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Ultradrawing and Ultimate Pensile Properties of Ultra-High Molecular Weight Polyethylene Nanocomposite Fibers Filled with Cellulose Nanofibers

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Abstract : Novel ultrahigh molecular weight polyethylene (UHMWPE)/cellulose nanofiber (CNF) (F100CNFy) and UHMWPE/modified cellulose nanofiber (MCNF) (F100MCNFxy) as-prepared nanocomposite fibers were prepared by spinning F100CNFy and F100MCNFxy gel solutions, respectively. Cellulose nanofibers were successfully prepared by proper acid treatment of cotton fibers using sulfuric acid solutions. The best prepared CNF is with specific surface areas around 120 m2/g and a nanofiber diameter of 20 nm. Modified cellulose nanofiber was prepared by grafting maleic anhydride grafted polyethylene (PE-g-MAH) onto cellulose nanofibers. The achievable draw ratio (Dra) values of each F100MCNFxy as-prepared fiber series specimens approached a maximal value as their MCNF contents reached the optimal value at 0.05 phr. In which, the maximum Dra value obtained for F100MCNFx0.05 as-prepared fiber specimen prepared at the optimal MCNF content reached another maximum value as the weight ratio of PE-g-MAH to CNF approach an optimal value at 6. Similar to those found for the achievable drawing properties of the as-prepared fibers, the orientation factor, tensile strength (σ f) and initial modulus (E) values of drawn F100MCNF6y fiber series specimens with a fixed draw ratio reach a maximal value as their MCNF contents approach the optimal value, wherein the σ f and E values of the drawn F100MCNFxy fiber specimens are significantly higher than those of the drawn F100 fiber specimens and corresponding drawn F100CNFy fiber specimens prepared at the same draw ratios and CNF contents but without modification. To understand the interesting ultradrawing, thermal, orientation and tensile properties of F100CNFy and F100MCNFxy fiber specimens, Fourier transform infra-red, specific surface areas, and transmission electron microcopic analyses of the original and modified CNF nanofillers were performed in this study.

Keywords : ultradrawing, cellulose nanofibers, ultrahigh molecular weight polyethylene, nanocomposite fibers
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