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A Novel Method to Manufacture Superhydrophobic and Insulating Polyester Nanofibers via a Meso-Porous Aerogel Powder

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Abstract : Silica aerogels are well-known meso-porous materials with high specific surface area (500–1000 m2/g), high porosity (80–99.8%), and low density (0.003–0.8 g/cm3). However, the silica aerogels generally are highly brittle due to their nanoporous nature. Physical and mechanical properties of the silica aerogels can be enhanced by compounding with the fibers. Although some reports presented incorporation of the fibers into the sol, followed by further modification and drying stages, no information regarding the aerogel powders as filler in the polymeric fibers is available. In this research, waterglass based aerogel powder was prepared in the following steps: sol–gel process to prepare a gel, followed by subsequent washing with propan-2-ol, n-Hexane, and TMCS, then ambient pressure drying, and ball milling. Inspired by limited dust releasing, aerogel powder was introduced to the PET electrospinning solution in an attempt to create required bulk and surface structure for the nano fibers to improve their hydrophobic and insulation properties. The samples evaluation was carried out by measuring density, porosity, contact angle, sliding angle, heat transfer, FTIR, BET and SEM. According to the results, porous silica aerogel powder was fabricated with mean pore diameter of 24 nm and contact angle of 145.9º. The results indicated the usefulness of the aerogel powder confined into nano fibers to control surface roughness for manipulating superhydrophobic nanowebs with sliding angle of 5˚ and water contact angle of 147º. It can be due to a multi-scale surface roughness which was created by nanowebs structure itself and nano fibers surface irregularity in presence of the aerogels while a laye of fluorocarbon created low surface energy. The wettability of a solid substrate is an important property that is controlled by both the chemical composition and geometry of the surface. Also, a decreasing trend in the heat transfer was observed from 22% for the nano fibers without any aerogel powder to 8% for the nano fibers with 4% aerogel powder. The development of thermal insulating materials has become increasingly more important than ever in view of the fossil energy depletion and global warming that call for more demanding energy-saving practices.

Keywords : Superhydrophobicity, Insulation, Sol-gel, Surface energy, Roughness.
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