GRADUATE STUDENT RESEARCH SEMINAR SERIES (2018)

THERMAL AND MECHANICAL CHARACTERIZATION OF NANOCOMPOSITE NANOFIBERS ELECTROSPUN FROM ULTRASONICALLY PROCESSED PEO-SIC SOLUTIONS

SPEAKER: STEPHANIE HUSLEY

Electrospun polymer nanocomposite nanofibers (PNNs) consist of nanomaterials confined within the polymer nanofiber matrix. PNNs composed of poly(ethylene oxide) (PEO) nanofibers reinforced with 3 wt% silicon carbide (SiC) nanoparticles were electrospun from PEO-SiC solutions prepared by ultrasonic liquid processing. A computational model was first used to determine the appropriate geometrical parameters of ultrasonic liquid processing for preparation of PEO-SiC solutions used for electrospinning. A design of experiments (DoE) study was then conducted to investigate the influence of solution viscosity, and power delivered by the ultrasonic probe to the solution – on the size of acoustic cavitation zone in the ultrasonic processing cell. Optimal geometric and process parameters determined from these studies were then used to prepare the PEO-SiC solutions. The mechanical and thermal properties of PEO-SiC PNNs were compared against neat PEO nanofibers fabricated using similar processing parameters, in order to determine the influence of nanoparticle reinforcement in PEO nanofibers on these properties. Uniaxial tensile testing of the nanofibers showed that the ultimate tensile strength (UTS) and strain-to-failure of PNNs was higher by 30% and 3.8% respectively, compared to neat PEO nanofibers. Thermal properties of the PNNs were characterized using thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC). The TGA analysis of the PNNs showed that the concentration of SiC nanoparticles used in the PEO-SiC solutions was similar to the SiC concentration in the electrospun PNNs. The TGA results are indicative of the effectiveness of ultrasonic liquid processing in enabling the polymer-nanoparticle solution to maintain the state of dispersion and distribution of nanoparticles throughout the electrospinning process. Additionally, the DSC analysis indicated a 14.5% increase in percent crystallinity of the PNNs compared to neat PEO nanofibers, thereby suggesting that the addition of nanoparticles can significantly influence the crystallization kinetics of PNNs. The enhancement in mechanical properties of the PNNs is thereby supported by the enhancement in nanofiber crystallinity. These results confirm that nanoparticle addition to polymer solutions using ultrasonic liquid processing can yield PNNs with enhanced mechanical and thermal properties, compared to neat polymer nanofibers. This study thus provides a baseline for further investigations regarding incorporation of much higher nanoparticle concentrations in PNNs using ultrasonic processing, and its effect on mechanical and physical property enhancement.

MONDAY, DECEMBER 3 3:00 PM

EIB 132