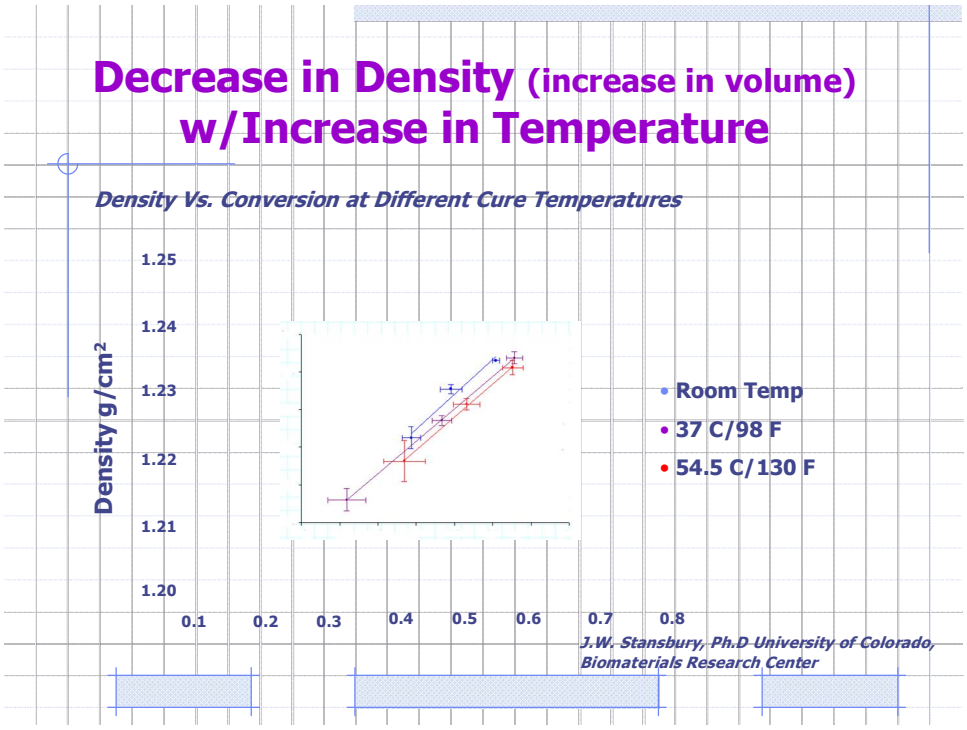

PERSONAL CORRESPONDENCE

Sent: Tuesday, September 28, 2004 11:20 AM
Subject: heat and shrinkage

Josh

I tried phoning you this morning. Sheldon gave me an idea of the question you raised regarding heating effects on polymerization shrinkage and yes, we have done some work to look at this. The attached file shows the results of doing varying degrees of partial polymerizations of an unfilled Bis-GMA/TEGDMA resin at three different cure temperatures. By doing the partial cures and constructing the linear fits between density and conversion, we have a good way to compare the data at different stages of polymerization. As you can see, we get lower density or less shrinkage for any given conversion for polymers formed at higher cure temperatures. One explanation for this is that the coefficient of thermal expansion for the monomer is greater than that of the cross-linked polymer. This means the polymerization takes place in an expanded state at elevated temperature, and some of this thermally induced additional free volume is not recovered upon polymer cooling. These results are based on final conversion and density measurements made after the specimens were stored for about a week. They are less dramatic than the even bigger differences that are observed during the polymerization process when we measure dynamic shrinkage and conversion simultaneously. Apparently, the initial lower density introduced by an

elevated cure temperature drifts upward as the specimen ages, but it does not reach the higher density obtained for the same degree of polymerization at ambient temperature. Let me know if that answers the questions you had.

Jeff

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