500c A Novel Method to Measure the Thermo-Mechanical and Behavioral Properties of Pharmaceutical and Biological Material Powders and Pastes

David Gonzalez, Behic Mert, and Osvaldo Campanella

A novel method to measure the thermo-mechanical properties of pharmaceutical and biological material powders and pastes was investigated in this study. The measurements were conducted using a device comprised of a signal generator and receiver, dynamic and static force transducers, a stack of piezoelectric actuator and an accelerometer. The device was attached to a Texture Analyzer (TA-XT2). Measurements were performed in compression for powders and in constant height for pastes on a digital hot plate as temperature was ramped from 0 to 150°C. Three molecular weights of polyethylene oxide (200,000 Da, 900,000 Da, and 2,000,000 Da) were investigated, as well as, a variety of other pharmaceutical powders (felodipine, and HPMCAS). Biological materials were also tested and included ungelatinized corn starch, pre-gelatinized and fragmented corn starch, and corn protein (zein). All measurements were performed in their powder state, except for the ungelatinized corn starch. A one-to-one ratio paste of water and ungelatinized corn starch was mixed for measurement of gelatinization temperatures and melting. During measurement, the chosen powder or paste was squeezed between two plates at random frequencies and the resulting mechanical impedance was obtained. Since the real and imaginary parts of the complex mechanical impedance are related to the viscous and elastic components of the material being tested, it was shown that both damping and stiffness of the sample can be obtained and related to its rheological and thermo-mechanical states during temperature ramping. Measurements, which included detection of melting temperatures, glass transition temperature ranges, and gelatinization temperatures, were attained with the new technique and compared favorably with those obtained by Differential Scanning Calorimetry (DSC) and Dynamic Mechanical Temperature Analysis (DMTA) for validation purposes.