Affect of Temperature on Packaging of Fused Polarization Maintaining Directional Coupler for Fiber Optic Gyroscope Application

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ABSTRACT

Polarization Maintaining (PM) directional coupler is one of the important components used for splitting and combining of optical power used in Fiber Optic Gyroscope (FOG). In this paper, we present effect of temperature on the performance of polarization maintaining directional coupler used in FOG. The effect of temperature on various coupler parameters like coupling ratio, insertion loss, excess loss and extinction ratio are analyzed and tested.

1.0 Introduction

Polarization Maintaining (PM) fiber directional is critical component used in FOG. PM fiber directional couplers with stable coupling ratio and Extinction Ratio (ER) are required to achieve a low random walk coefficient and good bias stability [1, 2] over the temperature range. Small PM fiber directional couplers are required for miniaturization of the different control, tactical and inertial grade FOG. The couplers need to be robust to perform well in environmental condition. Although polished coupler is giving the low loss and low polarization cross –talk but it has the limited performance over the temperature range [3], in addition to more fabrication time. Fused PM fiber directional couplers are ideal candidate for performance over the temperature range as fabrication process is easier than the polished PM fiber directional couplers at much lower cost. The critical parameters of PM fiber directional coupler are selection of fiber, epoxy used and packaging process. The packaging of PM directional coupler is carried out as primary packaging using quartz substrate, secondary packaging using the stainless steel tube and booting. During the primary and secondary packaging the epoxy used should not apply any stress during the temperature variation.

2.0 Fabrication and packaging process of PM fiber directional coupler

It consists of fiber PM fiber axes alignment, pulling and tapering of fiber, fusion and packaging. Alignment of birefringent axes is critical process which is very important for getting good ER. The birefringent axes of the two fibers are aligned parallel to each other using the precise rotating chucks and camera using as shown in Fig [1].

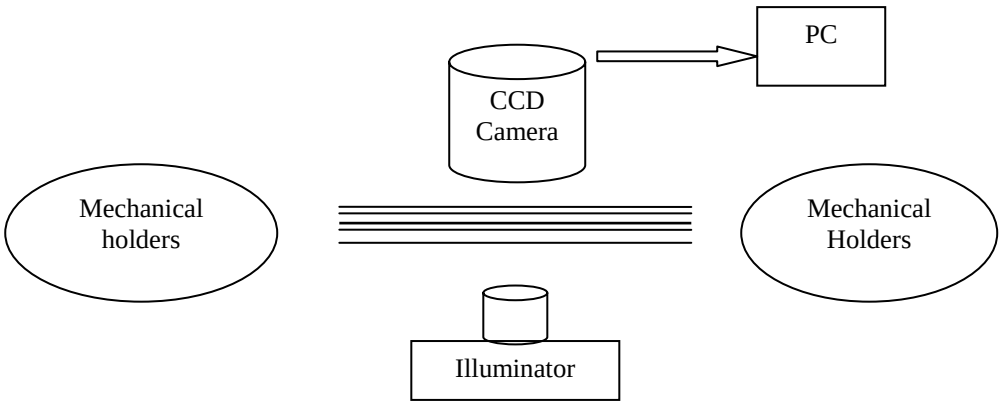

Fig [1]: Birefringent axes alignment assembly

The puling and tapering of the fiber affects the coupling ratio, so pulling is PM fiber is done online while monitoring the out put coupling ratio during the fusion process. During the fusion and pulling process the heating torch will automatically come to the top of the aligned fibers. This enables the fusion of the PM fibers. After the fusion process is over the packaging assembly come below the fused fibers then primary packaging will be done on the quartz substrate next step is secondary packaging on the stainless steel tube and booting using RTV epoxy to sustain the harsh environmental condition. Fig [2], Fig [3] and Fig [4].

Fig [2]

Fig [3]

Fig [4]

3.0 Test results of PM fiber directional coupler

Temperature ^{0}C	Coupling Ratio	Extinction Ratio (dB)	Insertion Loss dB
-20	46.99/53.01	7.766	3.88
25	47.78/52.22	26.5	3.762
65	48.42/51.58	26.3	3.714

Table [1]: Test results after booting.

We have fabricated PM fiber directional coupler of coupling ratio better than 48/52, loss less than 1.0 dB and Extinction Ratio better than 25 dB at room temperature. During the fabrication of the PM fiber directional coupler parameters like coupling ratio, loss has been monitored by the work station [4]. Tapering process has been optimized in such a way that the coupling ratio should not vary with respect to the input polarization [5].

We have finalized the PANDA fiber based on the yield of the couplers. After primary packaging we tested the coupler over the temperature -20 ^0C to 65 ^0C results has been reported in Table: [1].

4.0 Conclusion

The fabricated PM coupler is having coupling ration of 48/52 and ER of 26.5 dB at the room temperature which meets the FOG requirement. But at -20 ^0C ER is reduced to 7.7 dB due to epoxy used. So in our future work we have to optimize the epoxy used at varies packaging stages which gives the performance the required in FOG over temperature of -20 ^0C to 65 ^0C .

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