Diagnosis of upsets and damage using focused ion beams and direct microwave level measurement

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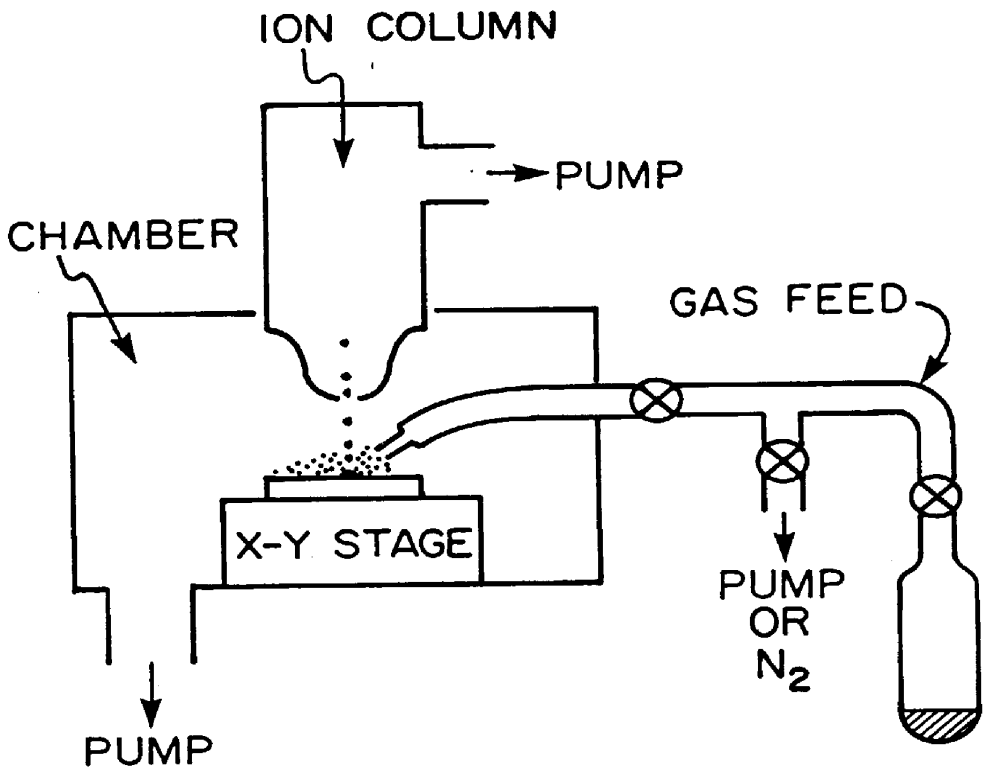
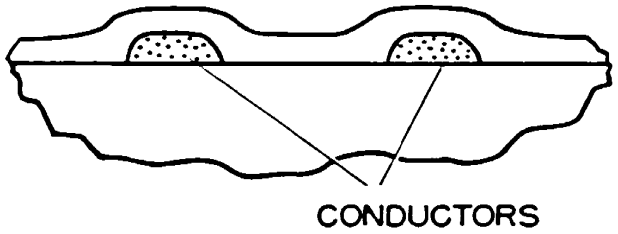
Outline

- focused ion beam (FIB) circuit editing
- FIB defect sectioning
- microwave power measurement with Schottky diodes
- power measurement based on thermal effects

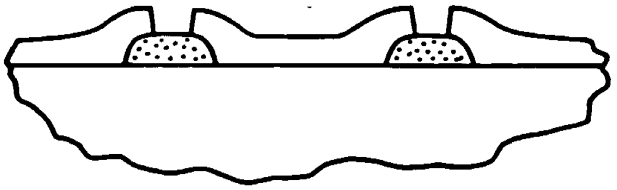
Schematic of Focused Ion Beam System
for Deposition or Gas Assisted Etching



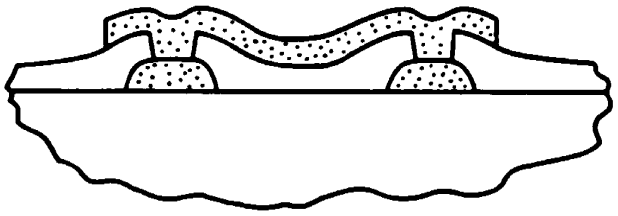
CIRCUIT REWIRING BY FOCUSED ION BEAM INDUCED DEPOSITION



CROSS SECTION OF TWO CONDUCTORS COVERED BY OXIDE.

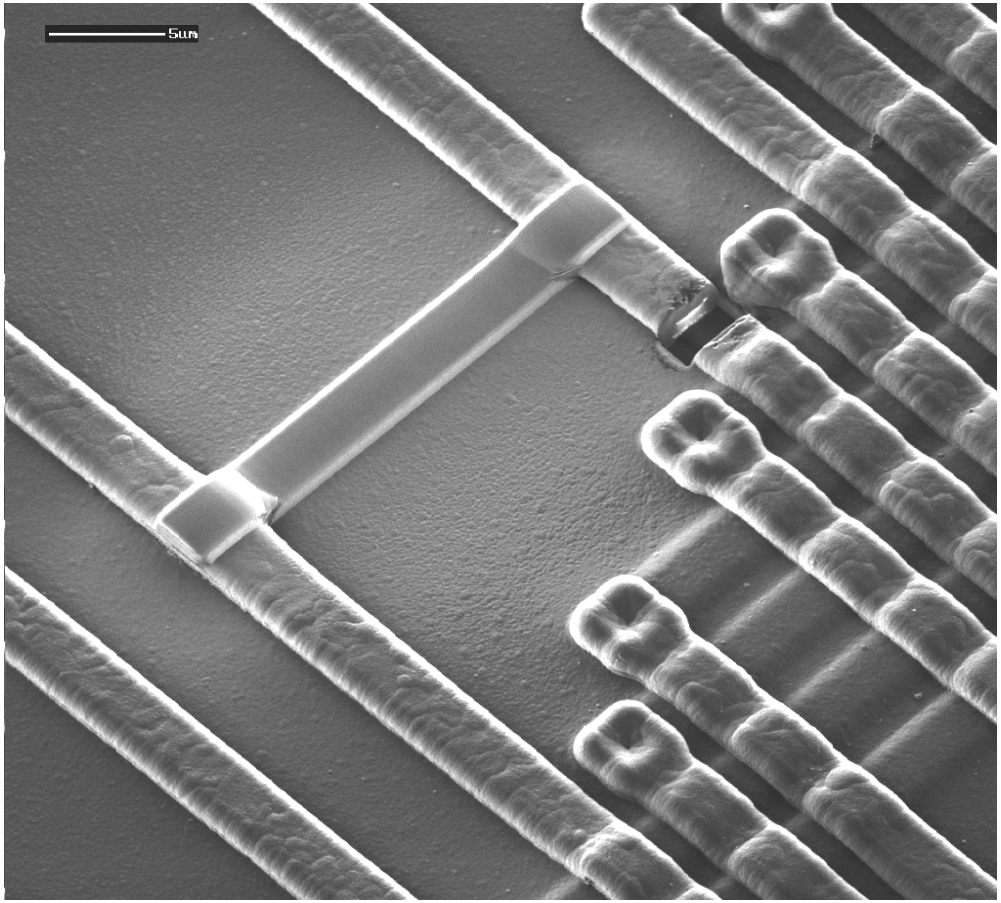


FOCUSED ION BEAM MILLED VIAS.

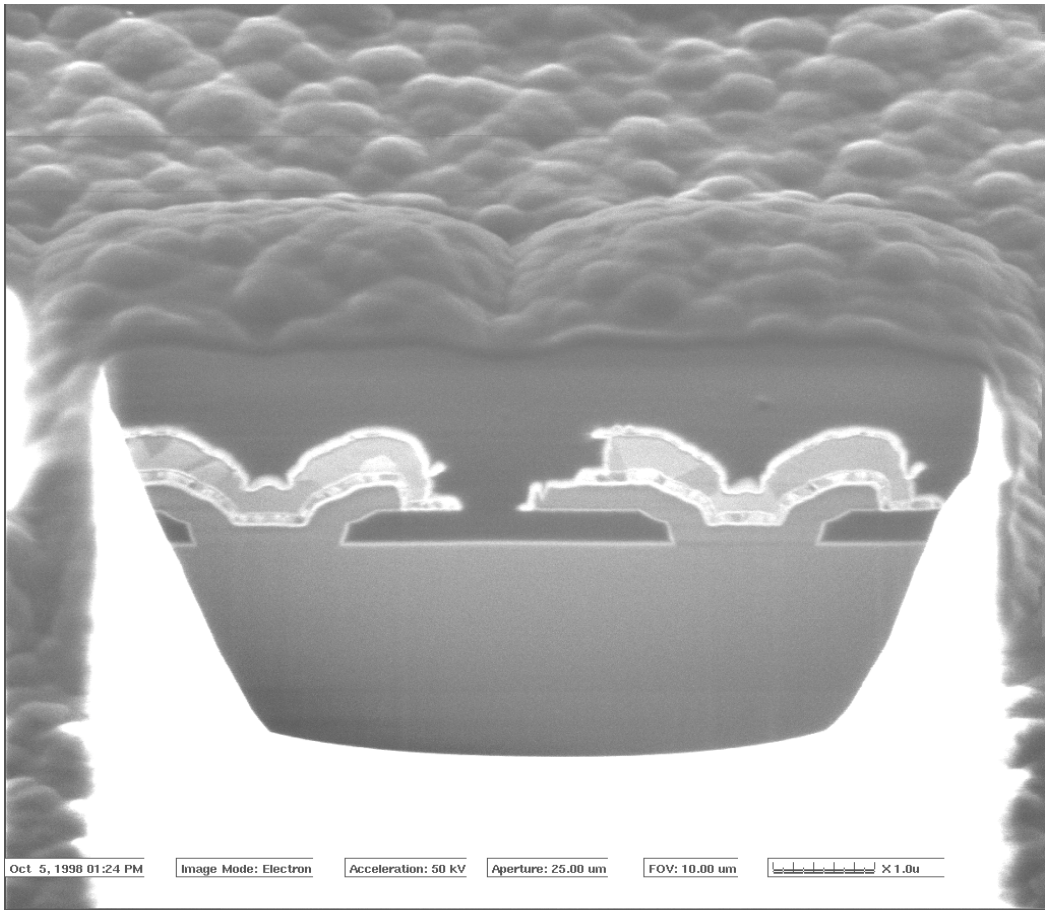


FOCUSED ION BEAM DEPOSITED CONNECTOR.

Example of FIB Circuit Rewiring: Cut and Jumper



FIB-Milled Circuit Cross Section



Schottky diode fabricated in MOSIS

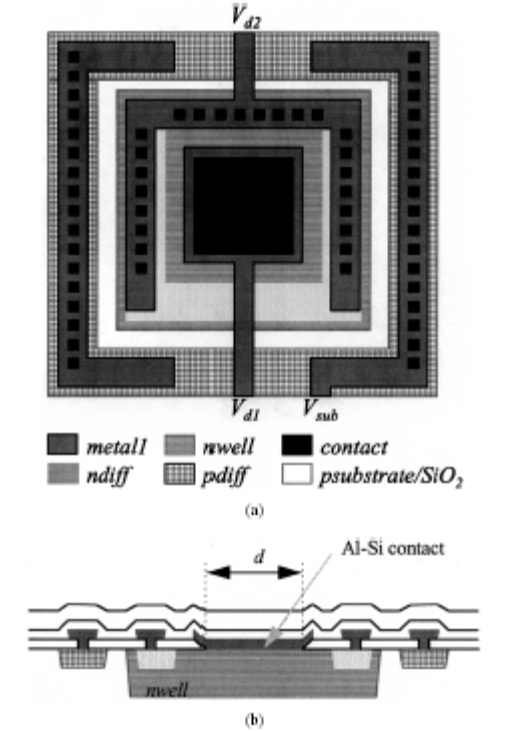
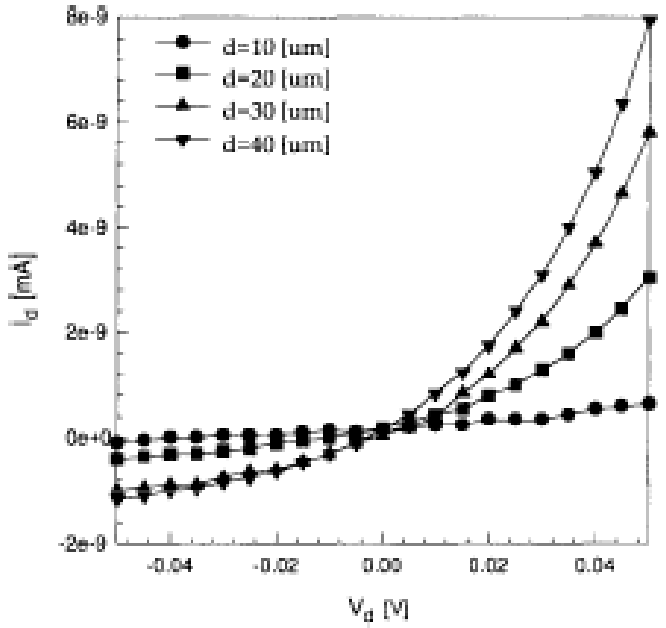


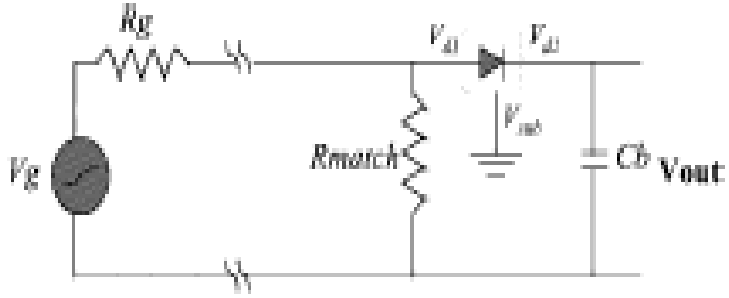
Fig. 1. (a) CAD layout of the Schottky diode with accompanying guard ring. (b) cross section showing Al-Si Schottky contact.

d=10, 20, 30, 40 : m

V. Milanovic, M. Gaitan,
J.C. Marshall M. E. Zaghloul,
IEEE Trans. Electr. Devices
43, 2210 (Dec. 1996)

Schottky diode characteristics and RF circuit used to test diodes





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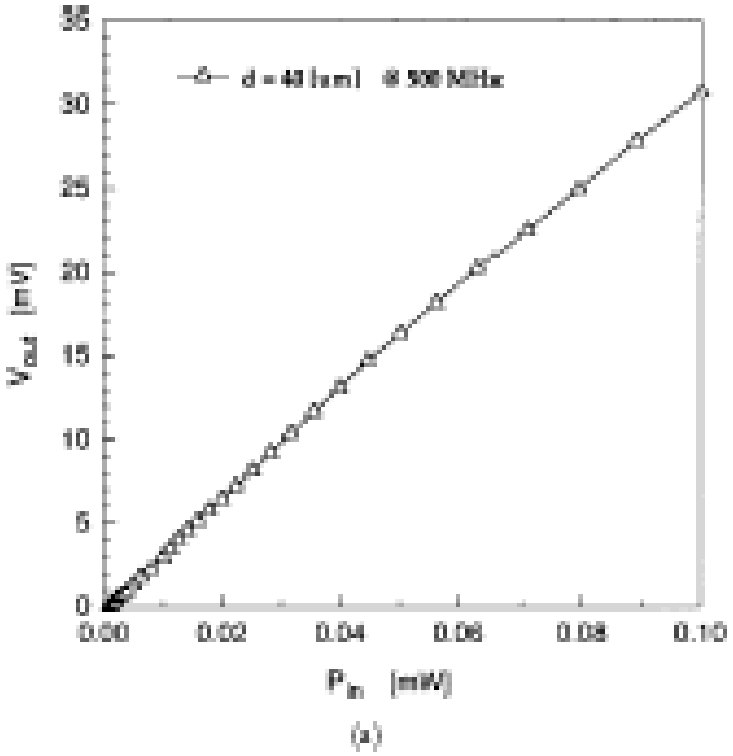
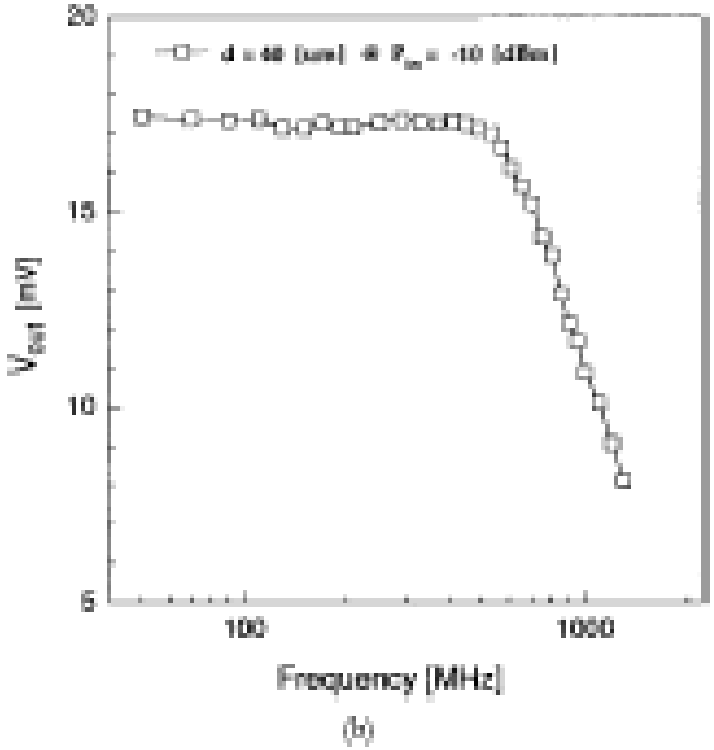
DC Voltage output vs. power in at 500Mhz.



Output voltage vs. Frequency



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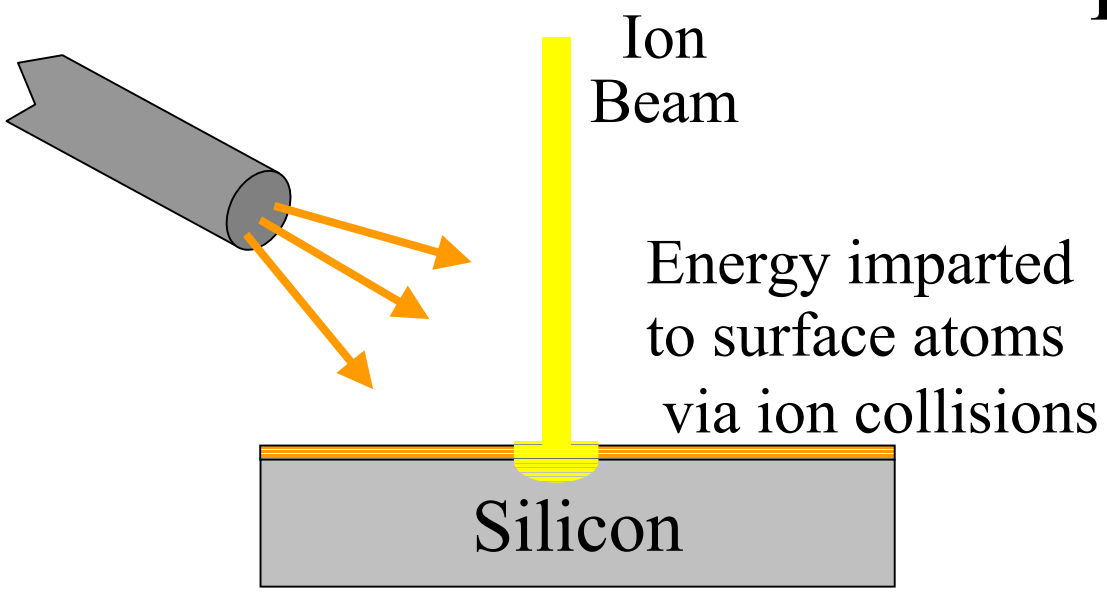
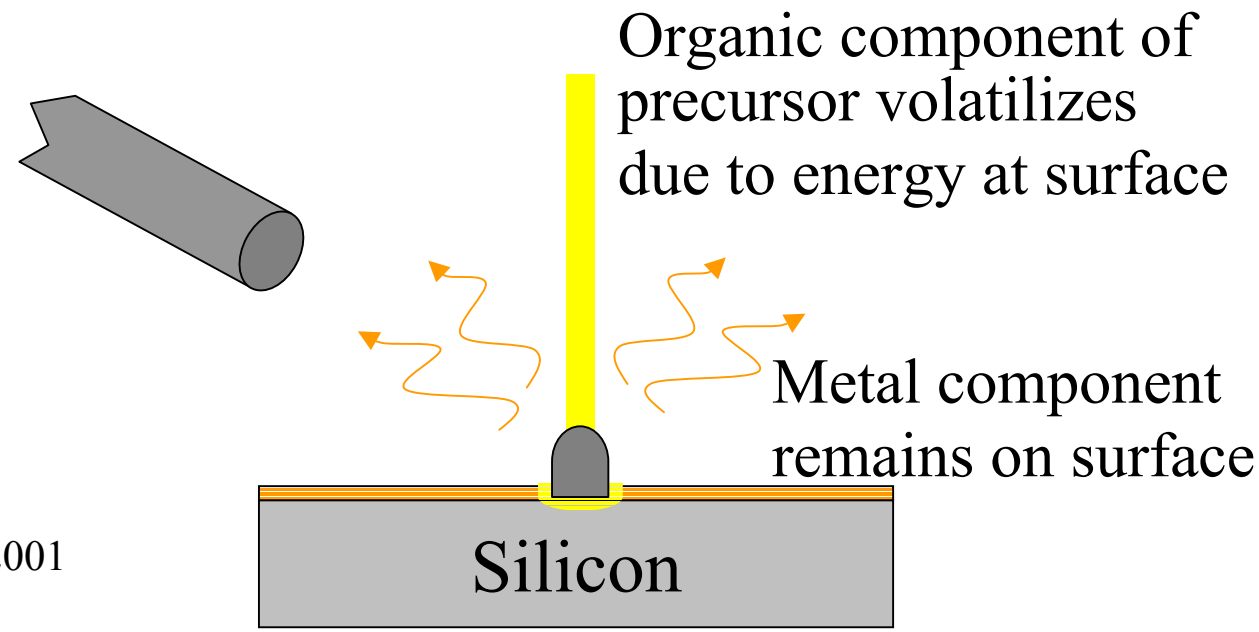
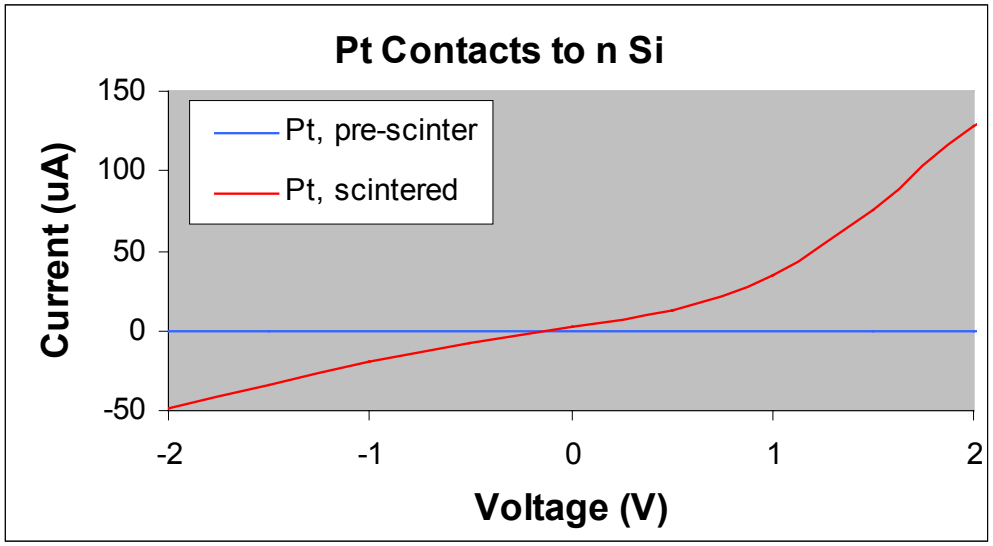
Ion-Induced Deposition

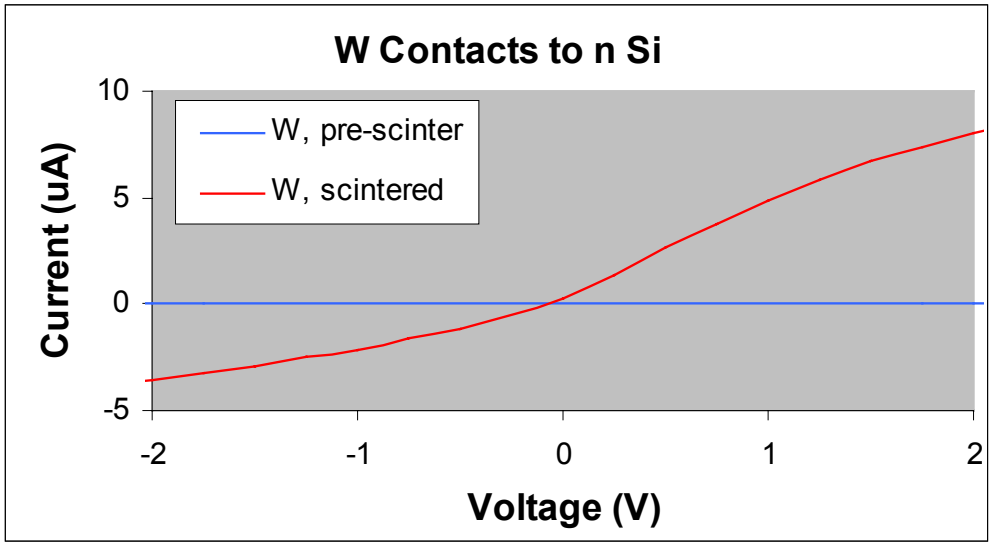




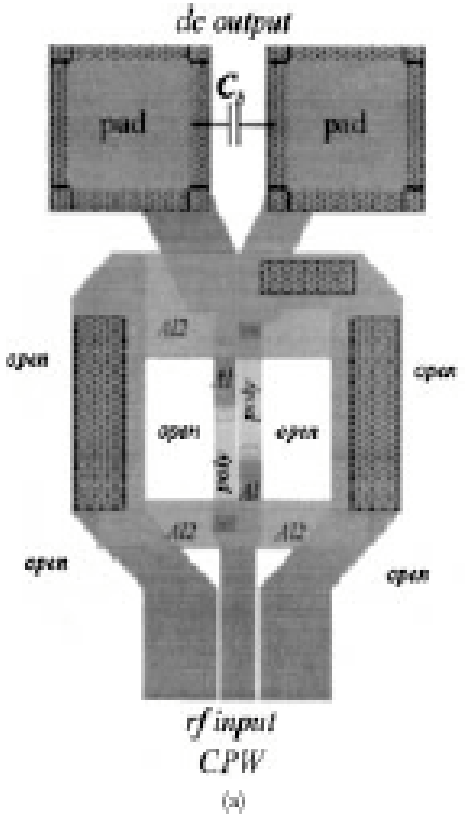
A. De Marco and J. Melngailis
Presented at EIPBN Conference 2001

FIB-Metal Contacts to n-Si

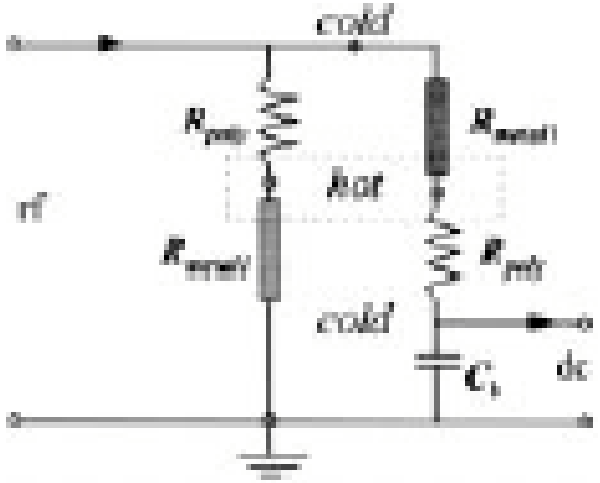




Undercut thermocouple detector on chip

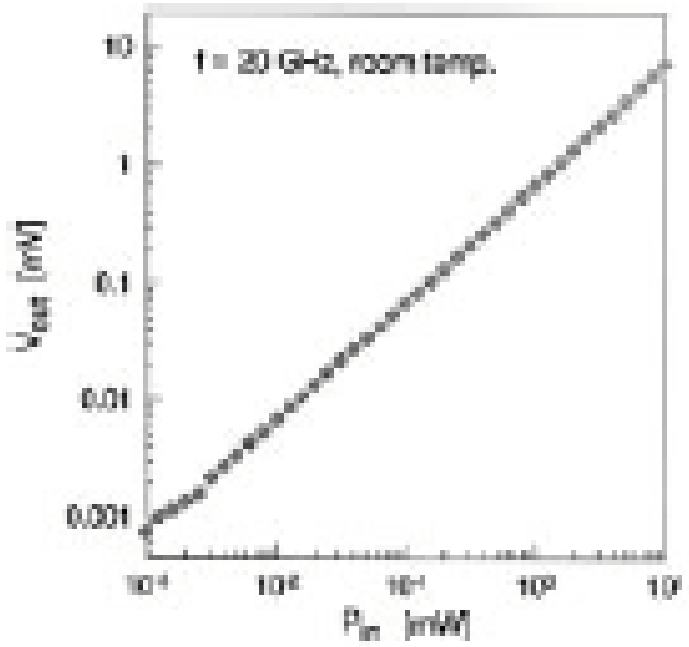


Thermocouple circuit

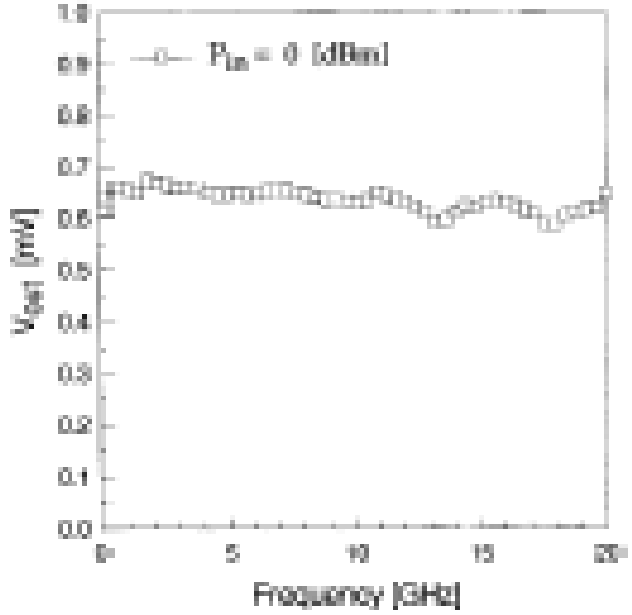


V. Milanovic, M. Gaitan, and M. Zaghloul, IEEE Trans. Microwave Theory and Techniques **46,** 550, (May 1998)

DC voltage out vs. RF power in at 20GHz



DC voltage out vs. frequency



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Plans for Schottky diode detector development and application:

(with U. Idaho and NIST)

Goal: increase maximum frequency to100GHz

(text book value: 142GHz) and integrate into IC's

-- fabricated directly in MOSIS

-- post-process with FIB deposition

-- post-process with conventional fab

-- integrate in "antenna" (wiring) structures and

other circuit elements

Plans for thermocouple detector development (as an alternative to Schottky diode):

(with NIST and U. Idaho)

-- fabricate in MOSIS, post process undercut

-- post process entire thermocouple

-- integrate in “antenna” (wiring) structures and other circuit elements

note: thermocouple detectors have very high maximum frequency, but slow transient response to pulses

Summary:

-- focused ion beams for circuit editing

and fault sectioning

--diode or thermal detectors will provide an *analog* measurement of the level of microwaves on circuits