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SOL-GEL TRANSITION AND GELATINIZATION KINETICS OF WHEAT STARCH

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During the last decades, biopolymers and particularly starch-based materials showed growing interest in replacing oil-based materials. Their large availability and very low cost make thermoplastic starch one of the main renewable resource materials to be used as a raw material or to be blended with synthetic polymers. Compared to other natural polymers, their processing properties are very complex since they involve numerous physical processes and chemical reactions (water diffusion, granule expansion, gelatinization, decomposition, melting and crystallization). Gelatinization, which is closely connected to the other phase transitions, is the main phenomenon involved in the conversion process from starch to thermoplastic starch since it refers to the destruction of the crystalline structure that includes granular swelling, native crystalline melting and molecular solubilization.

Rheological and optical microscopy experiments were conducted to monitor the sol-gel transition occurring during the gelatinization process of starch granules. During the gelatinization phenomenon, the grains grow and dissolve into the plasticizer (glycerol) leading to a drastic increase of the elastic modulus (G') and the loss modulus (G''), and to their crossover as a consequence of the formation of a physical gel. The kinetics of gelation were studied by oscillatory shear experiments and the influence of parameters such as temperature or solid volume fraction on the gelation process was investigated. The variation of the gel time with temperature for any composition of glycerol/starch suspension was predicted from the Dickinson model. The relaxation exponent (n) was calculated by varying the frequency at constant solid volume fraction and temperature. The deduced value indicates that the gelation process is described by percolation theory. Apparent activation energies were estimated from the rheological data as well as from the optical microscopy data and were found to be nearly the same.