Effect of Processing Conditions on the Properties of Hybrid Lignin/PAN Carbon Nanofibers

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In order to develop low cost carbon fibers, lignin nanofiber (LNF) mats were fabricated by electrospinning of a blend solution of polyacrylonitrile (PAN), lignin, and polyethylene oxide (PEO) in N, N-dimethylformamide (DMF). The LNFs were subjected to heat treatment processes including thermostabilization, carbonization. The effects of the PAN/lignin mass ratio and the heating rate of thermostabilization on the fiber morphology, fiber diameter, and mechanical properties of the CNF mats were investigated. As the lignin content in the precursor decreases, the diameter of the as-spun LNFs increases whereas the diameter, surface, and structure of the CNFs do not change significantly. The strength of CNF mats was found to increase as the proportion of lignin decreases, for slow heating rates. At faster heating rate (5˚C/min), the strength of the CNF mats (with different PAN/lignin ratios) remains unaffected. As the heating rate increases, the strength of the CNF mats increases greatly due to the fusing of the CNFs. The diameter and surface features of the CNFs were found to be unaffected by the heating rate. At slow heating rates of 0.5-2 ˚C/min, the mechanical properties of PAN/lignin-based CNF and PAN-based CNF mats were similar. However, the strength of the PAN/lignin-based CNF mats was found to be much higher than that of pure PAN-based CNF mats at a fast heating rate (5˚C/min). The mechanical properties of lignin carbon nanofiber was found to be affected by the complex interaction of thermal stabilization heating rate and carbonization temperature.