

High-temperature resistant optical fiber components with durable glass-ceramic coating

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Introduction

Recently, as signal power in optical communication networks increases, temperature of optical components tends to increase. High-temperature resistance of those components has been limited by organic adhesives used in the components for fixing optical fibers. In this study, we fabricated a heat resistant optical connecting component without organic adhesives by direct coating of a glass-ceramic onto single mode optical fibers (SMF). This paper describes the coating method of the glass-ceramic, and some properties of the coated SMF as optical components.

Experimental

A $\text{Li}_2\text{O}-\text{Al}_2\text{O}_3-\text{SiO}_2$ glass-ceramic which can be formed by drawing¹⁾ was used as the coating material. The composition and some properties of the glass-ceramic are shown in Table 1. Figure 1 is a schematic diagram of the coating process. The crystallized preform (12.5 mm in outer diameter, 1.0 mm in inner diameter, 200 mm in length) was drawn at 1200°C with a bare SMF (0.125 mm in diameter) which was fed into the center-hole of the preform. Dimensions, bending strength and optical propagation properties of the coated products were evaluated.

Results and discussion

Figure 2 shows a cross-sectional view of the glass-ceramic-coated SMF (GC-SMF). It was confirmed that the glass-ceramic bonded directly to the surface of the SMF with no gap, as shown in the inset in Fig. 2. GC-SMF showed accurate dimensions with sub-micrometer precision and the bending strength of 750 MPa. Figure 3 indicates optical connection loss of GC-SMF connected with standard optical terminals. The connection loss consists of propagation loss and alignment loss, which are given by the slope of the straight lines and the intercepts of ordinate, respectively. As shown in the figure, it was confirmed that GC-SMF has a low connection loss comparable to that of normal SMF. This was the case after the exposure to a hot-humid condition (85°C-85%RH) for 700 h. In addition, no change was observed in the connection loss even after the exposure to high-temperature (900°C) for 1h. This suggests that GC-SMF has excellent thermal durability under the high-temperature conditions in optical systems.

Conclusion

A novel technique for coating SMF with a glass-ceramic has been developed. It was confirmed that GC-SMF has suitable optical connection properties and durability. GC-SMF is expected to be applied to high-temperature resistant optical components used in high-power optical networks.

Reference

1) A. Sakamoto et al. Proc. 18th Int. Conf. Glass, C6,62(1998)

Table 1 Composition and properties of the glass-ceramic used for coating SMF

SiO ₂	Al ₂ O ₃	Li ₂ O	MgO	composition (mol%)					Total
				TiO ₂	ZrO ₂	K ₂ O	ZnO	BaO	
73.0	11.9	5.2	1.7	2.5	1.0	1.7	2.6	0.4	100.0
crystalline phase				CTE 30-1000°C (10 ⁻⁷ /°C)	softening point (°C)	melting point of crystalline phase (°C)	Young's modulus (Gpa)		
β-spodumene solid solution				30	1135	1220	80		

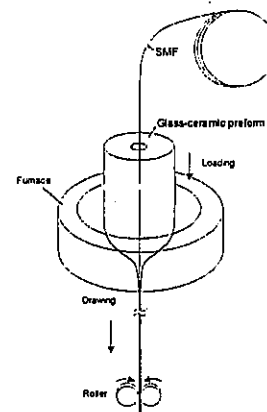


Fig. 1 Schematic diagram of coating process

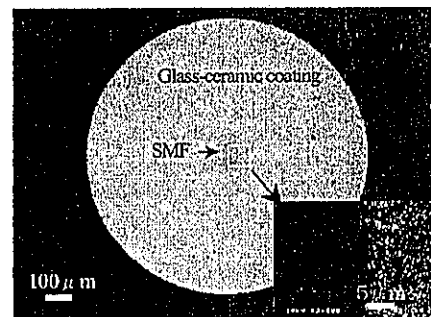


Fig. 2 Cross-sectional view of GC-SMF

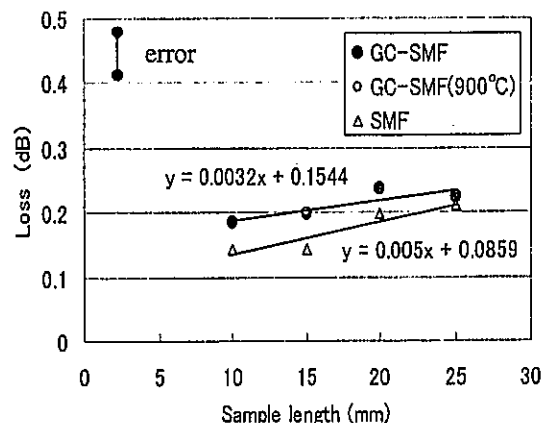


Fig. 3 Optical connection loss of GC-SMF