Multiple-Beam Fizeau Fringe-Pattern Analysis Using Fourier Transform Method for Accurate Measurement of Fiber Refractive Index Profile of Polymer Fiber

M. A. EL-MORSY,[1] T. YATAGAI,[1] A. HAMZA,[2] M. A. MABROUK,[3] T. Z. N. SOKKAR[2]

[1] Institute of Applied Physics, Yatagai Laboratory, University of Tsukuba, Tsukuba, Ibaraki 305-5873, Japan

[2] Physics Department, University of Mansoura, Mansoura, Egypt

[3] Physics Department, Damietta, University of Mansoura, Damietta, Egypt

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ABSTRACT: In this article the Fourier transform method is applied to analyze multiple-beam interference Fizeau fringes. The real part of the inverse Fourier transform is used to estimate a theoretical pattern. This pattern coincides with the experimental one. A derivative-sign binary image of the interference pattern is also used in automated determination of the contour line of the fringe pattern, regardless of the quality of this pattern. A correlation between the pixel size and the accuracy of the measured fiber refractive index is presented. © 2002 Wiley Periodicals, Inc. J Appl Polym Sci 85: 475–484, 2002

Key words: multiple-beam Fizeau fringes; refractive index profile; polyethylene fiber; fringe analysis; Fourier transform

INTRODUCTION

The study of the optical properties of fibers is a valuable task in fiber research because their structural characteristics are manifested in their optical properties. There are many parameters that affect the characteristics of optical fibers, such as the fiber radius, refractive index profile, numerical aperture, material dispersion, and attenuation. The refractive index profile and material dispersion have strong affects on the group delay characteristics of an optical fiber.[1] The values of the refractive indices of textile fibers, using plane polarized monochromatic light vibrating parallel and perpendicular to the fiber axis, give useful information about the molecular arrangement of these fibers. They can also provide information about the structural and mechanical properties of these fibers. Thus, refractive index measurements using accurate methods have been studied by numerous authors.[2–9]

Different techniques have been developed to determine the fiber refractive index profile. All of these techniques have their own advantages and disadvantages. The ideal measuring technique should be nondestructive and applicable to any preform and have high accuracy, high resolution, and easy measurement and processing of data.[10]

The multiple-beam Fizeau fringe system is a sensitive optical technique, and it needs no special sample preparation for measuring the refractive index profile of textile and optical fibers.[2,7,8,11] Interference fringes are formed across the fiber when immersed in a silvered liquid

Correspondence to: M. A. El-Morsey (elmorsy@optlab2.bk.tsukuba.ac.jp or elmorsym@yahoo.com).

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