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OPTICAL SIGNAL AND ENERGY TRANSMISSION FOR A RETINA IMPLANT

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Abstract: In this paper we present the development of a signal and energy transmission technique for a retina implant. This implant, called retina stimulator (RS), is part of a system designed to provide artificial vision for blind persons suffering from retinal defects, especially retinitis pigmentosa (RP). The system consists of two parts, a retina encoder (RE) outside the eye and the RS implanted onto the retina. This RS is provided with digital signals and energy via free space optical transmission at data rates of 200 kbit/s together with electrical power of 5 mW, respectively. An array of photovoltaic cells (PVC) monolithically integrated with a photodiode is used as energy and signal receiver. A receiver circuit powered by the PVC-array is developed and manufactured. It transforms the output of the photodiode into TTL-compatible data suitable for further digital processing.

Keywords: Retina implant, signal and energy transmission

Introduction: In the field of biomedical implants a new technology has emerged a few years ago: Intelligent implants. The first working device, now routinely implanted, was the cochlea implant [1], giving back the sensation of hearing to deaf persons with diseases of the outer ear. Currently, visual implants are under development, designed to provide vision to blind persons. Several groups of scientists around the world are working in this field using different approaches, e.g. cortical implants [2] or retinal implants [3,4]. This work is part of the development of a system using the epi-retinal approach [4]. The system which is sketched in Fig. 1 is supposed to help persons suffering from outer retinal diseases, especially retinitis pigmentosa.

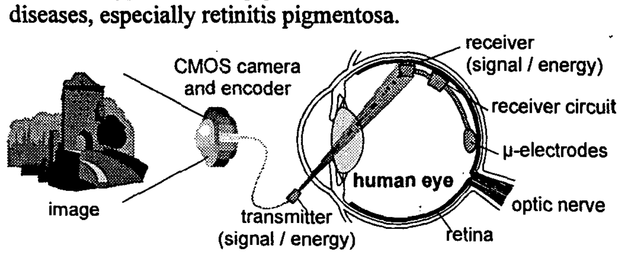

Fig. 1. Retina implant with optical signal and energy transmission

Results: First, a concept for simultaneous signal and energy transfer by optical means has been developed. As a transmitter, a pigtailed laser diode with a wavelength of 850 nm is used, corresponding to the absorption minimum of the eye. The cw output defining the transmitted power level is modulated with data and a clock signal. The output of the fiber together with a microlens system, is mounted in front of the eye directing the laser beam onto the retina and illuminating an area with 5 mm in diameter. This assures the functioning of the system for eye movements up to +/- 15°. Due to surgical reasons, the receiver size is limited to a maximum side length of 2 mm. On this chip a PVC-array consisting of 12 photovoltaic cells in series connection is monolithically integrated with a photodiode, operating as energy and signal receivers, respectively. The material of the device is GaAs/AlGaAs, providing high conversion efficiencies with the PVCs. A photograph of the receiver chip is shown in Fig. 2(a), in Fig. 2(b) I-V characteristics at different optical input powers are depicted.

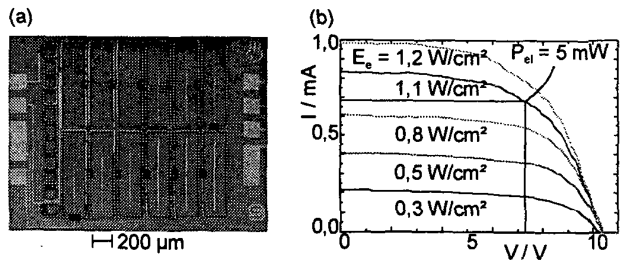

Fig. 2. (a) Photograph of the signal and energy receiver chip, (b) I-V characteristics of the PVC-array

A receiver circuit has been designed and manufactured using standard CMOS technology. This circuit powered by the PVC-array reconstructs the digitally coded signals and the clock from the output of the photodiode, transmitting them to a digital signal processor (DSP) integrated on the same chip. This has been demonstrated at a signal transmission rate of 200 kbit/s.

Conclusions: An optical signal and energy transmission technique was developed as part of a system for artificial vision. By transmitting digital signals at 200 kbit/s and 5 mW electrical power simultaneously, system requirements are met

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References:

[1] Y. Chen and J. Chen, Proc. of the 16th Int. Conf. of IEEE-EMBS, vol.2, pp. 978-9, New York, NY, USA, 1994
[2] M. Shah, R. Phillips, and R. Normann, IEEE Trans. Biomed. Eng., **45**, pp. 867-75, July 1998
[3] M. Schubert et al., AMST-1997 Symposium., Mater.Res. Soc., pp. 913-8. Pittsburgh, PA, USA, 1997
[4] R. Eckmiller, Ophthalmic Research **29**, pp. 281-9, 1997