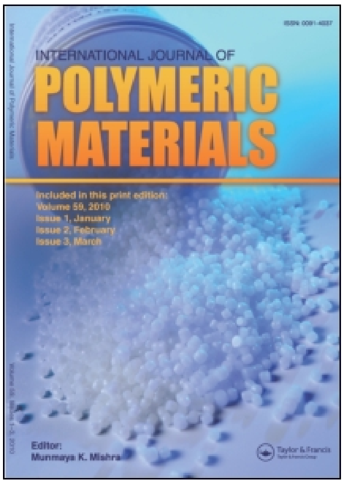

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Improvement in Adhesion by Biochemical Surface Treatment

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Improvement in Adhesion by Biochemical Surface Treatment

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The treatment of synthetic fibers surface with microoganisms to enhance the interaction at fiber/binder interface is investigated.

KEY WORDS Synthetic fibers, adhesion, microbial treatment, surface treatment, polyimid, poly-*p*-amidobenzimidazole.

INTRODUCTION

Interaction at the fiber/matrix interface is very important for strength and other properties of organoplastics and other composites. Poor wetting of synthetic fibers by molten polymers and low adhesional strength can be overcome by modification of fiber surface. The chemical, plasma-chemical or radiation methods of modification are complicated and have energy and other limitations.

The fiber surface treatment with microorganisms is technologically simple and ecologically harmless.

RESULTS AND DISCUSSION

Organic fibers of polyimide (PI) and poly-*p*-amidobenzimidazole for composites were tested. The fibers were subjected to microorganisms Bacteria Bacillus and Pseudomonas and mold fungi Aspergillus suspended in an aqueous nutrient for 7 to 14 days under standard conditions and moderate aeration. After the treatment was finished, the fibers were sterilizated in hot water and dried. In order to evaluate wetting and adhesion in filament/binder systems, polysulfone (PSF), polycarbonate (PC) and epoxy resins were used.

TABLE I

Properties of monofilaments after treatment

Fibre (Diameter ,nm)	Treatment	Strength, GPa	Wetting angle, °		Adhesion strength with PC, MPa
			PFS, 300°	Epoxy, 100°	
PI	Control	0.78	38	26	39.2
	Aspergillus	0.72	25	13	54.9
PAB1	Control	3.90	41	27	45.7
	Pseudomonas	3.67	26	19	57.3
	Bacillus	3.96	22	15	71.8

The microorganisms produce powerful proteolytic enzymes capable of breaking NH—CO bonds in proteins. Adaptability of the microorganisms allow some of them to produce enzymes that can break similar bonds in fibers.

The carboxylic groups liberated can undergo further etherification if alcohols, e.g. polyvinyl alcohol, are present in the nutrient. Thus, the chemistry of filament surface undergoes essential changes. This process depends on the type of microorganisms, the duration of treatment, and the nutrient composition. All this makes to control surface properties of fibers.[1-3] Since enxyme molecules are relatively large, and the internal layers of highly oriented strong fibers are packed densely, microbiological degradation affects only the fiber surface. The strength and appearance of fibers would not be changed by the treatment.

Microbiological treatment results in a greater degree of interaction at the fiber/binder interface. For all types of fibers, wetting with molten polymers of different chemical origin (both thermoplastics and epoxy oligomer) was improved. Adhesion of fibers to thermoplastics matrices also increased (Table I).

The microbiological treatment allowed to improve organoplastics properties. The ultimate compressive stress increased by 1.8 times. Besides, the observed failure mechanism of the composite was changed. Tests indicated the increased energy required to damage the interphase layer in the composite that contains modified fiber and the prevailing processes of multiple failure of fibers or blocks in the material. The photomicrographs of failed surfaces show variations in the failure mode for the composite containing modified fiber. In the materials with original fiber the latter is usually pulled out of the matrix owing to low adhesion, the modified fiber usually breaks without interfering contact with the matrix.

CONCLUSION

The treatment of synthetic fiber with microorganisms appears to be a simple and efficient method of improving compatibility of fibers with polymeric matrices and the strength of the composites.

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