1 INTRODUCTION

1.1 OVERVIEW OF FIBER OPTICS

The fiber optic industry began to expand on a large scale following the invention of the gallium arsenide (GaAs) semiconductor laser. Applications for fiber optic are diverse, from communication to sensors. Nevertheless, the potential for expansion is truly enormous. Amongst the vast range of technologies used for sensor systems, the distributed fiber optic sensor is unique in being able to provide a practical means by which a measurand may be determined at any point along a sensing fiber, extending to several tens of kilometers. Whilst it is always possible to use a large number of point sensors to meet this requirement, this is obviously a very cumbersome and costly solution. Distributed fiber sensing provides a much better solution by using only a single fiber to monitor a property that is dependent on the required measurand at the required number of points along the fiber.

Optical distributed fiber sensing is versatile in terms of its function due to the capability of exploiting invaluable information about properties of interest, such as temperature or strain, continuously along a length of sensing fiber. This technique can be utilized to monitor strain profiles in large structures such as dams and bridges to give a continuous, preventive monitoring. In addition, distributed sensing can be used to observe temperature contour along power cables. Since optical fiber is flexible and immune to electromagnetic interference, it is an attractive transducer for these applications.

In an optical sensing system, optical fiber plays an important role as a sensing medium that captures the changes in the measurands and influence the behavior of the propagating light field in the fiber core. Therefore, it is crucial to understand the fundamental of optical fibers and the scattering effects that are exploited in extracting the sensing signals. This chapter discusses the basics of optical fiber, which includes its characteristics, and the basic principles of Rayleigh and Brillouin scattering.

1.1.1 Optical Fiber

An optical fiber takes a form of a cylindrical dielectric waveguide (nonconducting waveguide) that can carry light along its axis, by the process of total internal reflection. The fiber consists of a core surrounded by a cladding layer, both of which are made of dielectric materials. It is necessary to have the refractive index of the core greater than that of the cladding in order to confine the optical signal in the core [J.M. Senior (1992)], as illustrated in Figure 1.1. The treatment of distributed fiber optic sensing has focused entirely on physical parameters of optical fiber that would be affected by temperature and strain. Some of the important properties of optical fiber are presented in the following sections.