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Rheological Behavior of Starch-Grafted Itaconic Acid Co-Acrylamide Polymers: Insights from Frequency Sweep, Strain Sweep, and Temperature Sweep Tests

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ABSTRACT

The rheology of starch-grafted itaconic acid co-acrylamide polymers is essential for understanding their behavior and optimizing their applications in fields such as food, pharmaceuticals, and biodegradable materials. The modification of starch with itaconic acid and acrylamide enhances its functional properties, including improved mechanical strength, water retention, and thermal stability. Rheological characterization using frequency sweep, strain sweep, and temperature sweep tests provides valuable insights into the material's viscoelastic and mechanical properties under different conditions.

The frequency sweep tests at lower frequencies exhibit the dominance of the storage modulus (G'), reflecting gel-like properties. As the frequency increases, the loss modulus (G") rises. The starch-grafted itaconic acid co-acrylamide polymer shows a significantly higher G' than native starch, indicating an improvement in its elasticity and gel formation ability. This suggests enhanced structural integrity and potential for use in gel-based applications.

The strain sweep test, conducted at a constant frequency of 1 rad/s, reveals that the grafted polymer has a larger linear viscoelastic region (LVR) compared to unmodified starch, indicating improved mechanical stability and resistance to deformation. This behavior suggests that the grafting of itaconic acid and acrylamide increases the polymer's ability to withstand stress without undergoing structural failure, which is crucial for maintaining product consistency in various applications.

Temperature sweep tests from 25 to 100 °C assess the thermal stability of the starch-grafted polymer. The obtained data show that the grafted polymer exhibits enhanced thermal resistance compared to native starch, with the storage modulus remaining relatively stable at higher temperatures. This suggests that the grafting process strengthens the polymer's ability to retain its mechanical properties under elevated temperatures, making it more suitable for high-temperature applications. These data were also verified by the corresponding thermal analysis data.

In conclusion, the rheological analysis of starch-grafted itaconic acid co-acrylamide polymers reveal significant improvements in elasticity, mechanical stability, and thermal resistance, making these materials ideal for a variety of industrial and commercial applications.