Finite element analysis of thermo-debonding mechanism in dental composites

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Abstract

Finite element method (FEM) has been extensively used for evaluating interfacial status inside biomaterials. This study using FEM was designed to evaluate the thermal stress behavior of a filler-matrix interface. The results were then compared to those of a previous study obtained by a laser thermoacoustic technique (LTAT). The experimental systems (75/25 Bis-GMA/TEGDMA resin reinforced with 0, 25, 50, and 75 wt% 8-microm silanized/unsilanized BaSiO6) as used in the previous study were modeled in this study. The established finite element models were based on coefficient of thermal expansion (CTE) Mismatch Phenomenon. The mechanical properties of the silane coupling agent, such as elastic modulus and thermal expansion coefficient used in the silanized model, were assumed to have optimal heat flux transfer. A third (imaginary) material was proposed to block the transfer of thermal stress between the filler and matrix in the unsilanized model. The thermal load simulation was based on steady-state thermal analysis. The results showed that: (1) The strain energy and interfacial shearing stress calculated from FEM validate the results from the previous LTAT study. (2) Comparing the stress distribution of silanized and unsilanized FEM models, the acoustic signals in LTAT study are mainly derived from debonding of the filler-matrix interface of silanized specimens, and from the matrix area of unsilanized specimens. Based on results to date, we conclude that the finite element method may be a powerful tool for exploring thermoacoustic mechanisms of dental composites..