Design of Carbon Fibers For High Performance Composites With Improved Modulus and Balanced Compressive Strength

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The developments of the next generation of carbon fiber reinforced composites requires a large increase in modulus and a balanced tensile and compressive properties on the basis of maintaining high elongation strength. The modulus and elongation strength of composites exhibit linear relationships to carbon fibers, while the compressive strength relies on carbon fiber surface topography, interfacial coating and epoxy matrix. For modulus improvement, we tend to prepare carbon fibers with combined high strength, high modulus and high ductility using gel spinning. Based on the mechanism study of gel spinning to regulate the physical structure of fibers, a high-performance polyacrylonitrile (PAN) precursor with good roundness was prepared by gel spinning through the selection of suitable solvent system and the adjustment of spinning process. The modulus and strength of the PAN fiber are 1.06 GPa and 18.6 GPa, respectively. The resulting carbon fibers show relatively good performance in lab scale, and the corresponding continuous line experiments will be conducted. Additionally, for the improvements of the compressive strength of composites, the following strategies are used: (1) the increase of carbon fiber diameter from 5 to 6 μm leads to more than 10% improvements; (2) for the first time, the surface morphology control of PAN and its carbon fiber surface from smooth to orderly grooves is achieved by dry-jet gel spinning, which is expected to improve the stress transfer and compressive strength; (3) polar/non-polar functional group control on carbon fiber surface for better stress transfer. Through above efforts, we hope to obtain a new high performance composite with 25% higher modulus and 30% higher compressive strength than T800H composites.