

Degradation Cracking of Poly(ethylene terephthalate) Filaments by Methylamine and *N*-Propylamine

M. HAGHIGHAT KISH, S. BORHANI

Textile Engineering Department, Amirkabir University of Technology, Tehran, Iran 15914

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ABSTRACT: Poly(ethylene terephthalate) (PET) filaments were degraded with aqueous solutions of *n*-propylamine and methylamine. The treated materials were examined by chemical microscopy and physical and mechanical methods. After partial degradation by aqueous solutions of amines, the surfaces of the filaments cracked. Direct observations of the cracking pattern formation and the changes in the physical properties of the filaments led to an explanation for the cracking pattern formation. The cracked patterns showed the swelled and deformed structure of the filaments. This explanation of the possible mechanisms for crack formation goes further than those discussed in previous research. © 2000 John Wiley & Sons, Inc. *J Appl Polym Sci* 78: 1923–1931, 2000

Key words: aminolysis; poly(ethylene terephthalate); filament; etching; degradation; stress cracking

INTRODUCTION

The effects of monofunctional amines on poly(ethylene terephthalate) (PET) fibers and films were studied previously from different points of view^{1–23} and recently a review article was published.²⁴ There are patents describing the application of amine treatments to polyester-fiber fabrics²⁴ to improve properties. From the industrial point of view, in the production of polyester fibers the spin finish components may produce regular crack patterns that affect the mechanical properties of the filaments.²⁵

During aminolysis amines attack the electron-deficient carbonyl carbon where chain scission and amide formation occur, which results in a reduction of the molecular weight of the sample.^{1,3,24} The techniques used in several studies^{5,7,10,11,13,15} mainly rely on the controversial

assumption that the ordered or crystalline regions are insoluble and the amines predominantly react with the noncrystalline regions.

Some reports show surface etching with a regular pattern that occurs upon amine treatments of PET fibers and films.^{4,13,14,16,17,20,21} Other reports^{16,20,21} suggest that amine etching of fibers is a stress-sensitive degradation process. The cause of crack formation is believed to be due to the residual stress developed during production processes and previous heat setting treatments, which is released by aminolysis.^{10,16,20} Naik and Bhat²¹ believe that the combination of degradation and the presence of built-in stress enhance cracking. Holmes²³ used vapor and an aqueous solution of *n*-butylamine to differentiate the different locations of attack by vapor and an aqueous solution of amine.

In the present study the problem was looked at with another viewpoint. It is believed that if the mechanism of formation of cracking patterns by amine etching is understood and the parameters involved are determined, then selecting the suitable amine treatment can produce proper surface

Correspondence to: M. Haghighat Kish (mhkish@cic.aku.ac.ir).

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