Thermal Stability of Gelatin Gels: Effect of Preparation Conditions on the Energy Barrier to Melting

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Aqueous gelatin solutions (sols) were prepared at the concentrations 10, 20, and 40 wt. %. The sols were converted into gels in two ways: isothermally, by quickly cooling to a constant temperature and annealing at it, and nonisothermally, by continuously cooling at a rate 1K/min. The melting kinetics of the resulting gels was measured by differential scanning calorimetry (DSC) performed at different heating rates. The DSC data were analyzed by an advanced isoconversional method that allows for detecting a variation in the experimental activation energy throughout a process. All isothermally prepared gels demonstrated that activation energy of melting decreases throughout the process in an almost linear fashion from about 170-190 down to about 90-100 kJ/mol. The decrease in the energy barriers points at continuously decreasing cooperativity of the process. It was found that the values of activation energy are not practically affected by the concentration and the time of annealing. However, raising the annealing temperature from 15 to 25C produced a gel that melts with activation energies that are respectively larger by 20-25 %. For nonisothermally prepared gels, activation energy of melting passes through a maximum of ~160 kJ/mol being around 120 at the beginning and end of the process. The behavior indicates that the process occurs via concurrent melting of diverse gel structures, which form on continuous cooling. Overall, the study suggests that the energy barrier to melting is primarily associated with the strength (i.e., size) of the crosslink centers (i.e., network junctions).