SESSION 4: DEVICES & MONOLITHIC CIRCUIT ELEMENTS

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Monolithic integrated circuits operating at frequencies in excess of 1 GHz are rapidly becoming realities of the marketplace. To remain competitive requires not only knowledge in semiconductor materials, device, and circuit technology, but also sophisticated ability to accurately measure, test, and characterize. Only then can sufficiently accurate models be developed with which to design, fabricate and efficiently produce. This session emphasizes the "tools" essential to furthering monolithic integrated circuit technology. Included are instrument probes and calibration methods, high performance heterojunction devices, high efficiency millimeter wave power devices, and accurate design models for on-chip spiral inductors. The session begins with a paper describing new and accurate techniques for probing a wafer or die at its intended operating frequency. While problems such as common lead inductance and capacitive coupling between adjacent lines are among the least of "worries" for a discrete device designer, the adverse crosstalk introduced is well known to the hybrid circuit designer and is of major concern to the designer of monolithic circuits. Not only must crosstalk be addressed within the integrated circuits, but I/O pads on the die must be both judiciously placed and of proper impedance if accurate probe measurements are to be obtained. Without adequate forethought being given to characterization and testing, testprobe crosstalk can be adversely impaired. For digital ICs, this frequently leads to a requirement for balanced, low impedance I/O pads. In addition to I/O impedance and pad placement to reduce crosstalk, additional consideration must be given to test pad placement to accurately measure propagation delay and phasing.

The high electron mobility transistor (HEMT) (also known as the selectively doped heterojunction transistor and as the two dimensional electron gas transistor) is rapidly setting new records for noise figure, associated gain, and upper operating frequency. Its special requirement for heteroepitaxial grown films complicates monolithic circuit design, but must be considered for analog circuit design. (One kilobit HEMT RAMs with subnanosecond access times have already been reported: 1984 IEEE ISSCC). State-of-the-art analog HEMT performance is described in the second paper.

High operating efficiency has been difficult to achieve with solid state devices operating in Kα band. The third paper describes an approach using molecular beam epitaxy (MBE). A power output of 0.46 W/mm of device gate periphery is achieved at 30 GHz. Also described is the Kα band test fixture.

The requirement to incorporate physically small inductors of high value and of respectable quality factor onto a monolithic IC is exceeded only by the requirement to design such inductors with a high degree of accuracy and yet be able to fabricate them. Our last paper provides inductor design information which will significantly improve the probability of success that a monolithic IC will perform as designed.

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