An advanced photon-emission microscope is combined with the latest image-processing software.

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An improved photon-emission-microscope (PEM) instrumentation system has been developed for use in diagnosing failure conditions in semiconductor devices, including complex integrated circuits. This system is designed primarily to image areas that emit photons, at wavelengths from 400 to 1,100 nm, associated with device failures caused by leakage of electric current through SiO₂ and other dielectric materials used in multilayer semiconductor structures. In addition, the system is sensitive enough to image areas that emit photons during normal operation. This system supplements a prior PEM system based on a photon-intensified, gated, charge-coupled-device (CCD) camera.

This system includes an optical microscope fitted with a low-light-level imaging subsystem based on a state-of-the-art high-resolution (1,024 × 1,024 pixel), cooled, back-illumination CCD camera in a light-proof enclosure. Another major subsystem is a computer running the latest in Windows-based image-processing software, which can facilitate generation of test reports and research papers by putting out image files in popular formats, including tagged image file (TIF), bit map (BMP), and Joint Photographic Experts Group (JPEG) formats.

A device under test (DUT) is placed on a translation stage under the microscope. This stage enables movement of the DUT along both axes perpendicular to the optical axis, as well as along the optical axis for focusing. Any of several microscope objective lenses affording different magnifications (5x, 20x, 50x, and 100x with extra long working distance) can be selected. The exposure time is programmable between 5 milliseconds and 2 hours. Provisions for setups of external equipment, including the power supply for the DUT and digital multimeters, can be incorporated into custom software.

In operation, the system integrates the photons emitted from the DUT, and the resulting bright spots (showing the locations of substantial emission of photons) are displayed superimposed on an image of the DUT that was acquired previously under visible light. Failure-analysis engineers can use the information in this display to locate failure sites on the DUT.

This work was done by Gregory A. Hall, Robert Youngquist, and Wasfy Mikhael of NASA’s Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-42121