氏名	ZHU PENG	
学位の種類	博士（ 工学 ）	
学位記番号	甲　第　６９５　号	
学位授与の日付	平成３０年９月３０日	
学位授与の要件	信州大学学位規程第５条第１項該当	
学位論文題目	Evaporation-induced surface modification of high performance fibers. 高性能繊維の蒸発誘起表面改質に関する研究。	
論文審査委員	主査　教　授	鮑　　力民
	教　授	後藤　康夫
	准教授	夏木　俊明
	准教授	若月　薫
	教　授	田上　秀一（ 福井大学 ）

論　文　内　容　の　要　旨

Evaporation-induced surface modification of high performance fibers

Double-coated TiO_2 nanoparticles (TMP) were prepared using a single-pot fabrication method in NMP. These particles contained a chemically bonded layer of γ-MPS and a layer of PEI that was absorbed via Van der Waals forces. All fabrication and experimental processes were conducted in NMP, which prevented the agglomeration of particles during the centrifugal drying process. The double-coated TiO_2 nanoparticles (TMP) exhibited improved dispersion in NMP because of steric stabilization of the polymer chains that were absorbed to the particle surface and depletion stabilization of the free polymer in the solvent. In the long-term dispersion stability test, we found that there was a common cycle during the process of the sedimentation in which the suspension shown turbid firstly, then upper clarification and lower turbidity appeared, and then a clear interface layer appeared, and then the part over the interface layer turbid again. The double-coated TiO_2 nanoparticles (TMP) also exhibited improved dispersion within the PEI nanocomposite films and increased interface adhesion between the TiO_2 nanoparticles and the PEI matrix. Therefore, the nanocomposite TMP/PEI film exhibited increased mechanical properties and UV resistance.

Poly(p-phenylene benzobisoxazole) (PBO) fibers were modified using the evaporation-induced surface modification method. Through this new method, nano-TiO_2 particles encapsulated with polyetherimide (PEI) chains were firmly adsorbed on the fiber surface. The results indicate that besides some nanospheres resulted from the initial agglomeration of PEI-encapsulated nano-TiO_2, a uniform coating layer with thickness of 84 nm was formed by absorption of polyetherimide (PEI)-encapsulated nano-TiO_2. This coating method changed the surface morphology of the PBO fibers, enhanced the surface roughness, and increased the poor UV resistance of untreated PBO fibers.

To improve the UV resistance of poly(p-phenylene benzobisoxazole) (PBO) fibers, a sub-100-nm-thick coating layer was prepared on PBO fibers by evaporating the suspension of polyetherimide encapsulated nano titanium dioxide (TiO_2) particles absorbed around the fiber surface. The effects of this evaporation-induced surface modification on the structure and properties of PBO fibers were investigated. The content ratio of nano-TiO_2 particles to PEI, the contents of nano-TiO_2 particles and PEI, and the evaporation method greatly influenced the surface modification of the PBO fibers, as confirmed by scanning electron microscopy observation. The ultraviolet (UV) resistance of the PBO fibers was improved after surface modification, which confirmed by single-fiber tensile strength test.

PEI nanoparticles were prepared on CF surfaces via an evaporation-induced surface modification method for which the particle diameter could be controlled by changing the PEI concentration. A possible formation mechanism for the PEI particles was proposed: the volatilization process during this modification was very long because of the nonvolatile nature of NMP, the PEI chains could form some separate solvent-containing balls before the evaporation ends, then shrinks with evaporation, eventually forming PEI nanoparticles. When the PEI concentration was not higher than 0.2%, the nanoparticle morphology was almost hemispherical; when the PEI concentration was over 0.2%, many spherical particles appeared above the hemispherical nanoparticles.