Chapter 1

Introduction

In 2009, Charles K. Kao has been awarded Physics Nobel Prize from The Royal Swedish Academy of Sciences for his influential contributions on the phenomena of light transmission in optical fibers for the communication use [1]. Chronically, the studies of component of light have been started since years ago and the research has growing rapidly, for example the analysis of light transmission inside the pure silica fiber has been recognized by Nobel Laureate recently. Now, the uses of optical fibers are ubiquitous. Optical communication allowed us to be updated with world-wide news, for examples the news of the outspread of Influenza A H1N1, economic downturn originated from Wall Street, or political developments in our homeland. The importance of this ability to communicate was made all too clear when services were severely interrupted within and with East Asia, Europe and U. S resulting from seven of the eight major undersea fiber cables near southern Taiwan being damaged due to an earthquake of 7.1 on the Richter scale on the 26th of December, 2006. This incident immediately affects the usage of telecommunication and these effects translated into drops in the stock market and foreign currency trading in most of the Asian countries. More significantly, some of the international banks had to stop providing the Automated Teller Machine (ATM) services to their customers. Furthermore, the breakdown of the communication highways had created some financial chaos in Wall Street, Shanghai, and Hong Kong [2, 3]. Such is our modern day dependence to optical fiber-based communication technologies.

As the wheel of progression continues to revolve, the applications of the optical fibers have been expanding in the areas like fiber sensing and bio-medicine; and yet, communication is still the primary market. Year 2009 is considered as the year of communication services revolution for Malaysian with the kickoff of world first *Worldwide Interoperability for Microwave Access* (WiMAX) service to public offered by Packet One Networks (Malaysia) Sdn. Bhd, and structuring WiMAX core network as well as services providing in Peninsular Malaysia by YTL e-Solutions Bhd (YTLE) with supports from her partners: Cisco, Clearwire Corp. and Samsung Electronics Co. Ltd [4-6]. As a counter action, Telekom Malaysia Bhd. (TM) started to roll-out High Speed Broadband (HSBB) service which implement through fiber-to-the-home (FTTH) technology [7, 8]. Announcements of these communication technologies are essential to sustain the growth of daily data carriages as well as to boosts up country's economy.

Even though the use of fiber is responsible for optical communications, it is not capable to process signal in a complex manner. The use of optical planar lightwave circuit can be seen as the right candidate. This optical planar device can be designed to handle functions like wavelength division multiplexing (WDM) and de-multiplexing, and optical switching. For optimum performance of the optical planar devices, waveguide alignment is a key factor. A proper alignment method will not only enhance the overall performance, it also can be used to characterize the losses in optical waveguide. Hence, the nature of the device alignment is interesting for this work by developing the alignment algorithms or using technique of software development. The aim of developing alignment algorithms are to characterize, fabricate device coupling of planar waveguides with better coupling efficiency of device is the target for this work. The same software development tool is also used to design optical circuit for UV writing waveguide which can be used for rapid device prototyping.

Thesis structure

Fabrication of silica on silicon to produce planar optical waveguides is the main activity in the laboratory, which the fabrication process will briefly present in Chapter 2. Here, the chapter begins with some historical background on the integrated optics which gives contribution to the development of optical planar waveguide; and also includes the progress of silica fabrication technology. The techniques of developing channels in the core layer are presented as well.

Chapter 3 is a chapter focused more on the theory of the waveguide alignment as well as some proposed theories by others researchers related to the UV writing of the waveguide channels. Waveguide alignment can be studied from electromagnetism theory of the light propagation within waveguide which eventually leads to the simplicity of formulation for coupling efficiency. Whereas the idea of UV written waveguide at the laser wavelength of 244nm is solely depends on the alteration of refractive index due to the photosensitive nature exhibited by glass when the glass is exposed to UV. The correspondent refractive index change is in the order of fraction of positive values, and therefore such modifications arise as a channel in the waveguides.

Chapter 4 will present the core of this work: software development for the waveguide alignment and writing. Algorithms and flow charts were discussed while presenting the software construction. Experimental setups for both activities are also included. Results obtained from the efficiency and developed software algorithms will be elaborated thoroughly in Chapter 5. And last but not least, conclusions and potential improvements for future work will be discussed later in Chapter 6.

References:

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