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WAFERMAP for Windows

APPLICATION NOTE 2: Difference/ Ratio Method

One of the best methods to compare different sets of wafer data (maps) are the difference and ratio method. One map can be subtracted from another map by subtracting individual measurements point by point. The resulting map will visualize the difference between the two maps.

This is a simple method, however it often requires two maps, which are identical regarding the individual coordinates of sites. In WAFERMAP such differences can be calculated without the necessity of identical grids (only the wafer diameter must be the same). This is possible because different grids will be transformed to the grid with higher density of sites before comparison.

It is also possible to calculate the ratio between two files in the same way. Using the difference method both maps should have almost the same mean value. Therefore one map must be normalized to the mean value of the second map.

On the next pages 3 different examples of these methods are shown together with actual test data.

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Comparison of pre- and postmaps:

One application of interest is to compare so-called pre- and postmaps. E.g. in case of Ti deposition the sheet resistance after sputtering can be mapped and compared to the resulting sheet resistance distribution after a following Rapid Thermal Processing step. The ratio map will visualize the influence of the Rapid Thermal Processing equipment (and possibly other influences such as problems during wafer cleaning before sputtering).

Example:

Titanium was sputtered with 600Å thickness on 200mm prime wafers. Then the wafer was annealed in a RTP chamber at approximately 700 °C in pure nitrogen. The sheet resistance was mapped before („premap“) (Fig.1) and after the RTP step („postmap“) (Fig.2). The ratio was calculated between both maps (in WAFERMAP for Windows select „Multi-File-Operations“ → „Compare“ → select the files in the 2 windows on the left → choose „X/Y“ in the center → click on „OK“) (Fig.3). The result shows a „signature“ of the RTP chamber.

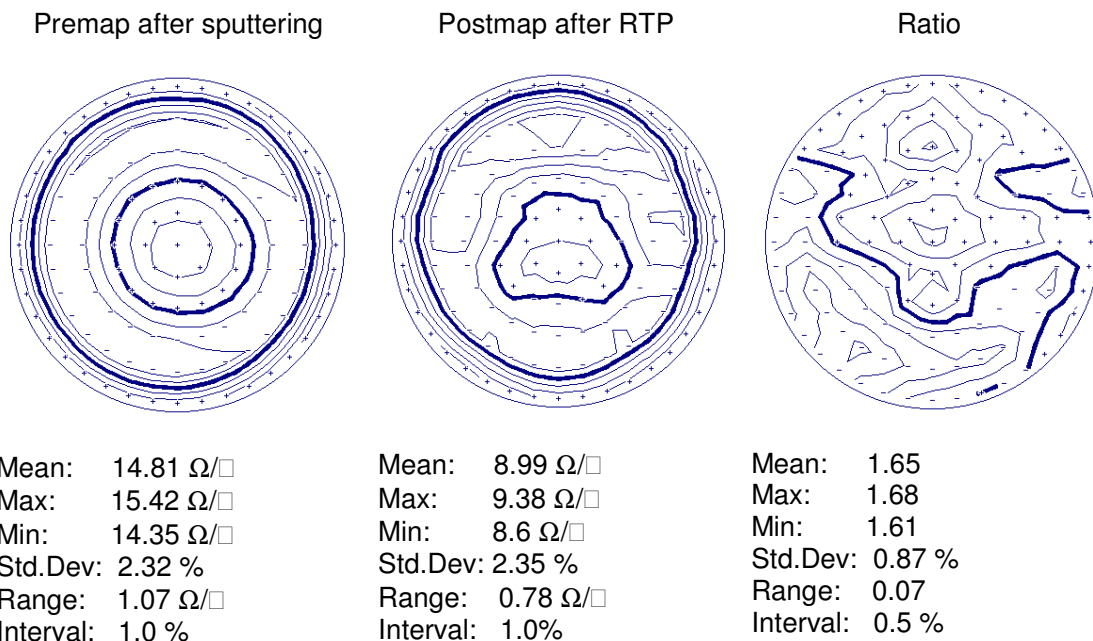


Fig. 1-3



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Comparison of maps measured under different conditions:

Another application is the comparison of maps generated on metrology tools such as 4 point probes or ellipsometers using the same test wafer. The resulting map will visualize differences between these tools.

Example:

A 200mm As implant-annealed wafer was chosen to measure the distribution of sheet resistance. 121 sites with 5mm edge exclusion were measured using an automated 4 point probe system. This tool allows for changing the direction of the probehead, so that the 4 points are arranged either radially or tangentially to the wafer periphery.

Shown below are two measurements on the same tool, using the same wafer, but with different adjustments of the probe direction (Fig.4,5). It is obvious, that there is almost no „visible“ difference in the shape of the contour lines. Only the difference map (Fig.6) is able to show the real difference (in WAFERMAP for Windows select „Multi-File-Operations“ → „Compare“ → select the two files in the 2 windows on the left → choose „X-Y“ in the center → click on „OK“).

The direction of the probe head arrangement has a direct influence mainly in the wafer edge region.

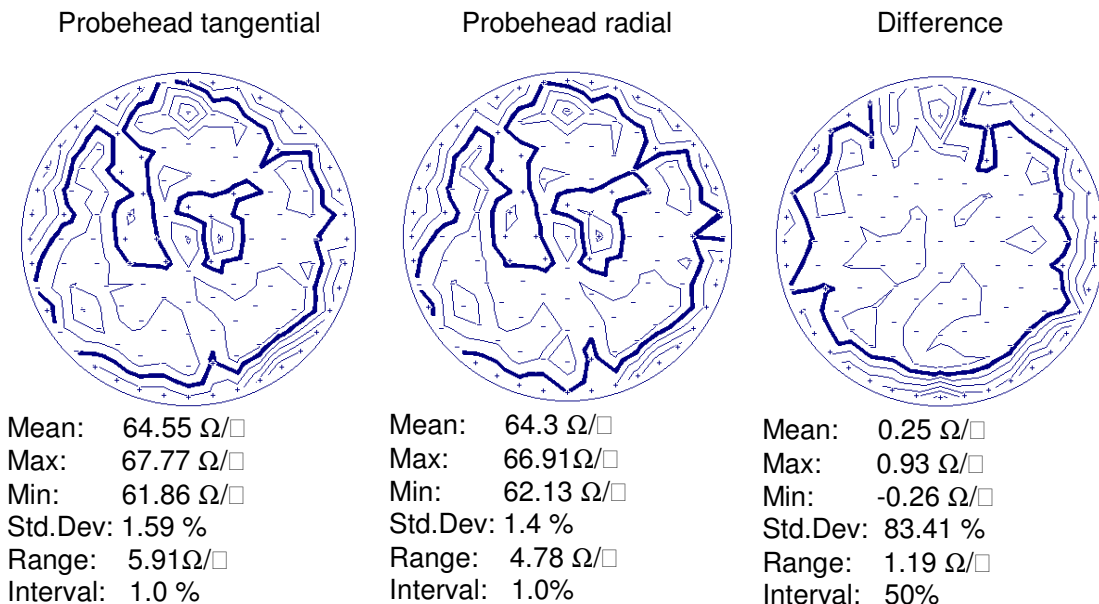


Fig. 4-6

Comparison of different metrology tools:

Another interesting application is the comparison of different metrology tools using the same test wafer. If both tools are in best conditions, the difference should be almost 0 and the resulting map should show statistically distributed differences. In other words, no distinct shape of the contour lines should be visible.

Example:

A 200mm As implant-annealed wafer was chosen to measure the distribution of sheet resistance. 121 sites with 5mm edge exclusion were measured. Two different 4 point probe measurement systems from different vendors at different locations were used (A and B). Shown below are both maps (Fig.7,8) and the calculated difference between both (in WAFERMAP for Windows select „Multi-File-Operations“→ „Compare“→ select the two files in the 2 windows on the left → choose „X-Y“ in the center → click on „OK“) (Fig.9).

The mean value varies slightly, the standard deviation is almost the same. There is no obvious difference between both maps visible, especially the difference map shows no „signature“.

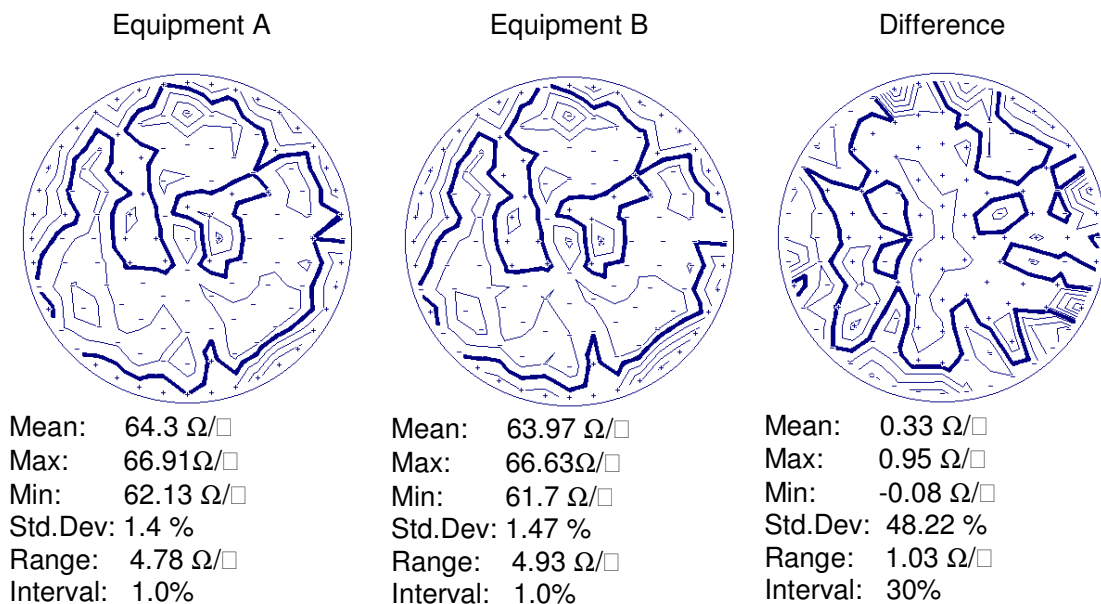


Fig. 7-9