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Multi-pixel type high speed photodetector array for optical wireless communications

Toshimasa Umezawa, Yuki Yoshida, and Naokatsu Yamamoto
National Institute of Information and Communications Technology, Tokyo 184-8795, Japan
e-mail: toshi_umezawa@nict.go.jp

In advanced wireless communications in indoor applications, optical wireless system (free space optical communication: FSO) using laser lightwave has a big potential of increasing data rate beyond 100 Gbps, however, the drawbacks will be optical alignment issue to 10 μm single mode fiber (SMF) in receivers. In practically, mechanically beam tracking and active alignment functions have been studied and employed to make a good alignment to 10 μm SMF in free space [1]. Because this approach is going against making compact and low cost transceiver design, the mechanical tracking function in the transceiver should be excluded. Recently we developed a large photodetective area high speed photodetector array (PDA) device for space division multiplexing fixed fiber communication applications [2], which will have a capability of large aperture receiver without the mechanical functions in optical wireless communications. In this paper, we present on the newly developed high speed multi-pixel type PDA device and its application for optical wireless communications. The bit error rate performance on a 40-Gbps PAM-4 optical signal detection system using a space diversity scheme will be also discussed.

In the device fabrication, the tradeoff relationship among frequency response, responsivity and crosstalk was carefully considered. It was fabricated by p-InP/i-InGaAs/n-InP compound semiconductor material. The pixel size of 30 μm, the pixel pitch of 14 μm, and the formation of 6 x 6 pixels without four corners (32-number of pixel) were employed respectively (see Fig. 1(a)). The back-side illuminated photodetector structure allows increasing the responsivity. The signal lines in co-planer waveguide transmission lines were connected to the p-metals in each pixel, and the ground lines were connected to the n-metals in the PIN structure (see Fig. 1(b)). In the RF characteristic, the 3dB bandwidth on average of 11.2 GHz was measured. The crosstalk in the device has to be minimized to reduce the signal processing complexity in space diversity in optical wireless communication demonstration. When the RF lightwave was fed to the center pixel, the crosstalk between the neighboring pixels was measured around approximately -20 dB at 10 GHz. In the demonstration of 1.5 m short distance optical wireless communication, we built an FSO receiver system with high robustness for the optical alignment process using the PDA device, and demonstrated high-speed signal (40 Gbps) detection with a space diversity (maximum ratio combining method) technique for DSP. We successfully recognized a large alignment tolerance of 12 mm in receiver without beam tracking. Moreover, we clearly found the effect of diversity in the 2 × 2 PDA in free space, which suggested improvement in the BER performance.

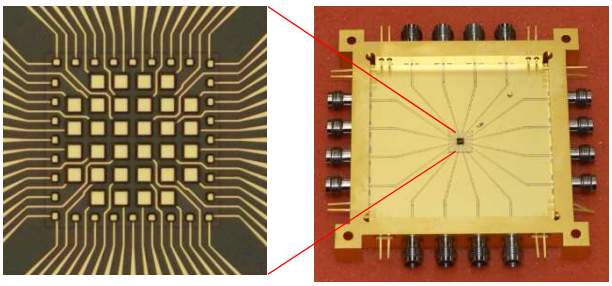

Fig. 1 Top-view photograph of multi-pixel type high speed PDA for optical wireless communications, (a) expanded view of PDA in center area (left), (b) fabricated module implemented with the PDA device (right)

References

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