

IMPROVEMENT IN DYEABILITY OF ULTRA-HIGH MOLECULAR WEIGHT POLYETHYLENE FIBER BY ELECTRON-BEAM GRAFTING

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ABSTRACT

Ultra-high molecular weight polyethylene (UHPE) is one of high performance fibers that generally has high crystallinity inducing high mechanical properties. Due to this high crystallinity, however, its processability such dyeing and functionalization is quite unsatisfactory. In this study, we grafted vinyl monomers bearing sulfonate group and phenyl groups on UHPE fiber by high energy radiation, electron-beam (EB) and the influences of the monomer type and irradiation conditions on dyeability of UHPE fiber with cationic dye and disperse dye were investigated. For experiments, UHPE fabric kindly provided by Toyobo Co., Ltd. were treated with three vinyl monomers, sodium p-styrenesulfonate (p-SSNa), 2-(4-Benzoyl-3-hydroxyphenoxy)ethyl acrylate (BHPE) and N-(4-Hydroxyphenyl)methacrylamide (HPMA). EB irradiation was carried out in different procedures, pre- and post-irradiations. In the pre-irradiation method, the fabric was exposed to EB first, then dipped in the monomer solution and aged at 80 degree C for 6 hrs to promote polymerization while the fabric was dipped in the monomer solution first, then exposed to EB and aged in the post-irradiation method. The grafting amount of p-SSNa on UHPE that was gravimetrically calculated, increased up to around 5%omf with increasing irradiation dose and the monomer concentration while those of BHPE and HPMA which bear phenyl groups, were up to 45%omf and 14%omf that were much higher than water soluble p-SSNa. Generally post-irradiation resulted in larger grafting amount. The color depth K/S of p-SSNa grafted-fabric dyed with cationic dye, methylene blue, increased up to 3.7 with increment of the grafting amount. The maximum K/S of BHPE-grafted UHPE dyed with CI Disperse Blue 56 was 4.9 and deep blue enough for commercial applications. However, hand-rubbing test indicated its poor resistivity. An observation of the fiber cross section by an optical microscope suggested the grafting on only fiber surface. Finally, high grafting of hydroxyphenyl monomer on UHPE by EB irradiation improved its dyeability though the color fastness to rubbing was insufficient.