# Wafer Charging Monitors, Inc.
## CHARM®-2 Applications Package

After twelve years of documented, successful industrial applications of the **re-usable** CHARM®-2 wafer charging monitors, WCM now also offers a complete package to provide on-site turn-around time and best measurement sensitivity. The package includes CHARM-2 wafers, WCM proprietary ChargeMap® data analysis and display software, technical notes explaining the CHARM-2 concepts, and applications training designed to convey to the user a working knowledge of CHARM-2 applications procedures, data analysis, and data interpretation.

### ChargeMap software environment

The key to successful, dependable on-site application of the patented CHARM-2 wafer charging monitors is WCM's proprietary ChargeMap data analysis and display software incorporating patented CHARM-2 data conversion techniques. ChargeMap was developed to provide a dedicated, **application-specific**, **automated data analysis environment** to enable the user to obtain CHARM-2 results with unmatched productivity and ease of use.

ChargeMap has been used by WCM to analyze thousands of CHARM-2 experiments in ion implanters, resist ashers, plasma etchers, and plasma deposition systems. ChargeMap reads CHARM-2 data files from standard parametric testers, and allows the user to generate wafer maps of surface-substrate voltages, UV dose, charge fluxes, and J-V characteristics - *the driving forces behind charging damage in IC process equipment.*

### ChargeMap makes CHARM-2 easy to use

The **re-usable CHARM-2 wafers** are first calibrated and programmed on a parametric tester, then placed in a process chamber where the collected charge or UV change the threshold voltages of the EEPROM transistors in their respective sensors. The CHARM-2 wafers are then tested on a parametric tester to collect the charging data, and to re-program the wafers for the next application.

ChargeMap is used at each step in this procedure to ensure the accuracy and repeatability of the CHARM-2 technique. It is used to **automatically verify the calibration parameters and the state of the EEPROM transistors, to ensure the accuracy of the CHARM-2 experimental results.**

ChargeMap provides exceptional versatility and functionality in the analysis of CHARM-2 charging data. During typical analysis procedure, the user will examine maps of wafer surface potentials, like the one shown in **Figure 1.**
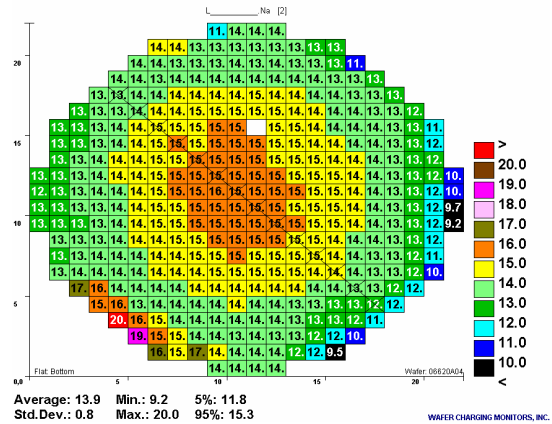


**Figure 1.** Voltages recorded by positive potential sensor.

Since regions of high potentials are not always accompanied by high current-densities which cause product damage, the user may click on suspect die locations to obtain the J-V characteristics of charging intensity at those locations, as shown in **Figure 2**.
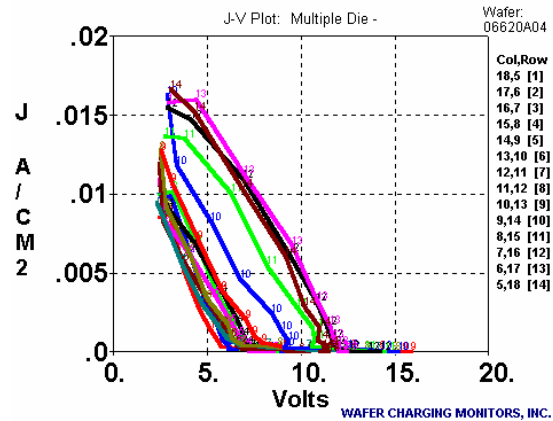


**Figure 2.** J-V plots for die indicated by "X" in Figure 1.

For comparison with product damage wafer maps, the user may input the gate oxide breakdown voltage, and obtain a contour map of the current density responsible for gate oxide damage, as shown in Figure 3.

It is apparent from Figure 3 that the locations of peak gate oxide current density, and thus the greatest damage, may differ from the locations of peak potential shown in Figure 1. This is one of the reasons why **surface potential measurements alone can be misleading**.
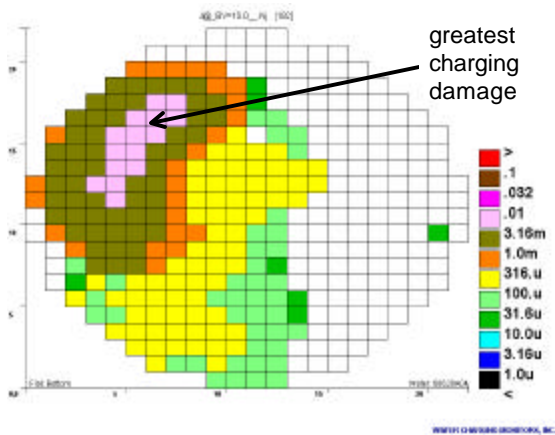
Figure 3. DamageMap™: Positive current density in A/cm² at a gate oxide breakdown voltage of 10 V.

*CHARM-2 is the only technique which provides current density wafer maps to accurately identify the regions of greatest charging damage.*

### Ease of use - evidence of extensive hands-on experience

The special-purpose ChargeMap software provides the high productivity data analysis and display functions used and refined by WCM in its own extensive customer support operations. Employing WINDOWS®-style pull-down menus, the user interface is intuitive, easily learned, and **optimized for ease of use**. Transitions between functions, e. g. from summary report to a particular wafer map, to a J-V plot, are done with a single mouse click on the item of interest. The user interface is uncluttered, providing the user with additional options only as needed by the context of the application.

### ChargeMap productivity-enhancing features

WCM's extensive experience with CHARM-2 data analysis allowed the automation of the data analysis procedure – **just a click on the "Analyze" button does the job!** Many other routine tasks, such as background data processing and batch printing of wafer maps and J-V plots are also automated. Parameter definition files and set-up files allow extensive customization of all performance options in ChargeMap - from wafer map colors and legends, to size of the images saved for insertion into documents and presentation foils.

ChargeMap also employs extensive features to ensure accuracy of results. Among these are **process time compensation** used to ensure accuracy of the voltage wafer maps, and **process temperature compensation** to ensure the accuracy of current density measurements. Also provided are numerous functions to allow easy

inspection of the CHARM-2 data, including user-adjustable data summaries and basic statistical functions.

To simplify comparisons of results, ChargeMap also provides the ability to **compute differences between data files obtained from different experiments**. This permits easy tracking of equipment drifts, and superior process optimization.

### ChargeMap is data-storage efficient

ChargeMap provides the ability to store only a subset of final results that are of significant interest. This feature also saves time when the results need to be reviewed again in the future.

### Inexpensive hardware and software platforms

ChargeMap software runs on IBM-compatible PC's with 8MB of memory, under all WINDOWS® operating systems, and allows the use of WINDOWS®-supported printers.

### ChargeMap is compatible with standard parametric testers

To ensure accurate, dependable CHARM-2 results, and to provide for flexible use of test resources, ChargeMap is designed to read CHARM data files from WCM-approved CHARM-2 calibration and test software used by WCM-approved makes and models of standard parametric testers. Please contact WAFER CHARGING MONITORS, INC. for a list of recommended choices.

### ChargeMap future enhancements

As inventors and developers of the CHARM-2 technique, WCM is committed to enhancements of the features incorporated in present and future generations of the CHARM monitor wafers. WCM's proprietary ChargeMap software anticipates these enhancements, to allow ChargeMap users to take immediate advantage of the full capabilities of all generations of CHARM wafer charging monitors.

### If you need more information, please contact

**Wafer Charging Monitors, Inc.**
**127 Marine Road**
**Woodside, CA 94062**
**tel.: 650-851-9313**
**fax: 650-851-2252**
**e-mail: sales@charm-2.com**
**web-site: http://www.charm-2.com**

CHARM®-2, ChargeMap®, and DamageMap™ are trademarks of Wafer Charging Monitors, Inc.
WINDOWS® is a trademark of Microsoft Corporation.