MULTICHIP MODULE HIGH SPEED TESTING

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Quarterly Progress Report
July 1, 1993-September 30, 1993

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Progress for the period July 1, 1993 - September 30, 1993 is described below, in the areas of the electrooptic testing of multichip modules.

Capacitor Structures Formed on Optical Fibers

As a first step in the fabrication of an electrooptic probe formed on an optical fiber, we have formed $Al/SiO_2/Al$ capacitors on a single-mode fiber. These structures have been useful for the elucidation of fabrication and alignment problems, and will also serve as decoupling capacitors for future high-speed probes.

Capacitors on optical fibers were formed by cleaving sections of 100 micron diameter single mode fiber and stripping the outer cladding using methylene chloride. The bare fiber sections were then fixed to a clean glass slide using polyimide at the fiber ends, which was then cured at 350° C; the glass slide served as a stable substrate for processing. The actual capacitor structures were formed by two thermal evaporations of Al (200 nm flat-surface thickness) and the plasma-enhanced chemical vapor deposition (PE-CVD) of SiO_2 (400 nm flat-surface thickness) using SiH_4 (2% in He) and O_2. The Al was evaporated using shadow masks which defined the actual capacitor structure. The fibers were then lifted from the slide and tested, using the metallized polyimide as contact pads for the electrical probes.

Figure 1 shows the capacitance versus length of the structures, measured at 1.0 MHz by a Boonton 72B capacitance meter. Parasitic capacitances in the leads were subtracted by zeroing the meter. The linear dependence of capacitance with length suggests reasonably well-controlled fabrication. The high value of 18 pF/mm also suggests significant contribution to the total capacitance from edge effects (see Fig. 2); this is also evident from variable frequency measurements on structures with thinner (100 nm) metallizations, which showed frequency-dependent capacitance values consistent with skin effects at the metallization edges, where the metal is thinnest due to geometric effects on the deposition. The leakage characteristics of the structures are excellent; leakage and low frequency lock-in measurements suggest shunt resistances in excess of 200 MΩ in all cases. The breakdown characteristics are also extremely good ($V_B > 100$ V).

The next step is the deposition of optical-quality Si or Ge films on the fibers to form an integratable photoconductor. X-ray photoelectron spectroscopy measurements have revealed significant oxygen contamination in our Si films which were deposited by PE-CVD using SiH_4; in the near future we will be improving the quality of our depositions or using facilities at IBM-Research or AT&T.

High-Speed Differential Photodetector for Electrooptic Transmission Line Measurements
Our earlier work had optimized the electrooptic performance of PMMA:red dye copolymer systems for use MCM electrooptic measurements, and had increased signal-to-noise ratio (SNR) sufficiently to observe real-time signals from coplanar electrodes. Since the speed and SNR of the measurements are completely dictated by the detection electronics, we have designed and built an amplified differential detector (see Fig. 3).

The detector is based on a high-speed current-to-voltage amplifier (Analog Modules 313A4) which has a gain of 20 kV/A and a 3 dB frequency of 350 MHz. The amplifier module is connected to two parallel photodiodes (EG&G FND-100) for differential detection, and the components are mounted in a shielded box with a 50 Ω BNC output connection. We are currently measuring the noise characteristics of the amplifier. In the future we plan to examine the electrooptic testing of GE-HDI coupons which are being sent by Walt Marcinkiewicz at GE-CRD.

Travel
Prof. Davis attended the IEEE Hybrid Multichip Module Conference in Santa Barbara in July.

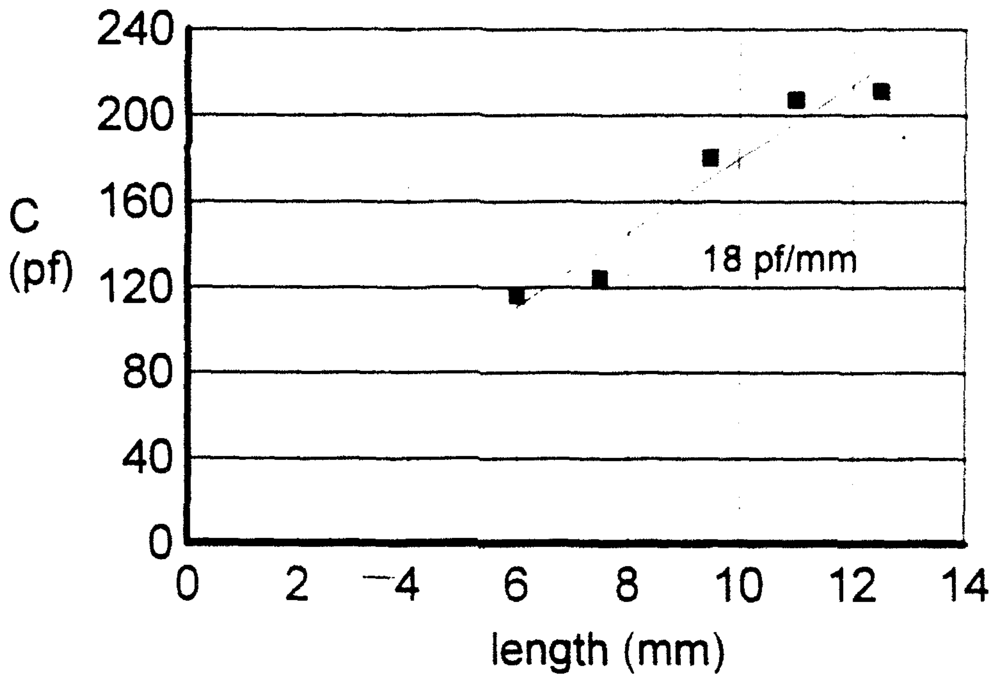

Fig. 1 Capacitance versus length for $Al/SiO_2/Al$ structures formed on a single-mode optical fiber by thermal evaporation and plasma-enhanced chemical vapor deposition. The capacitors exhibited very low leakage and very high breakdown voltage.

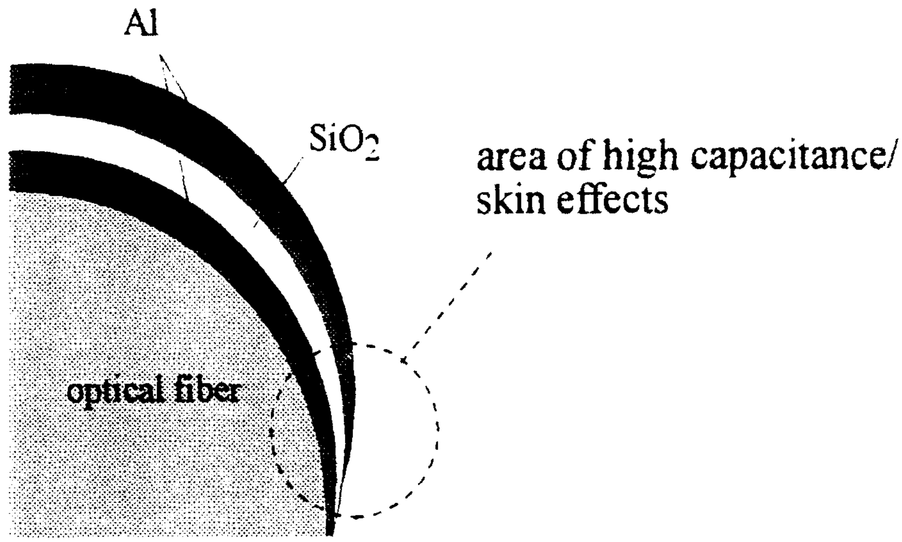

Fig. 2 Schematic of optical fiber capacitor edge geometry (not to scale). Higher than expected capacitance per unit length values, plus frequency-dependent capacitance values for structures with thin metallizations, suggest that significant capacitance is contributed by at the edge of the fiber, where the oxide and metallizations are thinnest.

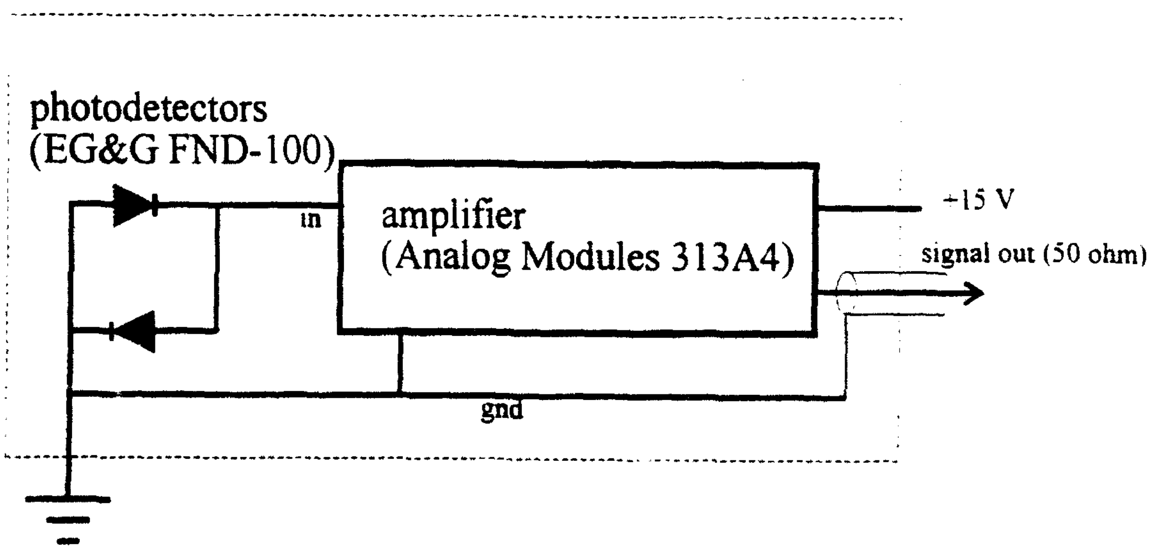

Fig. 3 Schematic of an amplified high-speed differential photodetector for use in electrooptic transmission line measurements.