

$$w_{sp} = \frac{m_2 - m_3}{V}$$

where  $m_2$  is the mass of the specimen, in micrograms ( $\mu\text{g}$ ), after immersion in water for 7 days;  $m_3$  is the reconditioned mass of the specimen, in micrograms ( $\mu\text{g}$ ); and,  $V$  is the volume of the specimen, in cubic millimeters. The dental composite test specimen exhibited a water sorption value of approximately 8.9 micrograms per cubic millimeter per week ( $\mu\text{g}/\text{mm}^3/\text{wk}$ ).

In accordance with the ANSI/ADA Specification No. 27 Section A2.4 Polymerization Shrinkage, a Type 1 test specimen was prepared by first determining the volume of capillary per mm division of a glass dilatometer tube. The tube has a length approximately 250 mm graduated in divisions of 1 mm with a ground glass end containing a capillary of uniform diameter approximately 0.7 mm. The tube was filled to different levels with mercury to determine the volume of the capillary. Once the volume is determined, the tube was fitted into a density bottle. The density bottle and dilatometer tube were immersed in a water bath maintained at  $25 \pm 0.1$  C. for at least two hours prior to testing the specimen. Approximately  $10 \text{ mm}^3$  of the dental composite material was mixed, and placed in the density bottle in the bath. The dilatometer tube was removed from the water bath, and a stream of air was blown through the capillary to remove any remaining water. The tube was placed into the bottle, sealed, and wiped off to remove excess displaced water. The top of the tube remained just above the water level in the bath. At 90 seconds from the start of mixing, a base reading of the meniscus level in the capillary tube [ $H_1$ ] was recorded. The meniscus level was recorded at 1 hour after the start of mixing [ $H_2$ ]. The volume change of the specimen was calculated using the formula  $V = [H_1 - H_2] \times A$ . The volume [ $V$ ] of the specimen at room temperature was determined using a second density bottle as follows: determine the mass of the dry specimen [ $M1$ ], the mass of the density bottle filled with water [ $M2$ ], and the mass of the density bottle filled with the test specimen and water [ $M3$ ]. The mass of water displaced was calculated using the formula [ $M1 + M2 - M3$ ]. The volume of the test specimen was calculated using the formula [ $M1 + M2 - M3$ ] divided by the density of water at the ambient temperature.

When preparing a Type 2 test specimen, the body of a density bottle having a removable cover was covered with black adhesive tape, leaving an aperture 1.5 square centimeters. The volume of a capillary tube was determined per mm division by weighing the tube filled to different levels with mercury. The density bottle with cover and dilatometer tube was immersed in a water bath maintained at  $25 \pm 0.1$  C. for at least 2 hours prior to testing the test specimen. The tube was removed from the bath, and a stream of air was blown through the capillary tube to remove any remaining water. Approximately  $10 \text{ mm}^3$  of the test material was placed into the density bottle such that the material lied near the aperture. The tube was placed into the density bottle. The bottle was sealed and wiped to remove any excess displaced water. The top of the tube remained just above the water level in the bath. Meniscus readings were recorded until the meniscus remained stable such that a first reading [ $H_1$ ] was recorded based upon 3 readings at 2 minute intervals which did not differ by more than 0.1 mm each. The aperture cover was then removed and the test specimen irradiated through the density bottle. The test specimen was irradiated with the recommended light known to one of ordinary skill in the art for at least four times for the recommended time period

known to one of ordinary skill in the art. The meniscus level was read at 1 hour after irradiation to record a second reading [ $H_2$ ]. The volume of the test specimen was calculated according to the steps for the Type 1 test specimen.

The percent polymerization shrinkage of the test specimen is calculated using the following equation:

$$S = \frac{V}{V + V} \times 100\%$$

where  $s$  is the percent polymerization shrinkage; and,  $V$  is the specimen volume. The dental composite test specimen exhibited a polymerization shrinkage by volume of approximately 1.98%.

In accordance with ANSI/ADA Specification No. 27 Section 7.7 Depth of Cure, a Type 2 dental composite test specimen was prepared using a mold. The mold was placed on a strip of film having a thickness of  $50 \pm 30 \mu\text{m}$ , and transparent to the activating radiation, e.g., polyester, that covered a piece of white filter paper. The mold was slightly overfilled with dental composite material such that the material was free of air bubbles. A second strip of transparent film was placed on top of the mold. The assembly was placed between two glass slides, each having a sufficient area to cover one end of the mold, and pressed to exude excess dental composite material. The glass slide covering the strip of transparent film was removed. An external energy source as known to one of ordinary skill in the art was placed against the transparent film, and the dental composite material was irradiated for a time sufficient to achieve a depth of cure of at least 2 mm. The dental composite test specimen was then removed from the mold, and its height was measured with a micrometer to record the depth of cure.

The dental composite exhibited a depth of cure of at least 5 mm due in part to the glass fibers used in the filler component, which allow for bulk-fill application. The glass fibers serve as transparent pipes, which transmit light to the bottom of the restoration. The composites allow use of mechanical packing and condensing with its attendant advantages. The ground, densified, embrittled glass fiber filler of the present invention may further be utilized in numerous other applications in the practice of dentistry, including periodontal splitting, tooth replacement, tooth stabilization, bridge manufacture, and the like. All of these will not be described herein, as such dental operations are well known to those practicing dentistry, i.e. those of ordinary skill in the art.

While preferred embodiments have been shown and described, various modifications and substitutions may be made thereto without departing from the spirit and scope of the invention. Accordingly, it is to be understood that the present invention has been described by way of illustrations and not limitation.

What is claimed is:

1. A dental restoration comprising:

a polymeric material; and

a filler material, wherein the filler material comprises ground, densified, embrittled glass particles;

wherein the restoration has an elastic modulus of greater than approximately 15 GPa.

2. The restoration of claim 1, wherein

the elastic modulus is between approximately 15 GPa and approximately 22 GPa.

3. The restoration of claim 2, wherein

the polymeric material is formed from a precursor material that comprises at least one acrylate or methacrylate monomer.