determine how dynamic polymerization stress development is influenced by thermal effects associated either with the internal reaction exotherm or modest external heating. Methods: Real-time measurements of polymerization conversion and shrinkage stress were monitored simultaneously on the same specimen using a near-infrared fiber optic system coupled with a cantilever beam tensometer. The internal specimen temperature was obtained with an embedded thermocouple and external specimen temperature control was achieved with an infrared heat lamp. The UV-initiated photopolymerization of a model unfilled resin consisting of Bis-GMA/TEGDMA (70:30 mass ratio) was evaluated. Triplicate specimens were irradiated for varied times at 23, 37 or 50°C as initial cure temperatures. Results: As the external temperature was varied, the maximum internal specimen temperatures ranged between 40.9±0.7°C and 73.0±3.9°C for photopolymerizations conducted at 23 and 50°C, respectively. Conversion values increased from 64 to 77% when the cure temperature was raised from 23 to 50°C, while shrinkage stress at 30 min increased from 2.82±0.09 to 3.45 MPa over the same range of cure temperatures. At the elevated cure temperatures, modest but significant stress relaxation was evident. Partial photocure studies, which involved extinguishing the curing light at various stages of conversion, followed by elimination of the external heating source, demonstrated that the contribution of the thermal contraction to overall stress development decreases as conversion increases.

Conclusions: As the temperature is increased, the reaction rate and final conversion achieved during the resin photopolymerization increased significantly. As the cure temperature was raised, the vitrification point, physically defined as the onset of rapid stress development with continued conversion, was delayed to higher conversion based on the internal specimen temperature reached. Polymerization stress increased with the increasing conversion and cure temperature. Support: NIDCR DE14227.

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