Simultaneous Measurement of Thermal Expansion and Bi-Dimensional Morphometric Parameters

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Recently developed software tools allow simultaneous measurement of thermal expansion and extract several useful morphometric parameters from one single double-beam optical dilatometry test. The optical dilatometry technique is usually employed to measure thermal expansion and for sintering studies, by recording on digital cameras a sample's dimensional changes as a function of the temperature. Double-beam optical dilatometry uses two cameras mounted on two independent optical systems to frame the two opposite tips of a sample. This allows high resolution measurements, and allows capture of high definition images. The extent of the displacement of each side of the sample, regardless if expanded or shrunk, relative to the start of the test can be determined by analyzing the images captured by the two cameras with image analysis software. Each frame is a high definition picture of a 100 µm x 100 µm section of each of the sample's edges magnified up to the optical limit of the light (0.5 µm). From the sequence of these images it is possible to simultaneously study thermal expansion and microscopic surface morphology variations. Initial sample's edge is never a straight line, but instead consists of a series of surface imperfections spaced by quasi-linear segments. It is thus possible to determine novel surface properties as for instance angle, length, roughness, and deviation from linearity. While most of those properties remain substantially stable in the material's plastic range, where it is completely solid, they show an abrupt, dramatic, easy-to-detect discontinuity as soon as liquid phases form on the surface, or in case the material off-gases and its surface bubbles. The surface properties determined by optical dilatometry can then be compared with results of heating microscopy, which instead frames the whole sample and specifically aims at shape detection. Results on ceramic materials are presented and discussed.