OptoMetrix, Inc.

Technology Newsletter Q2, 2001

President's Message

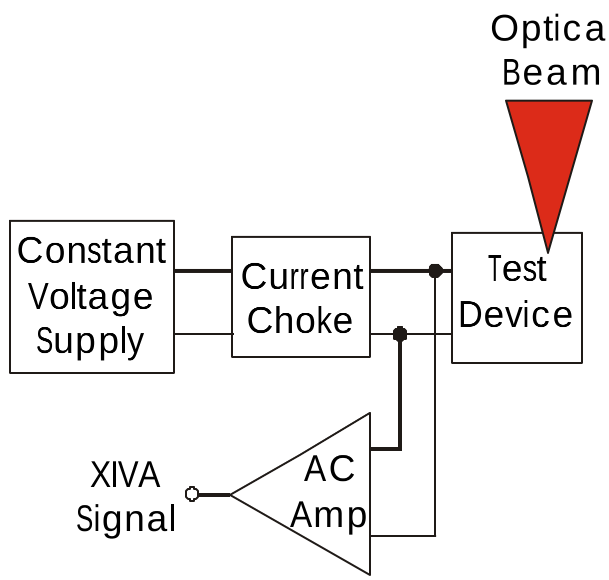
The purpose of this newsletter is to keep you up-to-date on the latest technical developments at OptoMetrix. I hope that you find it of value and perhaps you will pass it on to a colleague with similar interests. Feedback, both positive and negative, is always appreciated. I can be reached at rafalk@optomet.com.

R. Aaron Falk

Introducing XIVA - Advanced LIVA/TIVA Technology

Occasionally, good engineering and a bit of serendipity work together to bring the best of all things into one package. Such was the case with our new Externally Induced Voltage Alterations (XIVA) sensor head[1]. The original purpose of the development effort was to provide correct voltage bias on a test device, while maintaining the high sensitivity of the constant current sensing approach utilized in LIVA and TIVA. Not only was the original goal accomplished, but a factor of 10-20 improvement in signal-to-noise ratio (SNR) was also realized!

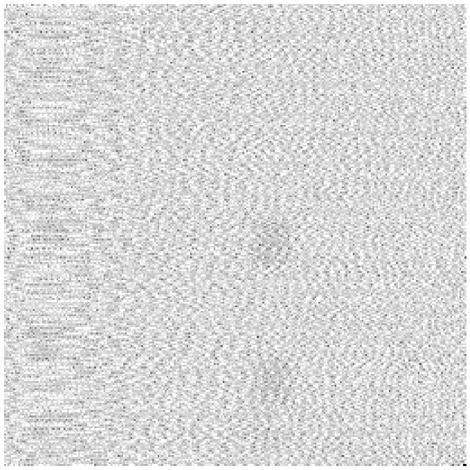
The application of constant voltage bias to the test device coupled with constant current sensing appears, at first, to be contradictory requirements. The contradiction is resolved by realizing that the voltage bias is a low frequency "signal" and the constant current sensing is a high frequency signal. The bias is a constant, whereas the XIVA signal only occurs as the scanning laser passes over the failure sight. An ideal current choke, placed in the bias lines produces the desired functional separation (see figure below). At low frequencies, the current choke has no effect on the circuit and proper voltage bias can be established. However, when the scanning laser causes a sudden change in impedance of the test device, the current choke acts to temporarily suppress any changes in the DC current level. Constant current sensing with constant voltage biasing is thereby achieved.



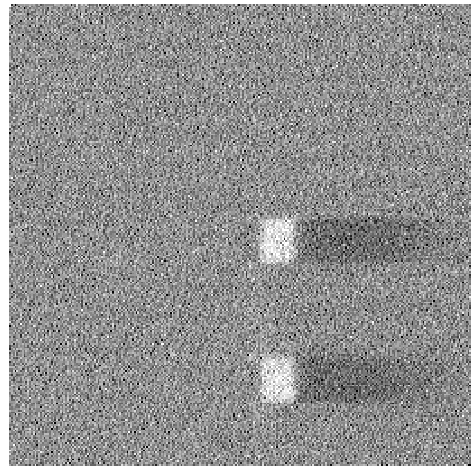
Block diagram of XIVA head utilizing current choke to separate bias and sensing functions.

The serendipity of this approach is that separation of the bias and sensing functions allows each to be separately optimized. Let's face it, constant current power supplies are not exactly optimum sensors. The XIVA sensor approach has allowed impressive gains in SNR as shown in the figures on the next page.

[1] Patent Pending

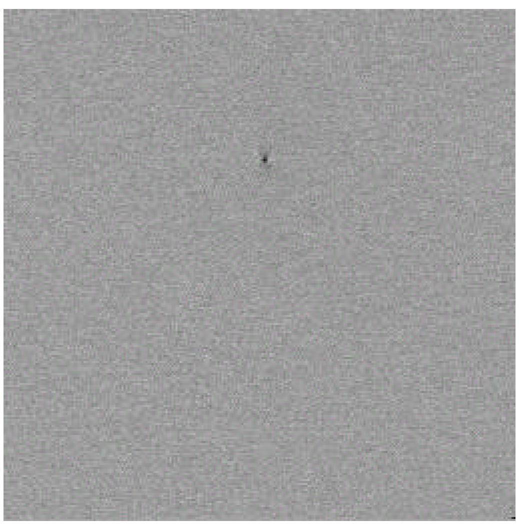


Barely observable signal using standard TIVA technique

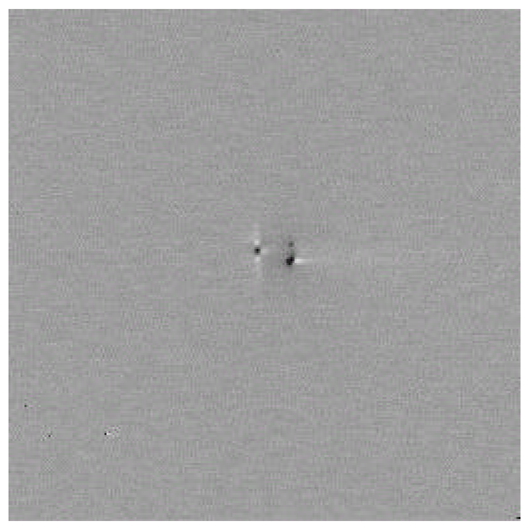


Strong signal using XIVA technique

Comparison of signals from TIVA and XIVA for metal serpentine test structures.



XIVA signal at 2.5X



Same location at 10X - XIVA signal resolves into three distinct sources

XIVA signals of level 5 short in SRAM. Scan time is ~ 1 second.

For the user, these gains translate into significant reduction in the time it takes to image a failure. SNR can always be improved by averaging over time. Unfortunately, the SNR only improves as the square root of the increase in averaging time. An increase in the SNR of 10 requires an increase in the averaging time of 100!

The figures above are XIVA images for a real world, Level 5, metal-metal short in an SRAM. Prior versions of TIVA required several minutes of averaging to produce equivalent images. The XIVA approach produced the image in 1 second. The noise level in the XIVA head represents a few parts in 10^5 thermally induced resistance change in the short.

Technique	***Physics***	***FA Applications***
OBIC (Optical Beam Induced Current)	Photovoltaic Effect	Location of Junction Defects
LIVA (Light Induced Voltage Alterations)	Photoconductive Effect	Location of Open Junctions and Substrate Damage
SEI (Seebeck Effect Imaging)	Seebeck (Thermal-Voltaic/Thermal Couple) Effect	Location of Opens
TIVA (Thermally Induced Voltage Alterations)	Thermal-Conductive Effect	Location of Shorts, Vias with Incorrect Resistance

Different measurement techniques that can be performed with the XIVA system.

Physics of XIVA

Understanding of the physics behind XIVA allows users to better utilize the tool for their particular application. A basic system utilizes a laser scanning (confocal) microscope to sequentially scan a focused laser spot over the integrated circuit. Scanning can be performed from the front or backside through selection of the laser wavelengths and some device preparation for backside scanning. As the focussed laser beam passes over an integrated circuit, it causes changes in the device electrical characteristics through two effects, generation of photo carriers and heating. If a laser wavelength is chosen to be below the semiconductor bandgap[2], then only heating occurs. Shorter wavelengths, above the bandgap, will produce both photo carriers and heating, however, photo carrier effects are orders of magnitude stronger and dominate any thermal signals. Both photo carrier generation and heating can cause changes in the circuit resistance (photoconductive and thermal-conductive effects) and cause currents to flow (photovoltaic and Seebeck/thermal couple effects).

[2] For topside probing, a dark coating can be used to allow surface heating without photo carrier generation.

Application of a constant current to the integrated circuit causes small voltage alterations to occur across the device when the scanned laser beam induces changes in the circuit. For XIVA, the current is only held constant for a moderate period of time, allowing voltage biasing of the test part.

Applications of XIVA

The primary purpose of XIVA is defect location. In some cases information on the nature of the defect can also be extracted - note that the three spots on the 10X XIVA image (previous page) are all different in their spatial characteristics. The table above indicates some of the potential applications of XIVA. Current research is producing additional applications, such as location of problem vias. The OptoMetrix XIVA system is available with multiple laser wavelengths in the same package (up to three), allowing all of the above techniques to be utilized in a single, turn-key system.

For more information on OptoMetrix products, contact us at sales@optomet.com or 425-251-6363 x18.