Reliability of passive optic splitting devices is compared with fused fiber type optical coupler and planar lightwave guide type optical coupler.

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[Abstract]

This test data informs to compare components from different manufactured coupler type. On the point of reliability, less than 1x8 output branching number, fuse type coupler was more stable than PLC type coupler. But more than 1x8 output branching number, PLC type coupler was more stable. This test data showed critical branching point, on the point of reliability.

1. Introduction

Korea telecom has established a base plan "Strategy of X-PON" to construct an infrastructure of access networks. In the passive optical device, the optical coupler is essential optical component to construct the PON transmission infrastructure. Within the recent years, passive optical networks (PON) for telecommunication and CATV have been developed which now are on the level to replace classical copper-based networks. In this new network, the passive optic NxN splitting devices distributes the optical signal. The Fig 1 shows PON architecture.

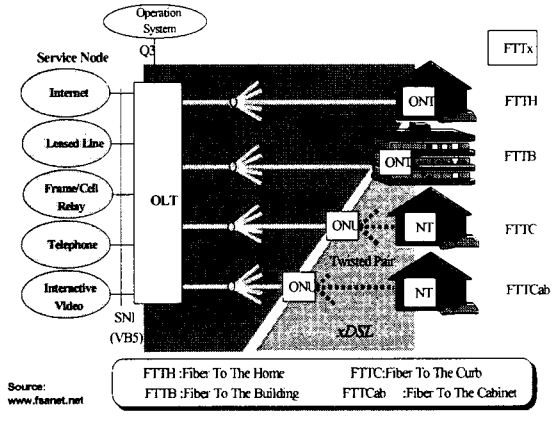


Fig 1. PON Architecture

In this network, most of the branching components are located in the subscriber loop where the environment normally is not very well controlled. Therefore, large temperature changes and high humidity effects may stress the components. So the reliability of passive optic splitting devices is important. We have developed and have tested the reliability of two different manufacture type branching devices (fiber type and PLC type coupler). Figure 2 show branching components made by different technologies.

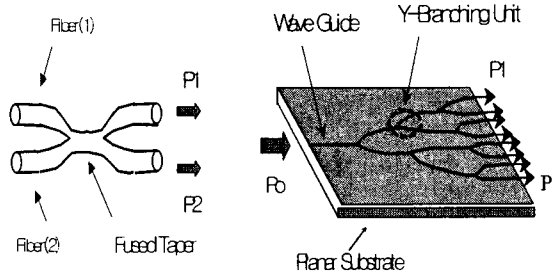


Fig 2. The branching component by different technologies. (a) Fiber type (b) PLC type

2. Test performs and Results

In the paper, on the respect of reliability of passive optic splitting devices, fused fiber type optical coupler and planar lightwave circuit type optical coupler, are compared and the experimental results of two type 1xN branching devices are presented.

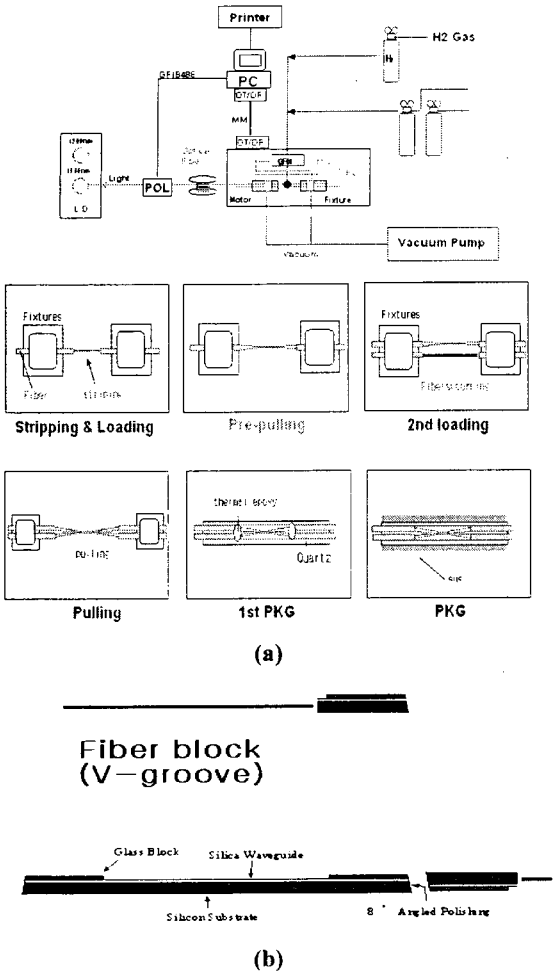


Fig 3. The fabrication of different technologies. (a) Fiber type (b) PLC type

The test performed is based on Bellcore spec. The test samples of two type branching devices have been made by KT (fiber type and PLC type coupler). The several sample of each type; 1x2, 1x4, 1x8, 1x16, 1x32 Fiber type branching devices and 1x2, 1x4, 1x8, 1x16, 1x32 of PLC type branching devices, were tested. The increase of loss during the Pre- and Post-temperature cycling test in the temperature range from -40℃ to +80℃ in combination with water immersion test in distilled water at 43℃ for a period of 6days was measured.

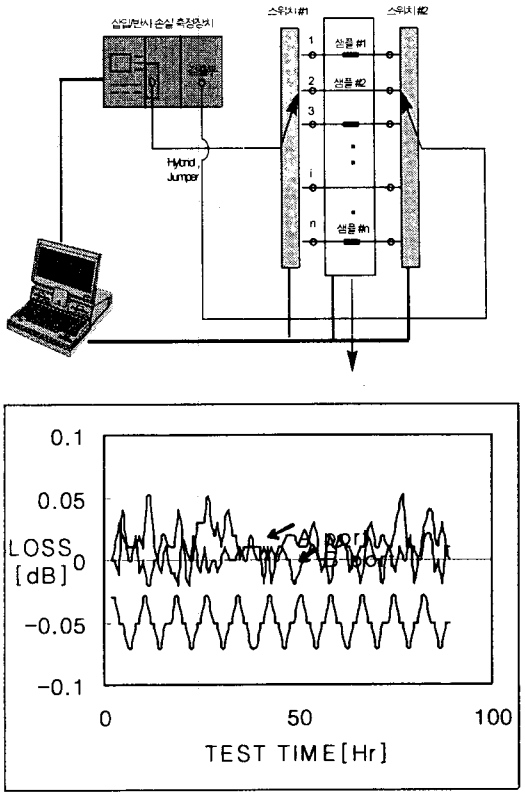


Fig 4. The test of branching component . (a) test set (b) Test result of fiber type

The loss variation was measured in the aging test under high and low temperature.

In the case of Fiber type branching devices, the increasing loss of 1x2, 1x4 did not exceed 0.3dB and the average increasing loss of 1x8, 1x16, 1x32 are about 0.5dB, 0.9dB, and 2.3dB respectively. In the case of planar lightwave circuit type branching devices, increasing loss of 1x4 was about 0.9dB, and the average increasing loss of 1x8, 1x16, and 1x32 did not exceed 1.4dB. In water immersion test, all components showed very stable results.

<Table1> Failure mode and failure mechanism for passive fiber optic branching devices

Failure modes	Failure mechanisms

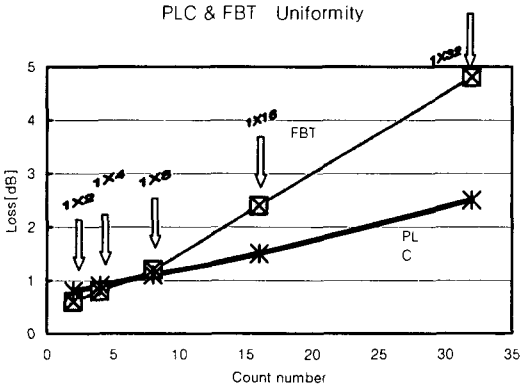
Increase of insertion loss	Fracture of the tapered resigns in fused fiber couplers Fracture of the interface between fiber and chip for integrated optical components
Increase of back reflection	Fracture of splice, fused tapers and interface as above Refractive index change of index matching material in interface in PLC

3. Failure mechanisms and failure modes

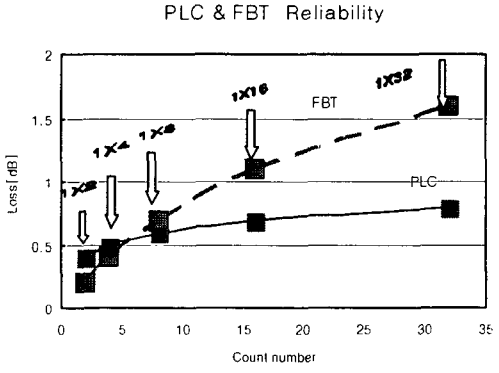
The principal failure modes and failure mechanisms for passive fiber optic branching devices are listed table 1. These failure mechanisms are driven by harsh environmental conditions. Especially the combination of high temperature and high humidity stresses the components and may lead to failure if these conditions are applied over long time.

4. Conclusion

This test data informs to compare components from different manufactured coupler type. On the point of reliability, less than 1x8 output branching number, fuse type coupler was more stable than PLC type coupler. This reason is that in the case of Fiber type branching devices, to realize 1x32 branching devices with 1x2 fused fiber coupler, it is necessary to concatenate 31 couplers. But more than 1x8 output branching number, PLC type coupler was more stable. This reason is that in the case of planar lightwave circuit, integrated optical devices are available as monolithic components on the chip and loss variation of temperature cycling is small at branching point located inside PLC, while most of loss variation in PLC type coupler dues to with fiber and PLC connection. This test data showed critical branching point, on the point of reliability, "What type coupler will be used in the PON network system, fused type or PLC type!"



(a)



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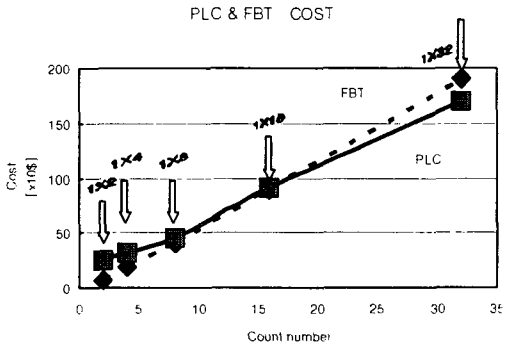

(c)

Fig 5. The compared with two component . (a) uniformity (b) reliability (c) cost