Broadband Microwave Non-Destructive Testing (NDT) of Silicon Wafer Conductivity Enhancing "Doping"

Craig E. Nelson   Consultant Engineer

Nelson Research, Inc.   2142 – N. 88th St. Seattle, WA. 98103 USA 206-498-9447   Craigmail @ aol.com

Experimental Goals

It was desired to learn if microwave Non-Destructive Testing (NDT) methods could be used to determine the extent to which silicon wafers, of the kind used in MEMS applications, have had their conductivity modified by various "doping" processes.

It was important that the method could, in theory at least, be applied in a way that did not require physical contact between the silicon wafer under test and the microwave test fixture..

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Test Setup

An Agilent Model E5170A Vector Network Analyzer was used in "through" or S21 mode to drive a 3 inch long piece of "hardline" coaxial cable wherein I had filed away part of the copper outside conductor in order to form a small oval shaped aperture upon which samples could be placed and electro-magnetically interrogated.

The coax was bent into a U shape where the middle part of the U was bent 90 degrees to the ends. The middle part of the "bent up" U that faced vertically upwards when the device was connected to the analyzer was the part that was milled to form the sensing aperture.

Small pieces of plastic were then clamped to the “hardline” coax so as to form a table upon which samples were placed. This table provided a small air gap that kept the samples from physically touching the coaxial cable and thus possibly making Ohmic contact or scratching the surface.

After setup, a "thru" calibration was performed using a 440 micron thick 25 Ohm-cm wafer as the reference datum. All the subsequent data is relative to this reference "zero".

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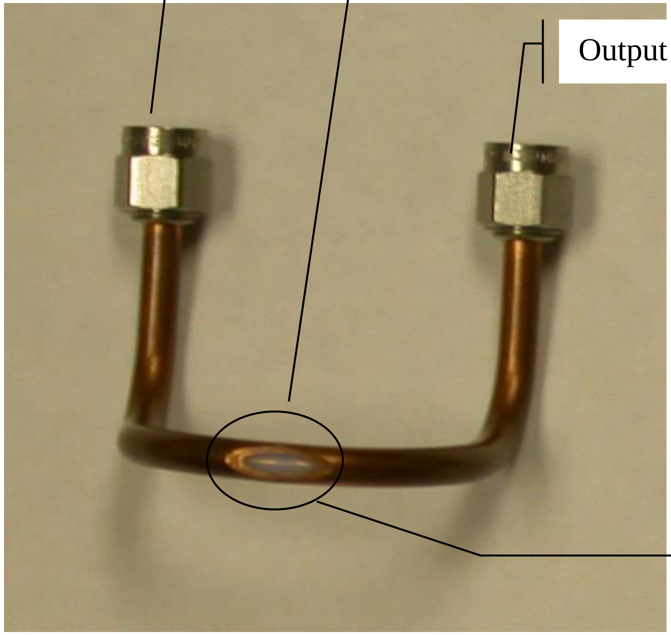

Microwave “Through Transmission” Non-Contacting Conductivity Sensor

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Resultant Data

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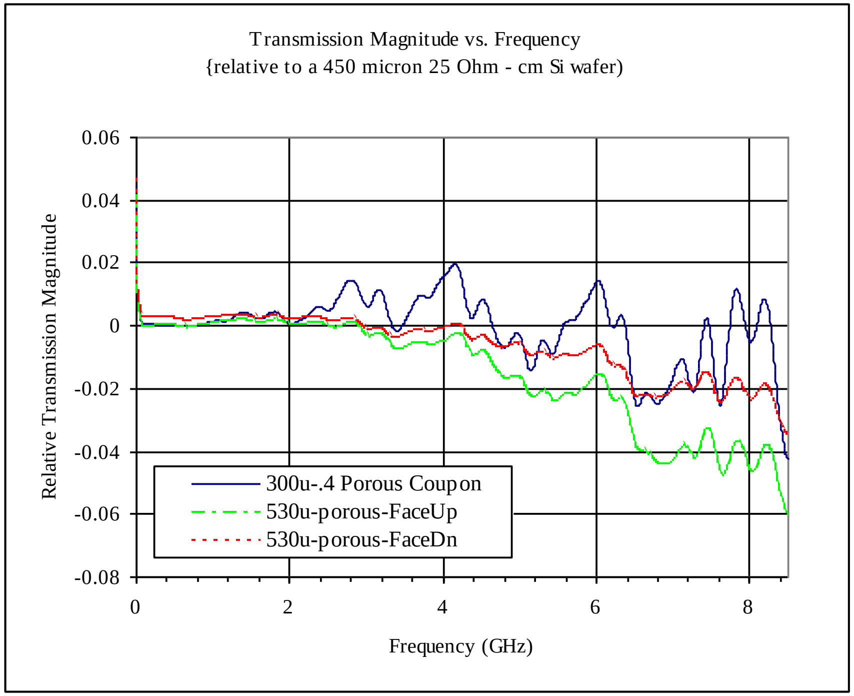
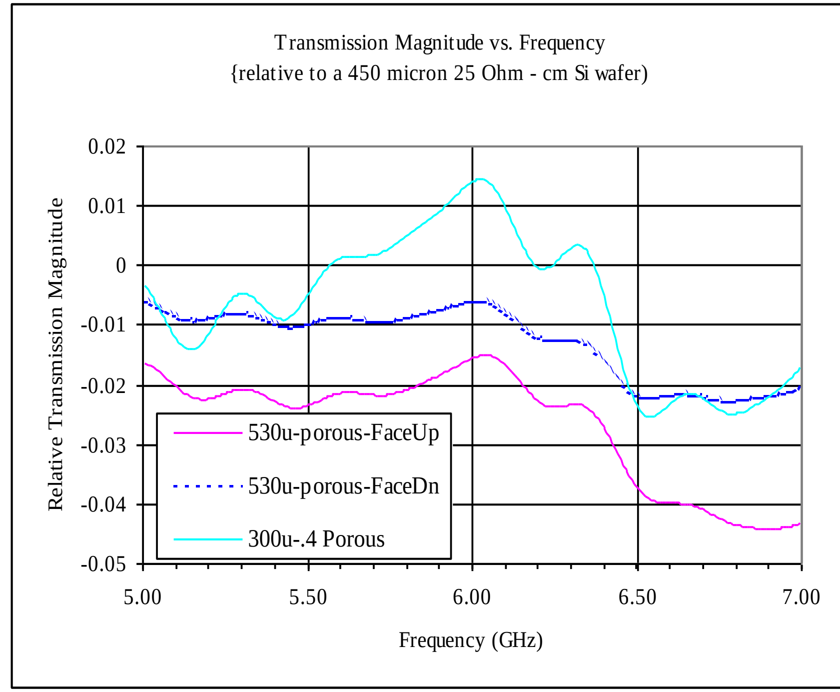
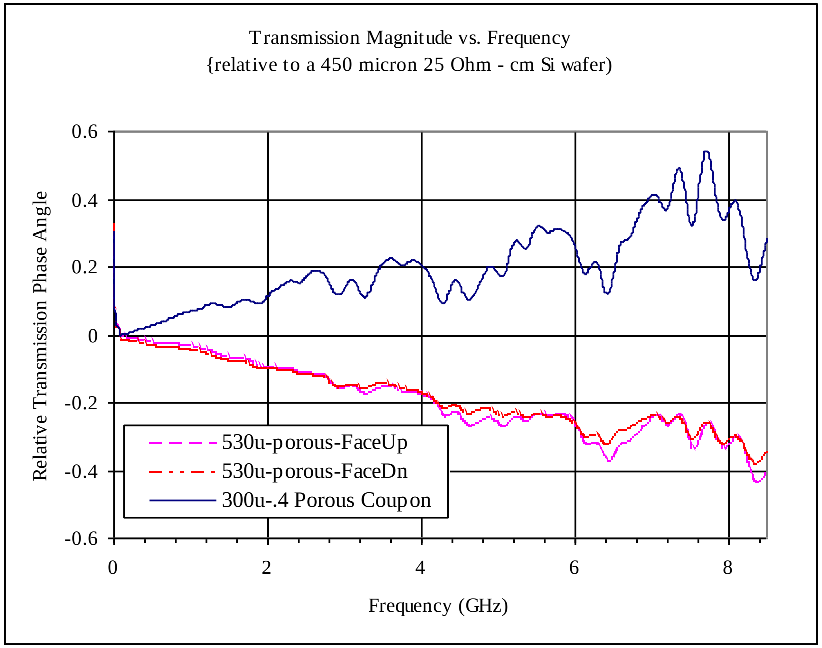


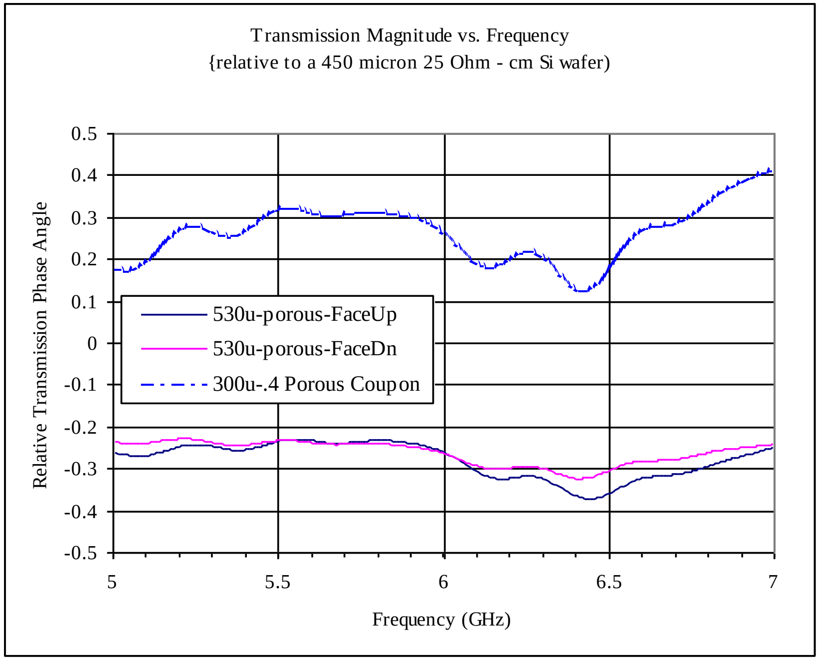


Full Frequency Sweep (.1 – 8 GHz)

Expanded Frequency Sweep (5 – 7 GHz)

Relative Amplitude Data





Full Frequency Sweep (.1 – 8 GHz)

Expanded Frequency Sweep (5 – 7 GHz)

Relative Phase Data

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Summary and Conclusions

Based on the experimental requirements, an instrumentation system was assembled, a broadband microwave sensor was designed and fabricated and broadband data were taken.

The results are encouraging. It seems that NDT magnitude and phase measurements, if made at one frequency (6 GHz), could be used to sense silicon wafer conductivity changes without contact between the measuring sensor and the wafer under test.

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