Acoustic Emissions Generated in Aged Dental Composites Using a Laser Thermoacoustic Technique.

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Abstract

The heating up of dental composites by laser will produce acoustic emissions (AEs) that may be related to fracture mechanisms in the composites. It has been proved that the mechanical properties of dental composites are affected by storage in food simulating liquids, i.e. 75% ethanol, which has a solubility parameter approximating to that of bisphenol glycidyl dimethacrylate (BisGMA) resin. A new method was innovated to evaluate the laser-induced AEs in dental composites aged by 75% ethanol solution. Model systems (50/50 BisGMA/TEGDMA resin filled with 0% and 75 wt.% 5-10 microm silanized BaSiO6) as well as three commercial composites (Marathon One, Z100 and Herculite XRV) were used in this study. Nine samples acting as the control group were tested to establish the correlation of AEs to laser power. The effect of ageing by immersion in 75% ethanol on AEs and diametral tensile strength (DTS) was then evaluated. A quasi-continuous wave CO2 laser was used to heat up the composites. AEs of frequency 100-200 kHz were collected, filtered, recorded and processed using a 4610 Smart Acoustic Monitor. Burst patterns, which formally were assumed to be correlated to fracture mechanisms, were also identified from the data obtained at laser power > or = 5 W for commercial composites and > or = 4 W for model systems. Higher laser powers cause the AE to increase for all composites except unfilled model resin. AEs as a function of power for all aged systems were flat (< 100 events) below 4 W. Emissions then rose sharply to > 1000 events at 7.1 W. Statistically significant differences were found between the AEs obtained at 5 W (commercial composites) and those at 4.3 W (model systems) for material systems and storage times. Marathon One was less affected by the laser and an abrupt change in AE was found between days 0 and 7 of storage for all commercial composites. The AE value from the unfilled model resin was found to be significantly different from that of the model composites. However, they showed an increase in AEs with length of storage time, which was inversely associated with the decreased tendency of their immersed DTS values. Laser-induced AEs may be a valuable adjunct to conventional mechanical testing.