UNIVERSITI TEKNOLOGI MARA

TUNABLE HIGHLY MULTIMODE POLYMER OPTICAL FIBRE POWER SPLITTER

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ABSTRACT

Optical power splitter based-on polymer optical fibre (POF) is a crucial component in an optical short distance application that requires optical power splitting. The evolution of optical applications provides a large market for the optical power splitter; hence has created demand for variable optical power splitter. The fixed power splitter device has been dominated the highly multimode waveguide area where it cannot be adjusted to amend once it had been fabricated. To the best of my knowledge, only two research works have been reported on tunable splitter device that employs POF. From the literatures, the tunable POF splitter device inherits slightly different splitting ratios, high loss, low controllable resolution and small variable range. The tunable splitter was developed based on angular misalignment technique within a hollow waveguide Y-junction, so predetermined power is allowed to split out asymmetrically to two output ports. The tunable power splitter was demonstrated based on the predefined end shape of POF and also compared to a standard design. The reshaping of fibre end from circular to rectangular cross section greatly reduces the interstitial space between POFs and mold-insert's waveguide; hence reduce major loss. Two designs of optical power splitter of dynamic power tuning capability with low excess loss and high tuning resolution are presented. The splitters utilized Y-junction waveguide design and one without a junction. The splitter with no junction employing circular to rectangular POF converters achieved a lower excess loss of 0.7 dB for a 50:50 power-splitting compared to Y-junction splitter employed circular POFs achieved an excess loss of 1.68 dB. Non-sequential ray-tracing simulation and mathematical expression of both the splitter designs are confirmed by theoretical investigation as well. The tunable splitter device was tested as vibration detection and surface profiler. There are three significant findings achieved from the research work. Firstly, by using misalignment technique the various deflection of the input-POF toward fixed output fibres produce a wide range of splitting ratios of 0% to 100%. The other finding is, the device achieves the tunable splitting ratio with superior resolution of 0.5 µm with 0.1% power variation by deflect light at 5-µm step-movement across the fibre ends of two receiving output-POFs. In addition to the tunability, the proposed device exhibits a very low loss due to the reshaping of the POF along the mold-insert.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

In this information age, internet has evolved dramatically; hence, the transmission of enormous amount of data is increasingly everyday [1]. The colossal demand of data transmission capacity has driven the rapid development of light wave technology. Modern optical communications begin almost six decades ago, where the semiconductor laser was invented [2] and the high-speed information transmitted through glass-fibre was demonstrated [3]. The demand for high data rate in short distance communication is driven by the availability of the broadband services [4]. Polymer optical fibre (POF) is the best candidates to the last 100-meter due to their excellent properties, electromagnetic immunity and simplicity in handling. Thanks to the POF flexibility and cost efficiency deployment that leads to practical devices development such as couplers, combiners, splitters and sensors. At the present time, the POF technology is greatly used in various industries including medical treatment, telecommunications, sensing, vehicles and many more.

The success of the POF over their glass counterparts are originates from the large structure of the waveguide up to 1-mm^2, allows millions of modes transporting signals to the receiver for less than 100-meter length. The large core enables relaxation of connector tolerances with any light sources and photodiodes, which saves total cost of the system. Furthermore, POF is a prominent selection for great flexibility and resistance to impacts and vibrations [5][6]. The research on this waveguide is limited due to the fact that highly multimode devices have smaller market demand due to high attenuation of polymer material compared to that of silica-based glass material. The attenuation of polymer-based material at 650-nm wavelength is 150 dB/km [7] and 0.2 dB/km at 1550 nm for a single-mode silica fibre. Thanks to the simplicity of components installation with a low operating cost, attracted the opportunity to thousands of new research areas.

POF power splitters are an important component in systems that require a passive bus-type architecture. The primary purpose of POF splitter device is to send and