IXL Pulsed Laser Equipment

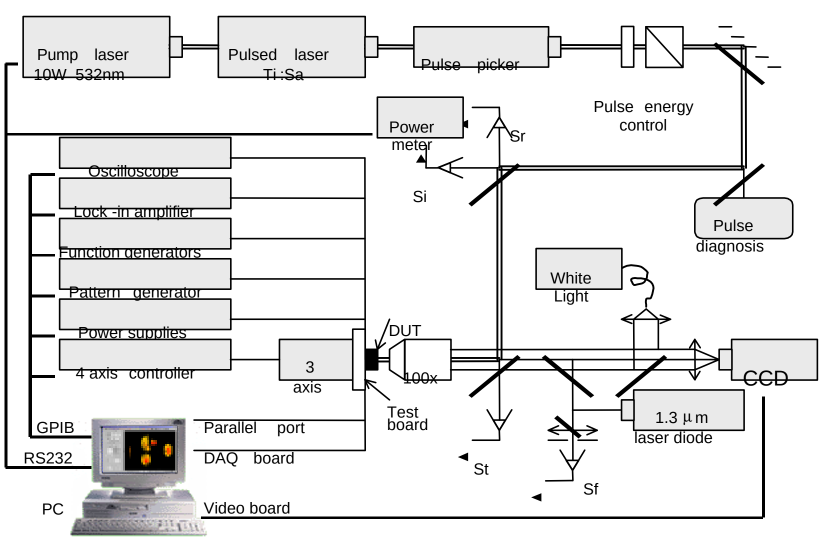
Dean LEWIS	Vincent POUGET
IXL Laboratory E-mail: lewis@ixl.fr	IXL Laboratory E-mail: pouget@ixl.fr
www.ixl.u-bordeaux.fr	

Applications :

Due to it's wavelength tunability, this IXL equipment allows both front side and backside Photoelectric Laser Stimulation (PLS) for failure analysis techniques in integrated circuits. Three main applications were developed:

- The first application consists in simulating experimentally the radiation with a pulsed laser. Using ultra-short laser pulses is a convenient way to simulate experimentally the spatial environment of integrated circuits when interactions with heavy ions occur. These particles generate temporally electrical disturbance called Single Event Effect (SEE). This IXL experimental set-up can be considered as a complementary tool for particle accelerators to evaluate the hardness assurance of integrated circuits for space applications.
- The second application concerns defect localization and characterization using OBIC techniques. The high sensitivity of the IXL equipment (the pulsed laser allows performing lock-in amplifier) allows localizing and studying latent defects as ESD defects for example.
- The third application concerns fault injection in electronic systems. One unique capability of the pulsed laser method is the possibility to inject an error into a circuit or a system with an accurate spatial and temporal positioning. This methodology which is called dynamic fault injection in integrated circuits allows to evaluate the efficiency of hard or soft correction systems. Using ultra-short pulses synchronized with the external clock of the device under test permits to perform a temporal study of the fault injection mechanisms.

Experimental set-up



IXL Experimental set-up for ICs testing with a pulsed laser.

The previous figure presents the main elements of the system. The laser source is a Ti:Sapphire (Ti:SA) oscillator (model Tsunami from Spectra-Physics) pumped by a 10W cw laser (model Millenia Xs from Spectra-Physics). The oscillator delivers 100fs or 1ps pulses at a frequency of 80MHz. The pulses wavelength is tunable in the red-NIR region from 730 to 1000nm. This tunability allows adjusting the penetration depth of the laser pulse in the semiconductor material. For front-side testing of silicon devices, a wavelength of 800nm is usually chosen, giving a penetration depth of approximately 12µm, which is sufficient to ensure efficient photo-generation in the active volume of modern devices. For backside testing, a longer penetration depth is needed to reach the active volume through the silicon substrate. The absorption coefficient of silicon rapidly drops for wavelengths higher than 1000nm, but we still want to induce a sufficient level of photo-generation in the active volume. Thus, the best compromise usually lies between 950 and 1000nm depending on the substrate thickness and doping level.

Because a pulses frequency of 80MHz would be too high in most cases for the DUT to come back to a steady state between two consecutive pulses, a pulse picker (model 3980-5S from Spectra-Physics) is used to reduce this frequency. The pulse picker is based on an acousto-optic gate synchronized with the incident pulses. The pulses frequency at the output of the pulse picker is adjustable from single-shot to 4MHz and the pulses triggering can be synchronized with the DUT clock. The pulse energy is controlled by the motorized rotation of an half-wave plate preceding a polarizer. Two leaks of the main beam are used for pulse diagnosis (temporal shape and wavelength measurements) and incident pulse energy measurement (Si). The pulse is finally focused on the surface of the DUT by a 100x microscope objective down to a spot size of approximately 1µm. The location of the pulse impact is visualized with a CCD camera. The customized microscope includes a pulse leak detector (St) for synchronization and a confocal infrared reflectance measurement system for backside imaging. The DUT and its test board are mounted on a 3-axis translation table with 0.1µm resolution. This table and the half-wave plate rotation are controlled by a 4 axis controller (model MM4005 from Newport). The scan is thus performed by moving the DUT under the beam rather than by using a scanning mirror, in order to preserve the normal incidence condition (and the optimal beam focusing).