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Fabrication and characterization of Low cost Plastic optical fiber couplers

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Abstract — *Plastic optical fiber (POF) couplers/splitters are become an essential tool in an optical networks. Its function is to couple or split any optical signals in a network and these couplers are known as passive devices. The requirement of POF couplers are increasing in day to day when compared to silica fibers and copper. A simple low cost 2x2 coupler and 1x2 couplers is fabricated using acrylic cement in this paper. The POF's are finely polished with known length and depth by removing the certain part of cladding and attached by placing the two fibers adjacent to each other with acrylic cement. The characterization of these couplers has been done and found that it produces 52:48 coupling ratio with an insertion loss of 2.83 dB. The light source used here is the laser diode with wavelength of 650nm and it is injected into the coupler and at the output a photo detector is used to measure the light in terms of photo current and later it is converted into current gain in terms of dB. This coupler fabrication process is simple and robust and different approach compared to other fabrication techniques in terms of cost and performance.*

Key Words: **POF coupler, Acrylic cement, passive optical device, coupling ratio.**

1. INTRODUCTION

In all applications of POF optical networks, proper couplers are required to split or combine the optical signals. Recently, POF couplers are widely used in the home networking and automobiles, so that the demand for POF devices has been increasing. Long-haul optical communication systems mainly used single-mode silica fibers with core diameter of 4–10 μm and cladding diameter of 125μm. Such systems have optical transmission systems transmitting multiple channels of data, video and audio signals over worldwide distance, and they can reach high traffic speed and large volume of transmitted data. In order to achieve lower costs in middle and short-haul optical communications system not single but multimode silica fibers with core diameters of 50 or 62.5 μm are to be used. To get further low cost communication systems multimode fiber waveguides having large core diameters have been introduced in practice. For that a good alternative is plastic optical fiber (POF) with core layer diameter 980 μm and diameter of the cladding layer 1,000 μm. Because of rapid widespread home networks, automotive and special optical sensors the demand for POF splitters/couplers is getting increased.

2. Mechanical Side Polishing

Here in this paper we used Standard step index Plastic optical Fiber of diameter 2.2mm. We have taken an U grooved metal plate with different dimensions and we choose to remove 500 microns of the inner core of the plastic fiber. After placing the fiber on this groove we used different polishing films/grit papers until 500 microns was removed.

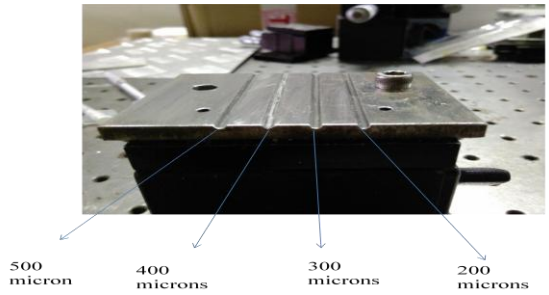

Fig 1: U shaped groove metal Plate

2.1 Attached with acrylic cement

After completion of side polishing for both fibers we attached this polishing region with a acrylic cement which contains Polymethylmethacrylate (PMMA) material. Here the polishing length is 55mm and polishing depth is 500microns i.e. exactly half of the plastic optical fiber and by using optical tools fibers aligned adjacently each other without any movement using syringe we added little amount of cement in between them and pressed gently and left at room temperature for 24 hours.

2.2 Connectors and Polishing Fiber End

The connectors used in this paper is HFBR model V pin Plastic connectors attached these connectors four ends and using an mechanical polishing Disk in 8 figured motion polished on different polishing films.

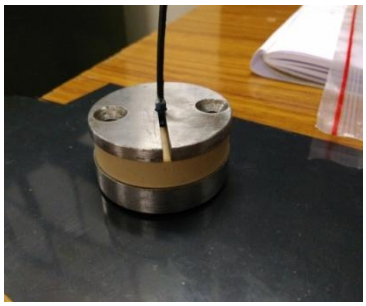

Fig 2: Polishing puck Design

2.3 Packaged Coupler

After attaching the connectors so to protect the coupling region we used small metal tube around it to cover the whole region so it will not bend or break and also finally an heat shrink tube is covered so then it will be look like well packaged coupler.

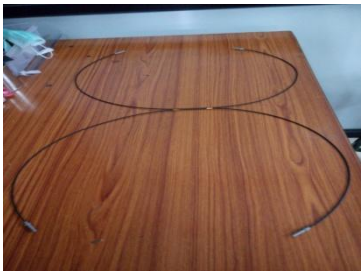

Fig 3: 2x2 Coupler with connectors fixed

2.4 1x2 coupler

The procedure is same as like fabrication of 2x2coupler for 1x2coupler too but here the polishing and coupling region is at the fiber end. The fiber ends of length (55mm) where side polishing is done with a polishing depth of 500 microns. The Polishing is done with different Grit papers from thicker to thinner and observed with digital microscope until the light emits indicates cladding is removed completely and now it looks like exactly half part of the core, and same steps is repeated to the second fiber and both with same length and polishing depth.

Figure 1.6: Zoomed 2x1 coupler fiber end

The packaging for 2x1 coupler is done by keeping a small needle across the coupling region which will be attached with superglue and so that it will not bend and again a heat shrink tube is covered around the needle and its looks rigid and apply araldite finally so this will be a better way to protect the coupling region

to avoid transmission losses and increase the coupling efficiency.

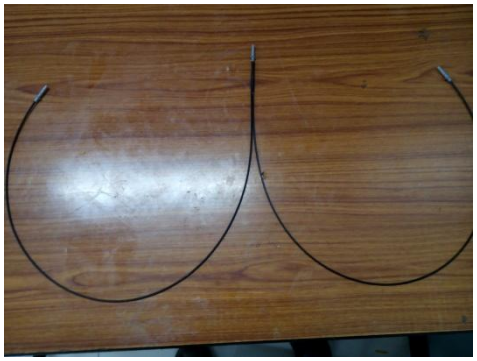

Figure 1.7: 2x1coupler with fixed connectors

3. Results

Table -1: Comparison of Coupling Ratio of two couplers

Couplers	Insertion loss	Excess loss	Coupling ratio
2x2	7.7dB	2.21dB	60:40
1x2	8.23dB	3.74dB	52:48

4. Conclusion

There are many fabrication Techniques for the couplers like heating and fusing, Tapering, Planar wave guide etc, but this coupler is made without any heating process in it and using a acrylic cement to attach these fiber and can be used as good coupler which shows 52:48 coupling ratio with 1x2 coupler. Plastic Couplers are mainly used in automotive and home networking and in many optical sensors.

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