# Refractive Index Profile of Polyethylene Fiber Using Interactive Multiple-Beam Fizeau Fringe Analysis

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

[1] Physics Department, Faculty of Science, University of Mansoura, Mansoura, Egypt

[2] Physics Department, Faculty of Science, Demietta, University of Mansoura, Demietta, Egypt

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**ABSTRACT:** A multiple-beam interference Fizeau fringes technique is used to measure the refractive index profile of drawn polyethylene fiber. The interference fringe shift in the fiber region has been analyzed automatically using an interactive algorithm. The method takes into consideration the refraction of the light beam when crossing the fiber. Plane polarized light vibrating parallel and perpendicular to the fiber axis are used to obtain the refractive index profiles of both cases. These profiles are used to determine some optical parameters such as the birefringence, the optical orientation function, the polarizability per unit volume, and the value $\Delta\alpha/3\alpha_o$, which related to the material structure. The reliability of the method is tested considering the results of drawn polyethylene fiber samples using the manual technique. © 2000 John Wiley & Sons, Inc. J Appl Polym Sci 77: 3099–3106, 2000

**Key words:** refractive index profile; polyethylene fiber; multiple-beam Fizeau fringe analysis

## INTRODUCTION

Multiple-beam interference of the Fizeau type is used by numerous authors to investigate textile and optical fibers.[1–4] Fiber investigation using this technique gives accurate results due to the sharpness of the interference fringes compared with two-beam interference. The methods in which a matching immersion liquids are used give good results on fiber refractive index profiles, especially when both liquid and fiber cladding have refractive indices close to each other. However, it is essential to take the effect of refraction of the beam through the liquid/fiber interface into consideration[4–6] to minimize the error in the measured data.

*Correspondence to:* M. A. Mabrouk.

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Automatic fringe pattern analysis is a powerful and inexpensive digital image-processing technique. It is used in many areas such as aerodynamics,[7] metrology and nondestructive testing,[8] and fiber investigation.[9] In fact, the source of producing the fringe pattern has little or no effect on the analysis algorithm.[10] The multiple-beam interference manual technique, used in fiber characterization, is a time-consuming process because the interferogram must be photographed, enlarged to a suitable magnification then the required data are obtained from the magnified image. These data can be obtained accurately and faster by analyzing the interference fringes with the aid of a computer program to determine the refractive index profile of the fiber.

In this article, an interactive fringe pattern analysis system is used with prepared software by ourselves, to measure (in a few minutes) the refractive index profile and some structural parameters as the optical orientation function, po-