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EuTTA Solution for Stabilized FMI

Introduction

Fluorescence micro-thermal imaging (FMI) is a technique for locating heat sources in an IC. The FMI process is significantly more sensitive than liquid crystal (Bruce 73), but somewhat more involved.

Sample preparation involves dropping a thin film of fluorescent material onto the sample. The FMI process begins by uniformly illuminating the sample with monochromic ultraviolet light. The fluorescent material absorbs energy from the light source then emits the energy at characteristic wavelengths, mostly 612 nm. The intensity of emitted light at 612 nm decreases with temperature. Heat sources are isolated by the intensity difference between the unbiased and biased sample. The “difference image” superimposed on the biased reference image maps hot spot locations.

Important Factors

The fluorescent material is critical. Europium 111 is the most well known (Barton 87). EuTTA[1] FMI solution prepared by Accelerated Analysis has demonstrated effectiveness in the laboratory. The product contains EuTTA and PMMA[2] dissolved in MEK[3]. The solution is ready to use as supplied in a convenient Teflon bottle with applicator tip.

Uniformity and stability of the UV illumination are important. Sample bias and its relationship to the image capture process are also critical. Hardware and software developed by Jim Colvin of FA Instruments, San Jose, CA is specifically designed to take the hassle out of controlling the UV illumination and optimizing collecting thermal images. The technique called "Stabilized Thermal Imaging" or, more specifically, "Stabilized FMI" improves sensitivity by a factor of 100 over conventional FMI.

Stabilized Thermal Imaging

Sensitivity for thermal imaging is improved by collecting and averaging several frames while the sample is biased "on". Similarly, several frames are collected and averaged from an unbiased sample. The averaging does filter out random thermal noise, but heat spreads laterally outward from point sources causing a gradual increase in the background temperature. As a result, improvement in signal to noise can be lost by the growing background temperature.

Stabilized Thermal Imaging overcomes this limitation with dramatic effect. The systematic error described above is reduced by switching the sample "on" and "off" just long enough to collect single frames. Each frame included in the average will be in an identical stage of warming. Likewise, "off" frames collected will be in the same stage of cooling. If extended heating time is required, "on" and "off" durations can be extended to collect two, four, or more frames at a time. The improvement in FMI by stabilization is readily achieved using hardware and software developed by FA Instruments (www.fainstruments.com).

[1]EuTTA: Europium (111) or europium thenoytrifuoroacetonate.
[2]PMMA: Polymethylmethacrylate. This plastic material supports the EuTTA within its matrix.
[3]MEK: Methylethylketone. This solvent, similar to acetone, evaporates quickly, leaving the EuTTA neatly trapped in an acrylic like film.

To apply FMI Solution…

1. Apply one or two drops of solution to a clean semiconductor surface.
2. Allow solution to spread over the IC. Solution should spread readily. Some experimentation may be required to achieve a thin, even film. Some users spin the sample to spread the solution; others blow gently with N_2 to spread the solution. Film thickness must be sufficient to absorb UV energy, but thin enough not to distort surface characteristics. (Add a few drops of pure MEK to thin the solution if necessary.)
3. The sample is ready to use immediately. Drying the sample for several minutes will allow evaporation of MEK.
4. After drying, the film can be removed with acetone or MEK.

References:

Barton, D. "Fluorescent Microthermographic Imaging."
Proceedings of 20th ISTFA, 1994. 87-96.

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