Monolithic Millimeter-wave and Submillimeter-wave Integrated Circuit (MMIC and S-MMIC) Testing Capabilities at JPL up to 500 GHz

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Over the years, our group has been developing on-wafer and waveguide testing capabilities for MMIC amplifiers, oscillators, transistors, and diode circuits up to 500 GHz. In this work, we outline the present state-of-the-art in terms of on-wafer *S*-parameter measurements, on-wafer noise figure measurements, and on-wafer power measurements up to 350 GHz for a variety of MMIC and new Submillimeter-wave MMIC (S-MMICs) chips. The first S-MMIC chips are described in Reference [1] and were tested at JPL and fabricated at NGST, and include single stage HEMT amplifiers with 2.5 dB of gain at 300 GHz. Figure 1a, below, shows the on-wafer full 2-port vector network analyzer test set used for the measurements up to 325 GHz.

Several years ago we reported the state-of-the-art in HEMT doubler technology up to 320 GHz using on-wafer test equipment outside of its recommended frequency range, which resulted in large uncertainty in measured power data [2]. Today, together with GGB Industries and OML Laboratories, we have developed the submillimeter-wave test sets to measure noise figure and power data to within 1 dB of accuracy on-wafer. Below in Figure 1b is a photograph of our on-wafer noise figure test set, capable of less than +/- 1 dB accuracy up to 270 GHz.

In this work, we will describe the key components required for the measurements, highlight recent test results on MMIC and S-MMIC chips, and plans for future wafer probing up to 500 GHz.

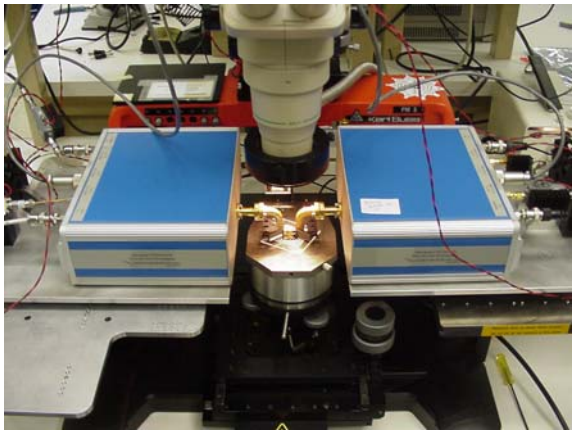

Figure 1a. On-wafer *S*-parameter test set up to 325 GHz.

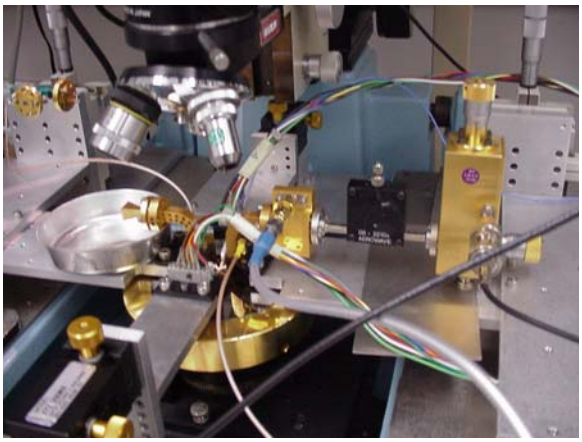

Figure 1b. On-wafer noise figure test set at 270 GHz.

[1] "Demonstration of a Sub-MillimeterWave Integrated Circuit (SMMIC) using InP HEMT with a 35-nm Gate," W. R. Deal, S. Din, V. Radisic, J. Padilla, G. Mei, W. Yoshida, P. Liu, J. Uyeda, M. Barsky, T. Gaier, A. Fung, L. Samoska, and R. Lai, *28th IEEE Compound Semiconductor Integrated Circuit Symposium Digest*, San Antonio, TX, November, 2006.
[2] "Advanced HEMT MMIC Circuits for Millimeter-wave and Submillimeter-wave Power Sources," Lorene Samoska, Jean Bruston, and Alejandro Peralta, *Proceedings of the Far Infrared, Millimeter, and Submillimeter-wave Detector Workshop*, Monterey, CA, April 1-3rd, 2002.

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