Low Power Phototransceivers and Phototransceiver Arrays for High Density Optical Interconnect and Imaging Applications

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ABSTRACT

Image sensor technologies being envisioned at the present time will utilize advances in optics, optoelectronics and micromechanical components. A densely packed two-dimensional array of phototransceivers, which can detect, process and transmit image signals with high sensitivity and efficiency and can dissipate little power, would be an attractive element in current image sensing applications. Unlike the requirements of conventional lightwave WDM-based applications, very stringent power handling and power dissipation requirements have to be met. The bandwidth is usually not an important parameter in such massively parallel optical interconnects. There is, therefore, a need to develop low-power phototransceivers.

Low-power phototransceivers with very low-power dissipation and high optical gain have been demonstrated by us incorporating a microcavity light-emitting diode (MCLED) or a low-threshold vertical-cavity surface-emitting diode (VCSEL) as the light-emitter and a modulated barrier photodiode (MBPD or Camel diode) or heterojunction phototransistor (HPT) as the light detector. Two innovative integration schemes, lateral and vertical, of the low-power phototransceiver have been demonstrated.

In the lateral integration scheme, the Camel diode exhibits a responsivity of 1.8×10^3A/W for 630nm input light at an input power of 10nW. The output wavelength of the phototransceiver is 980nm. The phototransceiver exhibits an optical gain of 18dB and power dissipation of 110μW. Low-power phototransceivers with lateral integration of the HPT and MCLED/VCSEL have also been implemented. In this scheme, the HPT exhibits a responsivity of 60A/W for an input optical power of 1μW at 850nm input wavelength. The MCLED-based phototransceiver exhibits an optical gain of 7dB and power dissipation of 400μW for an input power of 1.5μW. The VCSEL-based phototransceiver exhibits an optical gain of 10dB and power dissipation of 760μW for an input power of 2.5μW.

A novel vertically integrated phototransceiver, wherein the HPT and MCLED are connected by a tunnel junction, will be described. The phototransceiver exhibits an optical gain of 13 dB and power dissipation of 400μW for an input power of 5μW. The phototransceiver arrays demonstrate good uniformity, low optical crosstalk and imaging capabilities. The performance, advantages and limitations of the different integration schemes will be discussed.

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