"PC connection with low insertion loss using GCF"

Masanao Iida Kazuya Saito Masanori Wada Hirokazu Takeuchi

Process & Product Development Department, Electric Products Division

Nippon Electric Glass Co., Ltd

1. Introduction

Most of the connectors for optical communication are connected with both ends of them in Physical Contact. At this time, the insertion loss depends on the offset of the fiber at the part of PC by the concentricity of the inner diameter toward the outer diameter and eccentricity of the fiber toward the inner diameter. Therefore, the relation between the offset and the insertion loss are shown in the following equation;

$$\text{Loss} = 4.34(d/(W/2))^2 \qquad (1)$$

Where; d: the offset, W: the core diameter of the fiber.

We made some investigations with our GCF (Glass Ceramic Ferrule) about the relation between the dimensional accuracy of the ferrule and the optical fiber, and the insertion loss.

2. Experiment

First, we fabricated a connector with a ferrule. Its concentricity is less than 0.7 μm, and the inner diameter of the ferrule is 1 μm bigger than the optical fiber. With the connector, we made the investigation on the properties of the insertion loss with connecting randomly without tuning of the offset of the fiber. Assuming that the clearance between ferrule hole and fiber is 1 μm (the concentricity: less than 0.7 μm), the maximum offset must be 1.7 μm. The insertion loss results in 0.5dB at maximum by the equation (1).

3. Results

The results of the experiment are shown in Figure 1.

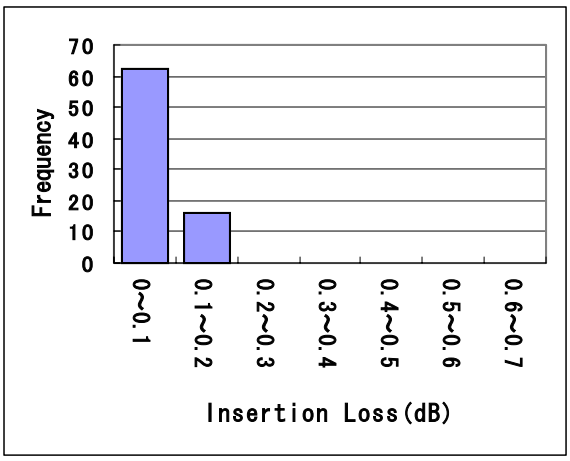

Figure.1 Insertion loss of GCF

In figure 1, we got the data of insertion loss 0.06dB in average, 0.14dB at maximum and 0.03dB in STD respectively. These results indicate excellent properties of the insertion loss compared to the above-mentioned value, 0.5dB. The value of the eccentricity of the fiber toward the inner diameter was less than our assumption. That is supposed to be its reason. Assuming that the optical fiber is 0.4 μm centering on the ferrule, the above-mentioned results and our calculation will be matched.

Then, with SEM, we observed the face of the GCF, which the fiber is inserted. The results are shown in Figure 2. It shows that the fiber is located in the center of the ferrule. The reason is supposed that the inside and outside of GCF are properly controlled rough and the rough surface effects to the fiber centering of the inner diameter. Also, this effect was observed only with GCF. It was not shown with the smooth and transparent glass ferrule (Figure 3) or Zirconia ceramic ferrule. The results of the insertion loss by Glass Ferrules and Zirconia ceramic ferrules are shown in Figure 4 and Figure 5.

The dimension of the Zirconia Ferrule that we prepared is as following;

・Concentricity:1.0μm

・Inner diameter of the ferrule:1 μm bigger than the optical fiber

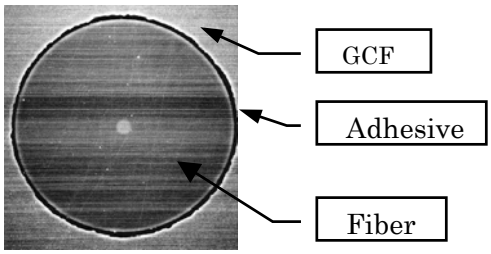

Figure.2 SEM image of GCF

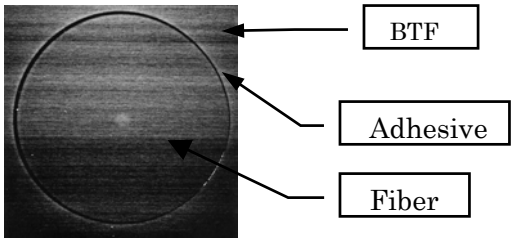

Figure.3 SEM image of BTF

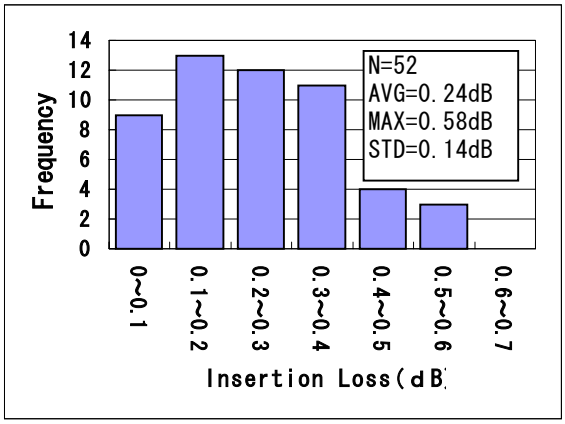

Figure.4 Insertion loss of Glass Ferrule

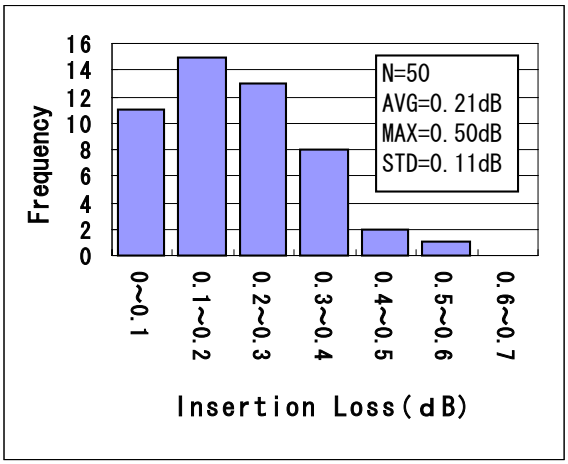

Figure.5 Insertion loss of Zirconia ceramic Ferrule