VA-1 10 Gb/s Monolithic Integrated MSM-Photodiode AlGaAs/GaAs-HEMT Optoelectronic Receiver—V. Hurm, J. Rosenzweig, M. Ludwig, W. Benz, R. Osorio, M. Berroth, A. Hülsmann, G. Kaufel, K. Köhler, B. Raynor, and Jo. Schneider, Fraunhofer-Institut für Angewandte Festkörperphysik, D-7800 Freiburg, Germany.

Several research groups have reported on the technology of monolithic integration of MESFET's on GaAs with photodetectors for light of 0.85-μm wavelength. In this paper we present the first photoreceiver which is based on a metal-semiconductor-metal (MSM) phtotodiode and AlGaAs/GaAs HEMT's.

The photoreceiver was fabricated using our established 0.5-μm recessed-gate process for double delta-doped quantum-well HEMT's [1], [2]. The following mean values for the enhancement and depletion HEMT parameters, respectively, have been obtained: threshold voltage: 0.1 and -0.5 V, transconductance: 500 and 390 ms/mm, source resistance: 0.7 and 0.6 $\Omega \cdot$ mm, transit frequency: 35 and 30 GHz. This process now includes photodiodes. A deep wet etch was used to deposit the photodiodes on an undoped GaAs buffer layer. The 1-μm-wide photodiode fingers with 1.5-μm spacing were defined by electron-beam lithography and subsequent lift-off of Ti/Pt/Au Schottky metal. The dc reponsivities of the photodiodes to light of 0.84-μm wavelength were 0.25 A/W for 4-V and 0.35 A/W for 10-V bias voltage, respectively. The dark current at 4 V was less than 2 nA for a photodiode with an active area of 25×25 μm^2.

The monolithic integrated optoelectronic receiver consists of an MSM photodiode, a transimpedance amplifier, and a 50-Ω output buffer. The transimpedance stage is composed of two enhancement transistors (gate widths 40 μm), two 1-kΩ NiCr thin-film load resistors, and a 500-Ω NiCr feedback resistor. The output stage is a source-follower with a constant current load (gate widths 80 μm). All high-frequency measurements on the receiver were performed on-wafer using CASCADE probes. The photodiode was irradiated by 0.84-μm light from a high-speed ORTEL laser diode via a single-mode fiber. The current driving the laser diode was modulated to obtain up to 0.8-mW peak-to-peak modulated optical signals. The -3-dB bandwidth for sinusoidal modulated incident light lies at 8.2 GHz. The circuit response to pulse-modulated non-return-to-zero (NRZ) optical signals was tested at data rates up to 10 GB/s using an ANRITSU pulse pattern generator. The eye diagram of the output voltage demonstrates that the optoelectronic receiver operates successfully for a 10-Gb/s NRZ pseudorandom data stream of length $2^7 - 1$ b.

[1] K. Köhler, P. Ganser, K. H. Bachem, M. Maier, J. Hornung, and A. Hülsmann, in *Proc. Int. Symp. on GaAs and Related Compounds*, 1990, Inst. Phys. Conf. Ser., 112, p. 521, 1990.

[2] A. Hülsmann, G. Kaufel, K. Köhler, B. Raynor, K. H. Glorer, E. Olander, B. Weismann, J. Schneider, T. Jakobus, in *Proc. Int. Symp. on GaAs and Related Compounds*, 1990, Inst. Phys. Conf. Ser., 112, p. 429, 1990.