ON Semiconductor

Electrical Failure Analysis Laboratory
ON Semiconductor Piešťany

New built Failure Analysis Laboratory in ONPY

EFA Laboratory, ON Semiconductor Piestany

Previous activities on moving Laser cutter and installing new photoemission microscope, described in previous issues of ON Semi News, gives the foundation for growth of a new in-house Failure Analysis laboratory in ONPY. This laboratory is named Electrical Failure Analysis Lab and is located in the ONPY2 clean room right next to epitaxy and KLA (T149). The room was created from old wafer storage and extended by part of epitaxy area (was described in previous issue of ON Semi News). The laboratory is focused on looking for fails and failures in semiconductor devices and structures which are produced in ONPY1, ONPY2 and in other ON Semi locations (Roznov, etc.). Failure Analysis (FA) is the process of determining how and why a semiconductor device has failed. The FA results are used to give feedback to process engineering so that process issues can be eliminated leading to ultimately improve yields.

Obr. 1. Pracovisko fotoemisného mikroskopu

Similar laboratories exist within ON Semi in Phoenix, Roznov, Seremban, Leshan and OSPI.

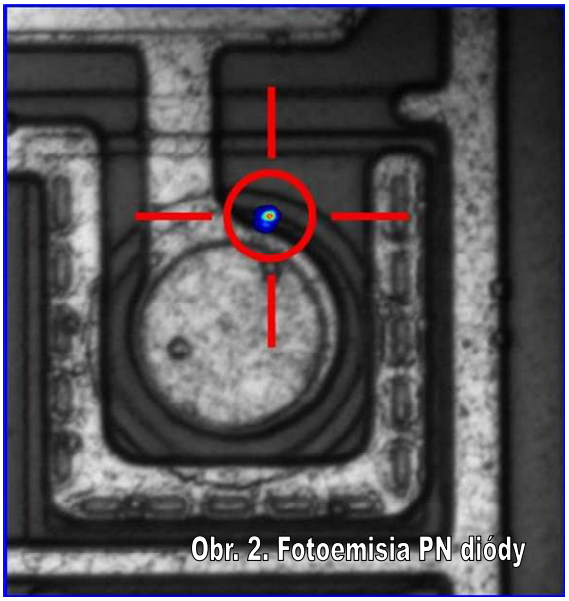
In the past ONPY engineers were sending failed material to Phoenix PAL. Disadvantage was cycle time, because it requires time for transport and analysis. The own analysis was limited by priorities, because Phoenix PAL was and is solving most of customer returns for whole ON Semi. In order to minimize analysis cycle time, the EFA laboratory was built. Today, EFA Lab covers most of analyses for ONPY2 and ONPY1. Additionally, cooperates with other PALs (Phoenix, Roznov) and supports Roznov's Design Center (EFA Laboratory was introduced to RDC two weeks ago).

Thanks to investment from the last year the laboratory offers numerous analytical techniques such are laser cutting, electrical measurements with probe heads, probe cards, microprobes, DC, Impedance, C-V, C-t measurements, localization of hot spots by use of liquid crystals and several others.

The Laser cutter built in ONPY is a unique tool within ON Semi. This equipment offers simultaneous laser cutting with parallel monitoring of DC characteristics and application of liquid crystals. For instance such ability is used for laser marking of hot spots in large structures (e.g. capacitors) for further cross-sectioning. More information on this equipment can be found in page 11 of ON Semi news 4/2006 and in [1].

Photoemission microscope Phemos-1000 (Fig. 1) was purchased from HAMAMTSU this year in basic configuration with cooled CCD camera. This tool is used for localization of leakages in semiconductors; this practically means that the tool is able to localize areas where photons are generated from the sample as result of current flow. This can be used for

detection of forward, reverse biased PN junctions, breakdowns in oxides, PolySi filaments, insufficient Metal-PolySi contacts, hot electrons (MOSFETs in saturation region), and several others.


Obr. 2. Fotoemisia PN diódy

Unfortunately, photoemission cannot be used for detection of leakages between metal lines or doped PolySi lines which are formed by insufficient etch, particle contamination, etc.

However, such leakages can be detected by liquid crystals though there is a limitation on the minimal power consumed by sample under test and is usual in the mW range. If the leakage is less liquid crystals are not usable.

Due to compact construction of Phemos-1000 it is possible to upgrade this tool with laser scanning and OBIRCH (TIVA/XIVA) analytical technique. OBIRCH (Optical Beam Induced Resistor Change) [1] has high sensitivity to detect and localize leakage sites within integrated circuits and is still missing in the EFA Laboratory. Principally in this analytical technique, the laser beam locally heats and scans over the sample with recording of resistance change. The result of such scan is imaged with OBIRCH centers (similar to photoemission imaging).

Based on current experience OBIRCH / TIVA / XIVA is an indispensable technique for covering FA analysis in ONPY.

Photoemission and OBIRCH are nondestructive analytical methods applicable from front side as well as from back side (Fig. 3) of semiconductor sample. More information can be found on EFA Lab internal web page [1]. The samples under photoemission are biased by DC Measurement Rack, which includes several DC sources and Curve tracer. This option is applicable for integrated circuits (ICs) with lower count of required biases. For more difficult ICs the DTS II tester is currently installed in EFA lab. Besides the mentioned tools, Leica microscope found in ONPY stock is recalled. Further plans on this tool is to get UV mode or Laser scanning to increase resolution (practical achievable magnifications are 15k-25k) and go far behind regular optical resolution (typically 2k). Such an upgrade is requiring finances and we hope it will be possible in the future.

EFA laboratory cooperates with defectivity group, which covers activities on FIB (focus ion beam) cutting, SEM (Scanning Electron Microscope) inspections, EDX (Energy-dispersive X-ray spectroscopy) analysis and several others.


Obr. 3. Backside fotoemisia, detail

Generally speaking in EFA Lab the problem is localized within investigated

sample giving a notice to FIB, SEM, etc where to look for physical root cause.

It needs to be noted that equipment connected with sample preparation and treatment (FIB, SEM, SELA, ALLIED, and others) is necessary part of each Failure Analysis Laboratory. However, Failure analyses are currently covered by a single engineer, importance of the lab and its addition are reflected in solving of numerous issues for ONPY2, ONPY1, etc. These analyses are documented in EFA reports and up to today more than 14 such reports were created. Several of them can be found directly in [1] as examples for individual analytical techniques.

For accessing of information on new ONPY EFA Laboratory, the internal web pages were created, the address is http://onpy.onsemi.com/efa. On these pages you can find EFA Lab details, plans, available tools, techniques with examples and explanations. Also there are listed activities (trainings, seminars, workshops, etc.), results of Internship students who worked in EFA Lab. For instance results on characterization of photoemission of MOSFET (see section "Others" for mentioned results) performed by M. Ziga, who attended internship program in this year. In this place I would like to thank Peter Blecha for his great job on programming of the EFA Lab web pages, Radoslav Derdák for IT support and Dave Lundeen for language support.

For education purposes for our engineers several books focused on FA were purchased (list can be found in section "Other" in [1]). The books are available for ONPY engineers in the Device library [2]. EFA support can be request by form located in section „Analysis Request". This is preliminary solution, with plan to be part of PAL society, by sharing PAMS (Product Analysis Management System) designed by PAL Phoenix and used by other PALs (Roznov, OSPI, etc.)

There is a plan to extend EFA support for external customers such are Semikron Vrbove, AMI Semiconductor and others.

It is important to think into the future and look for opportunities to extend analytical techniques in EFA laboratory, at least by mentioned OBIRCH or TIVA respectivelly others.

At the end of this article I would like to wish you Merry Christmas and Happy New Year 2008.

Literature

[1] Internal EFA Laboratory ON Semi web pages
[2] Device library (Owner: Process Integration)

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