SOLECON LABORATORIES INCORPORATED

NEWSLETTER

Number 4 November 1999

# How do we stack up?

In a previous newsletter, we had reported our participation in a Spreading Resistance Round Robin. The event was sponsored by IMEC, the research consortium in Belgium, and included 20 participants from around the world. It consisted of profiling about a dozen samples of varying complexity, which thoroughly tested all aspects of each participant's practice of SRA. The overall performance of the various labs was summarized in a report that was issued recently. In a simplified scoring scheme where the participants were rated "good", "medium" or "bad" in 18 categories. We were one of only two labs who had no "bad" ratings. Our score of 14 "good" categories was the best reported. We are so proud of Greg in our Tustin lab, who did the actual measurements, for confirming that Solecon Labs really is the world-wide leader in SRA.

One of the reasons we did so well is that we have replaced the original stage drive steppers on our probes with ones of our own design. Another is our expertise in polishing smooth flat bevels. Both of these reasons contribute to our ability to measure junction depths with much better precision than most of the other participants. In general, our norm of paying a lot of attention to detail, from careful work in calibration to double checking bevel angles was shown to be necessary for good performance.


**AND HERE'S HOW WE ALL STACK UP… LEFT TO RIGHT STANDING… NATASHA, JOSEPH, DANNY, JIMMY, TINA, MARC, ANDY, MIKE, WAYNE, LAURA… MIDDLE ROW… SHELLY, SHEILA, GINA, MARYLOU SITTING… DAN, DAVE, AUGY, & LAST BUT NOT LEAST IN THE FOREGROUND IS MAX, THE DOG.**

## Rolling off Dave's deck...

Times change, and people come and go. It has been nearly three years since Dan took over operations here in San Jose. But that event was my cue to embark on a new adventure: Bobbi and I have been living on a sailboat, mainly in Mexico, for much of that time. We have cruised on the Mexican Riviera and sweltered in the Sea of Cortez. And we absolutely love it. We are very grateful to the dependable crew here at Solecon Labs who have kept things running while we play.

I still have a deep interest in the mathematics of SRA and continue to work on improvements to the computer programs used in the Lab. Trying to do that with a laptop on a moving boat takes a lot of discipline, but I'm doing my best! Meanwhile, Solecon Labs is embarking on a serious project to upgrade our SRA hardware. We have brought Wayne Borglum in to guide us through the project, including porting my beloved software from our ancient HP machines to modern computers. Look on our website from time to time for evidence that we may actually be accomplishing something.

Hasta la vista!

Dave

**S/V After You**

## onto Dan's rolltop...

September, 1996 brought me back to corporate from our lab in southern California. The weather seems to be a little dryer and a little warmer there during the summer months; and I certainly don't miss the Santa Anas that come down out of the hills and straight into my sinuses!

It has been surprisingly busy around here since I've been back and turn time has suffered. While we lost one probe operator, we added three and re-instituted the weekend shift. This works out well, because even though we have six spreading resistance probes here, the lightly loaded ones do tend to get backed up during regular hours.

After 15 years of using the original Prometrix OmniMap, Solecon Labs has acquired a new four-point probe sheet resistance mapping system from Creative Design Engineering, Inc. This tester extends our mapping capability to 200 and 300 mm wafers. We use it routinely to map the sheet resistance of the monitor wafers submitted for spreading resistance analysis. This is to verify that the spreading resistance profile taken at one point is representative of the whole wafer. If the wafer is not uniform the customer is consulted about the location to be used for the spreading resistance profile. Because sheet resistance can also be determined from an integration of the SR profile, the value of the sheet resistance obtained from a four-point probe can also be used to verify and calibrate the SRP results. Please contact Natasha Robinson if you would like a copy of the Rs maps of your monitor wafers.

Dan

## & into the front office.

Did you know..

- We accept MasterCard and Visa.
- We have had our web site up and running for about two years now…www.solecon.com.
- MaryLou and Natasha run the front office. This involves, but is not limited to initial customer interface, and administrative handling including purchase orders and billing issues. MaryLou has (despite popular belief) the ability to handle all of the above mentioned in Natasha's absence; after all, she is the mentor.
- Natasha, now working on year 8 with Solecon still has very little technical understanding of SRA. She refuses to learn…and what she does know…she has learnt by osmosis. So, please, try not to stretch her limits and just ask to speak with technical staff.
- Confidentiality is very impor-tant and it really needs to be observed in this high tech world of ours that is so full of secrets. You, the customer, often get that word hurled at you when all you want to do is get your hands on some profiles. We are very sorry to say but we are just going to reiterate that here. If you want someone else's results – even if he or she sits in the cube across the hallway – please, please, please have the original requestor call us or email us giving us the appropriate authorization.

# ULTRA SHALLOW PROFILING

Solecon Labs is currently involved in an ongoing effort to improve our ability to characterize ultra-shallow junctions. There are two factors that are essential in measuring ultra-shallow profiles – ***sample preparation*** and ***advanced probe conditioning. Sample preparaton*** is critical in providing accurate and repeatable results for sub-100 nm junctions. Bevel angles less than .001 radians are required. An ***advanced conditioned probe*** is necessary to give the operator the sensitivity required to detect the junction. Currently, we are able to obtain .002 bevel angles. With a 2µ horizontal step, and a bevel angle of .002, the depth increment would be 40Å per data point; in a 1000Å structure 25 data points would be obtainable. In certain applications, using the same conductivity type substrate as the implanted species can be helpful to doing spreading resistance characterization of shallow layers.

If possible, please give us a call before preparing your samples with ultra shallow structures. We would like to discuss the details with you so we may understand what is required and let you know some of the technical issues which we may encounter while profiling your sample.

# QUIZTIME...QUIZTIME...QUIZTIME...QUIZTIME...QUIZTIME

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| *Why do we require that you state a maximum depth of interest on our request form?* | *An appropriate bevel angle is needed to provide optimum resolution in your main area of interest. Take the following example into consideration – a shallow, silicided, poly emitter with a thin base on an epi/buried layer would require an angle less than .0025 to properly characterize the surface. A steeper .01 angle is needed to reach the buried layer/substrate junction.* |
| *How does the size of the pattern effect the profile that we are able to produce for you?* | *Our minimum requirements are 20$^m$ x 100$^m$. A good rule of thumb is to have at least 100$^m$ for each layer to be profiled (e.g.) emit, base, epi, buried layer would require at least 400$^m$ to provide adequate characterization and resolution. Standard SRP bars are 50$^m$ x 500$^m$ and some customers are even giving us bars up to 1000$^m$ long to profile.* |
| *Why are we asking you to remove nitride from the wafer surface?* | *Nitride makes sample preparation very difficult. During the beveling process nitride may gouge and scratch the silicon making it impossible to collect meaningful data. It also takes an incredible amount of time to bevel through the nitride.* |

# Doping Type Determination using Hot Probes

The analysis of the data collected by a Spreading Resistance Probe depends critically on the conductivity type of the regions being analyzed. A number of ways exist to determine conductivity type. Among them are wafer flat location, Hall effect, rectification, and thermal emf. Measurement of the thermal emf (Seebeck voltage) involves placing two contacts onto the sample with a temperature differential between them. A Spreading Resistance Probe is readily adapted to measure the Seebeck voltage as it is a two point contact probe method.

In actual use, one of the probes is heated a few degrees above the ambient temperature. The SR probe is reconfigured to make a voltage measurement. The sample is then probed parallel to and immediately adjacent to the SR profile location. The amplified Seebeck voltage is then plotted with the SRP resistance data.

The analysis of both sets of data usually allows the reliable determination of the conductivity type for each layer. At resistivities above $10^3$ Ω-cm *p*-type material may appear to be *n*-type due largely to the fact that the thermally generated current flowing into the 'voltmeter' is small enough that it is swamped by the input bias currents inherent in the input circuitry. This situation is normally recognizable when analyzing a SRP profile by the lack of any corresponding indication of a junction in the resistance data where the type change is indicated in the Seebeck voltage. Thus type determination on high resistivity materials may require the application of common sense in the interpretation of the measurements

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