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THE EFFECT OF POLYMERIZATION TECHNIQUES ON THE PROPERTIES OF CARBON FIBER

Abstract

Carbon fiber(CF) is a kind of special fiber with the light weight and the high carbon content more than 90 percent. Because of the characteristics of high strength, high modulus, heat-resistance, heat-resistant, low thermal expansion coefficient, fatigue-resistance, electrical and thermal conductivity, CF has been widely used in the aerospace industry. Polymerization is the first and the most important step of CF preparation, the quality of the spinning dope will influence the spinnability of the CF precursor and the mechanical properties of CF eventually. Therefore, this paper mainly studies the effect of polymerization techniques on the properties of CF. The polymerization techniques studied are as follows: The different number of comonomers in the polymerization including the binary copolymerization, the ternary copolymerization and the quaternary copolymerization; the heating model of the polymerization including the polymer solution heated continuously and with two-stage; the hydrophilic modification of the spinning dope including the dope aminated before and after the copolymerization. The conversion rate of the polymerization, the viscosity of the dope, the molecular weight and the distribution of the molecular weights have been characterized for studying the microstructure of the polymer solution. The morphologies of the fiber have been characterized by the Scanning Electron Microscope (SEM) and Metallographic Microscope. The thermal properties of the fiber have been analyzed by the Differential Scanning Calorimeter (DSC). The crystallization and orientation of the precursor have been characterized by the X - ray Diffraction (XRD).The mechanical properties of the fiber have been characterized by the Electromechanical Testing Machine. It was found that the ternary copolymerization was the ideal polymerization system and the tensile strength of the CF could be above 4900MPa. Heating the polymer solution with two-stage could obtain the ultrahigh molecular weight polyacrylonitrile (PAN) which improved the structure of the spinning dope and provided the long molecular chains in the precursor, so the mechanical properties of the fiber was improved. Aminated comonomer could increase the copolymerization speed rate, the hydrophilicity of the copolymer, and cause the lower temperature during the preoxidation stage.
keywords:carbon fiber, copolymerization, microstructure, thermal properties