Thermally stable and low-loss optical waveguide using optical-fiber-embedded epoxy matrix for optical printed-circuit board applications

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ABSTRACT

This paper proposes a low-loss and thermally stable waveguide component for optical printed-circuit board (OPCB) applications. The proposed waveguide component is formed using silica fiber as a waveguide medium and seamlessly linking the 90°-bent parts to the planar optical layer. The component was designed through considerations of optical loss, mechanical failure, thermal stability, module packaging, and applicability in PCB system in determination of fiber-core-diameter, bending radius, waveguide-mounting epoxy material, and packaging structure. In the experiment, we used a multimode fiber with 100μm-core-diameter, a MT-ferrule component to hold the 90°-bent fiber and to package the surface modules, and a 353ND thermo-curable epoxy resin to mount the ferrule parts on planar fiber layer. The optimized bending radius was selected near 3mm to avoid mechanical failure. The measured average value of the insertion loss for the whole waveguide component was as low as -0.145dB. In the thermal test similar to the PCB lamination process, the loss characteristics were not significantly degraded. In the packaging of optical transmitter (Tx) and receiver (Rx) modules, we used a ceramic lid on which optical devices and IC chips were integrated and guide holes were formed. The optical Tx/Rx modules assembled on the waveguide plate showed a successful data transmission up to 8Gbps. The results demonstrate that our proposed waveguide component can be applied for a simple fabrication of OPCBs.

Keywords: Optical interconnection, optical waveguide, optical printed circuit board (OPCB), thermal stability, bending loss

1. INTRODUCTION

Optical interconnection is a promising solution to overcome the limitations of electrical interconnection, such as power consumption, bandwidth, electromagnetic interference, and impedance mismatching. Optical interconnection also meets high-speed data transmission in computer systems. As demands for high speed data transmission increase dramatically, electrical interconnect reaches its uppermost limit. Moreover, data rates continue to grow higher so that solutions for compact packaging of data processing chips and data transmission lines are needed. Thus, extensive researches are carried out, based on the integration of optical interconnection lines and components in/on printed circuit board (PCB) such as packaging of optoelectronic components on optical PCBs (OPCBs), in which optical waveguide layers are embedded in the PCB.