Chemically etched fiber-optic coupler with tunable splitting ratio

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1. Introduction

Fused coupler, an all-fiber passive branching component plays a key role in fiber optic communication network for light branching/splitting, wavelength multiplexing/ de-multiplexing, filtering, polarization selective splitting etc. [1,2]. The fabrication of fused-coupler has been achieved using several methods namely, Flame fusion, Optical irradiation etc. [3] and the technology is fully developed. However, an already fabricated fused coupler having a fixed power-splitting ratio at a particular wavelength cannot be achieved for any other wavelength unless the coupling segment gets reformed. In this research, we developed a dynamic light-coupling circuit by chemically etching a pair of twisted, identical SMF-28 fibers and tuning their coupling ratio by dipping the segment into a liquid with variable refractive indices (RI). The performance of such devices in terms of twisted length, number of turns and the excitation wavelength has also been investigated.

2. Experimental setup

Initially, the active segment of the coupler is formed by twisting two identical and cleaved SMF-28 fibers and fixing it on two micro-positioner stages. The composite optical circuit is then made in contact with a potential etchant (40% conc. Hydrofluoric acid, HF), placed on a 3-D translational stage (MTS series, Holmarc), to reduce the overall dimension of the constituting fibers such that evanescent wave interaction can take place. The input port of this 2×2 system is then connected to the 1310 nm source and the output ports (transmitted port and coupled port) to the detectors (S-142C, Thorlabs) to monitor/control the coupling such that the preservation of the coupler having a desired splitting ratio can be attained. As soon as the etchant is removed, the segment is then dipped in the NaOH solution to detach the remaining HF solution followed by washed in de-ionized water, till the moment output power stabilize, to make device contamination-free. The test segment is then fixed on a π-shaped frame which is further immersed in the glycerin solution of varying concentration from 10% to 80% (equivalent to RI change from 1.344 to 1.443). The output power from both the detector is measured through power meter (PM320E, Thorlabs).

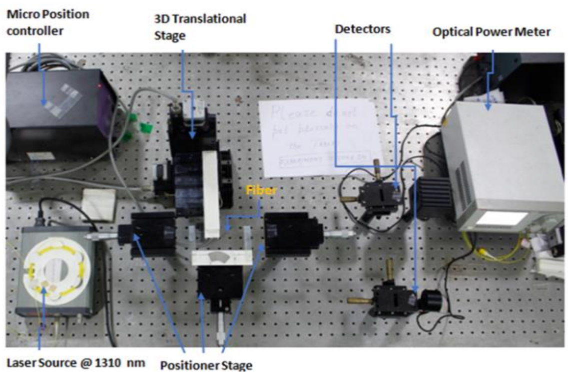

Fig. 1: Experimental setup

3. Results and discussion

Out of a series of experiment that has been carried out, in Fig. 2, the direct-port and coupled-port power of a typical test coupler (characterized by cleaved length ~ 8cm, twisted length ~ 4cm, number of twist = 4) is plotted at the operating wavelength 1310 nm. An increase in the coupling efficiency from 18.5 dB to 2.4 dB is achieved with the increase in glycerin concentration (λ=1.31 μm). However, the efficiency can be enhanced further from 10.7 dB to 0.11 dB at λ=1.55 μm. The spectral characteristic of such coupler has also been studied by illuminating the input port with the broadband source and measuring the output spectra through optical spectrum analyzer (Agilent 86146B). A complimentary output at the coupled port with respect to the transmitted port is observed for a wavelength band from 1200 nm to 1600 nm. The qualitative demonstration through a theoretical model is underway and would be presented in detail in the conference.

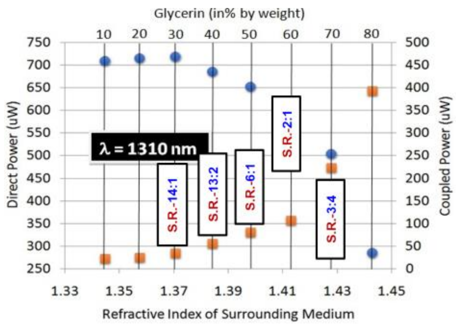

Fig. 2: The variation of direct port and coupled port power as a function of glycerin concentration at 1310 nm

References

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