The Contributions of Soy Protein Quaternary Structures on Viscoelastic Properties of Polyethylene Oxide/Soy Protein Composites

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More than four-and-a-half million acres of Kansas land were covered in soybeans in 2018, with Kansas farmers harvesting an average of 44 bushels per acre worth a combined total of $1.6 billion. Soybeans are mostly used for animal feed, however the capabilities of soybeans to produce functional materials have the potential to benefit sustainable materials applications and the Kansas agricultural economy. The goal of this study is to determine how quaternary structures of soy protein isolate (SPI) affect the viscoelastic properties of polyethylene oxide (PEO)/SPI composites, subjected to various denaturation and aggregation conditions of SPI. Ball milled PEO/SPI composites (PEO/10wt%SPI-BM) showed little variation in viscoelastic behaviors with that of pure PEO, with typical liquid-like behaviors. Composites made with water (PEO/SPI-H_2O) at 10wt% SPI concentration exhibited a weakened frequency dependence of storage (G') and loss (G") moduli, indicating a transition to solid-like behavior. This solid-like behavior was even more pronounced in PEO/10wt% SPI-DMSO (dimethyl sulfoxide) composites. A Tan(δ) below 1 for PEO/10wt%SPI-DMSO composites indicated the presence of a strong SPI network, which was responsible for such a transition. Composites made with both solvents at 1wt% SPI loading produced the highest dielectric constants, with the SPI-PEO interactions created in H_2O favoring dipole motions more than those in DMSO. α-relaxation of PEO also favored composites made with H_2O, with PEO/1wt% SPI-H_2O producing the fastest α-relaxation. However, network structures provided great resistance to α-relaxation, with PEO/10wt% SPI-DMSO composites producing the longest relaxation time, particularly at elevated temperatures.