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Investigation on the mechanical properties of yarn produced by blending of PAN/Nylon nanofibers

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Abstract
Producing the yarn from nanofibres is considered as one of the great potentials in electrospinning. These yarns can be used in various fields of medical applications and filtration. Different polymers can be used in nanofiber yarn production. Many researches have been done on PAN nanofiber yarn production which these yarns had low mechanical properties without heat setting. The aim of this research is to improve mechanical properties of PAN nanofiber yarns by blending of Nylon66 nanofiber.To produce high tenacity Nylon66 nanofiber yarn three remarkable parameter was investigated. These parameters include solvent, molecular weight of polymer and polymer solution concentration. Results showed that solvent affect on mechanical properties of Nylon66 nanofiber yarn. To produce nanofiber yarn in high concentration of polymer solution, formic acid is suitable. In low concentration, mix of formic acid and chloroform (with 3 to 1 ratio) produce high tenacity nanofiber yarn. WAXD was used to confirm this result.
In the second approach, two different molecular weight of nylon66 polymer was used to produce yarns in two different ways: a) the same nanofiber diameter yarn b) the same viscosity of polymer solution. Two solvent systems as mentioned above were used in this process. Results indicate that in method (a) molecular weight affect on mechanical properties of Nylon66 nanofiber yarn related to solvent. It means that molecular weight has no effect on yarn mechanical properties with formic acid solvent. But in the presence of chloroform, molecular weight increase improves mechanical properties of yarns. In method (b) molecular weight increase improve yarn mechanical properties.
In the next approach, effect of solution concentration was investigated. Tenacity and extension of the nanofiber yarns were increased by concentration increasing. More increasing in concentration can decrease tenacity and extension. SSP-cl 10% solution produce nanofiber yarn with 120.2 MPa tenacity. In result, SSP-cl 10% solution was selected to produce hybrid yarns with PAN nanofibers. The equality of the diameter fibers in hybrid yarns is so important. Because of this PAN 10.5% solution with the same viscosity and nanofiber dimater with SSP-cl 10% was selected. Hybrid yarns of PAN/ SSP-cl was electrospun in different ratio. This hybrid had no difference in mechanical properties with PAN yarns. Auto-cl 12% is another solution with the same viscosity and nanofiber diameter with PAN 10.5%. This hybrid yarn was electrospun in different ratio too. PAN/Auto-cl 60:40 was improved in mechanical properties in compare with PAN yarns. Tenacity of the hybrid was 61 MPa which increased 47.7%, Extension was decreased 44.2% and Modulus increased 52% in compare with PAN yarns. SSP 14% is the other solution with the same nanofiber diameter with PAN 10.5% which was used to PAN/SSP hybrid production. Tenacity and modulus of PAN/SSP 40:60 increased 44.3% and 57.6%, respectively, in compare with PAN nanofiber yarn. Elastic recovery and moisture regain of PAN/Auto-cl hybrid was investigated. Elastic recovery of PAN/Auto-cl 60:40 increased 38%. Hybrid yarn regain increased with increasing in Nylon66 percentage.
Key words: mechanical properties of nanofibre yarns, polyacrylonitrile, Nylon66, wide angle X-ray diffraction, hybrid nanofibre yarn, Elastic recovery and moisture regain.