Electrical Failure Analysis expansion for ONPY2

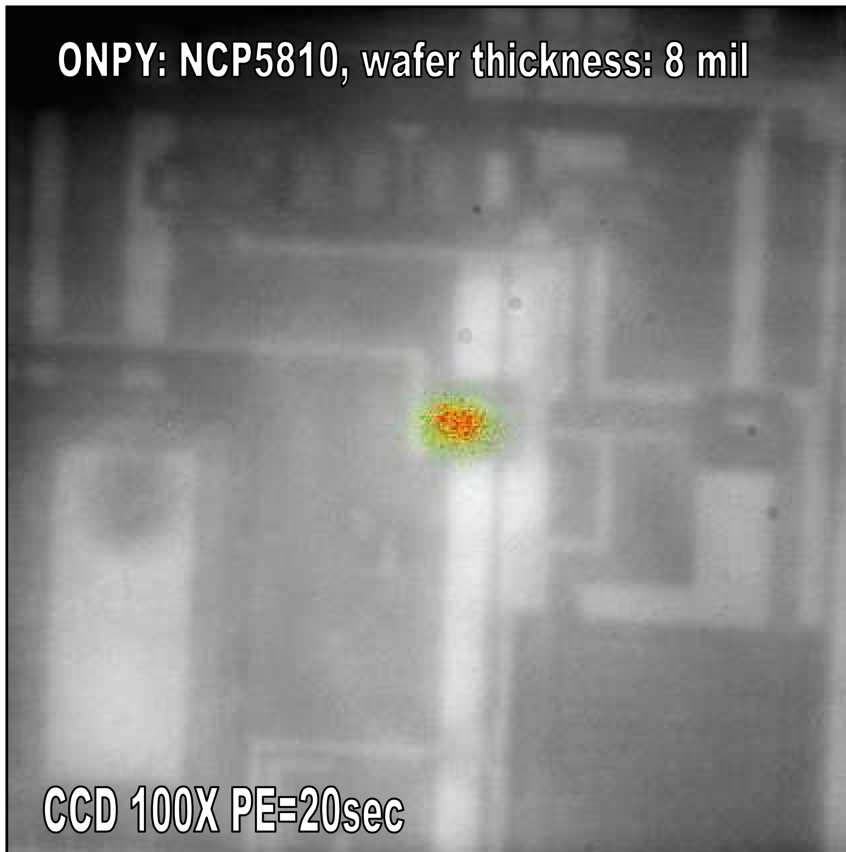
Subject:

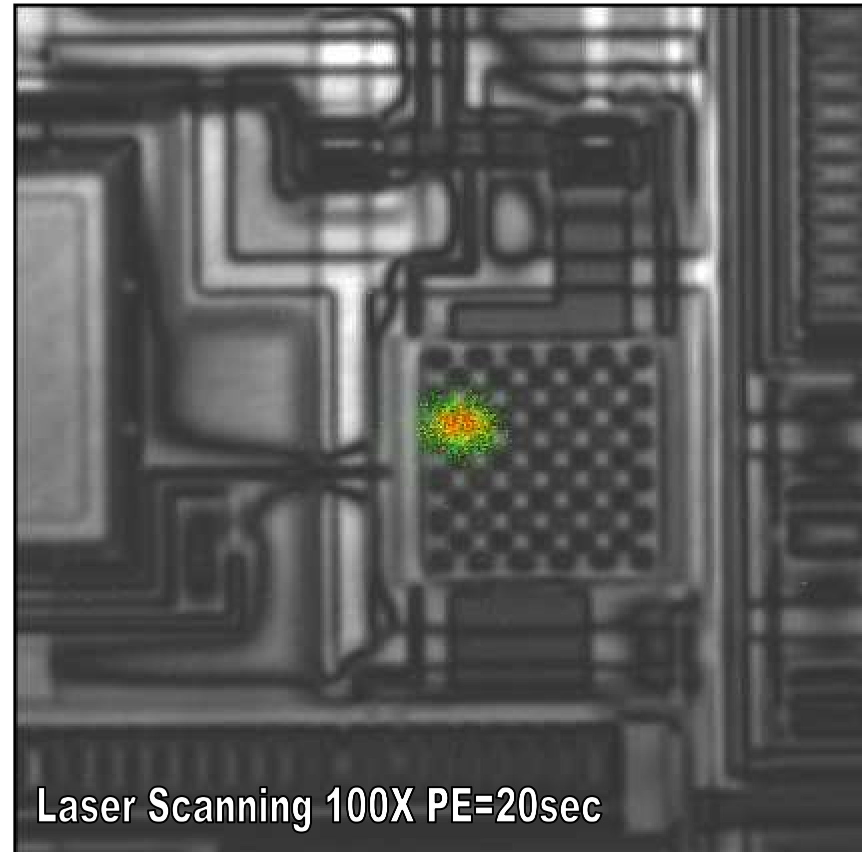
Advantages of upgrading PHEMOS-1000 photoemission microscope with laser scanning and OBIRCH/TIVA modules

Device Team ONPY2
Written by V. Kulikov in 25 Sept. 2006, updated 6.Oct.2006

ON Semiconductor
Piestany, Slovakia

Photoemission image quality (backside I-R CCD versus IR-laser scanning)





Since pattern image is taken from the back-side of the wafer, its quality depends on wafer thickness (the thinner the better quality of the pattern image). The comparison of pattern images taken by back side IR + CCD versus IR laser scanning is shown above. As can be seen the quality of the pattern image taken by laser scanning is substantially better compared to the regular I-R CCD. (Note: photoemission image is shifted because used demo system was not calibrated). **Improved pattern image laser scanning can be applied in many further failure techniques (see following slides).**

TIVA, IR-OBIRCH techniques (Laser Induced Thermal Stimulation, source: Hamamatsu)

TIVA (Thermally Induced Voltage Alteration) is powerful defect analysis tool for fast localization of device defects, particularly the defects found in metal interconnections such as voids, short circuits and resistive vias. The voltage alteration data overlays the LSM image to support the full range of laser-based failure analysis techniques available including TIVA, LIVA (Light Induced Voltage Alteration), OBIC (Optical Beam Induced Current), OBIRCH and SEI (Seebeck Effect Imaging).

Thermal laser stimulation is able to:

- localize current related defects from the front side as well as from the backside of ICs
- metallic defects such as Micro-bridges, parasitic vias, etc.
- non metallic defects such as melted poly-silicon or melted silicon spikes
- Affected vias and contacts
- defects in capacitors and other structures
- Gate related defects: Melted polysilicon or silicon spike in the silicon oxide
- practically localizes defects where phonon emission is not generated

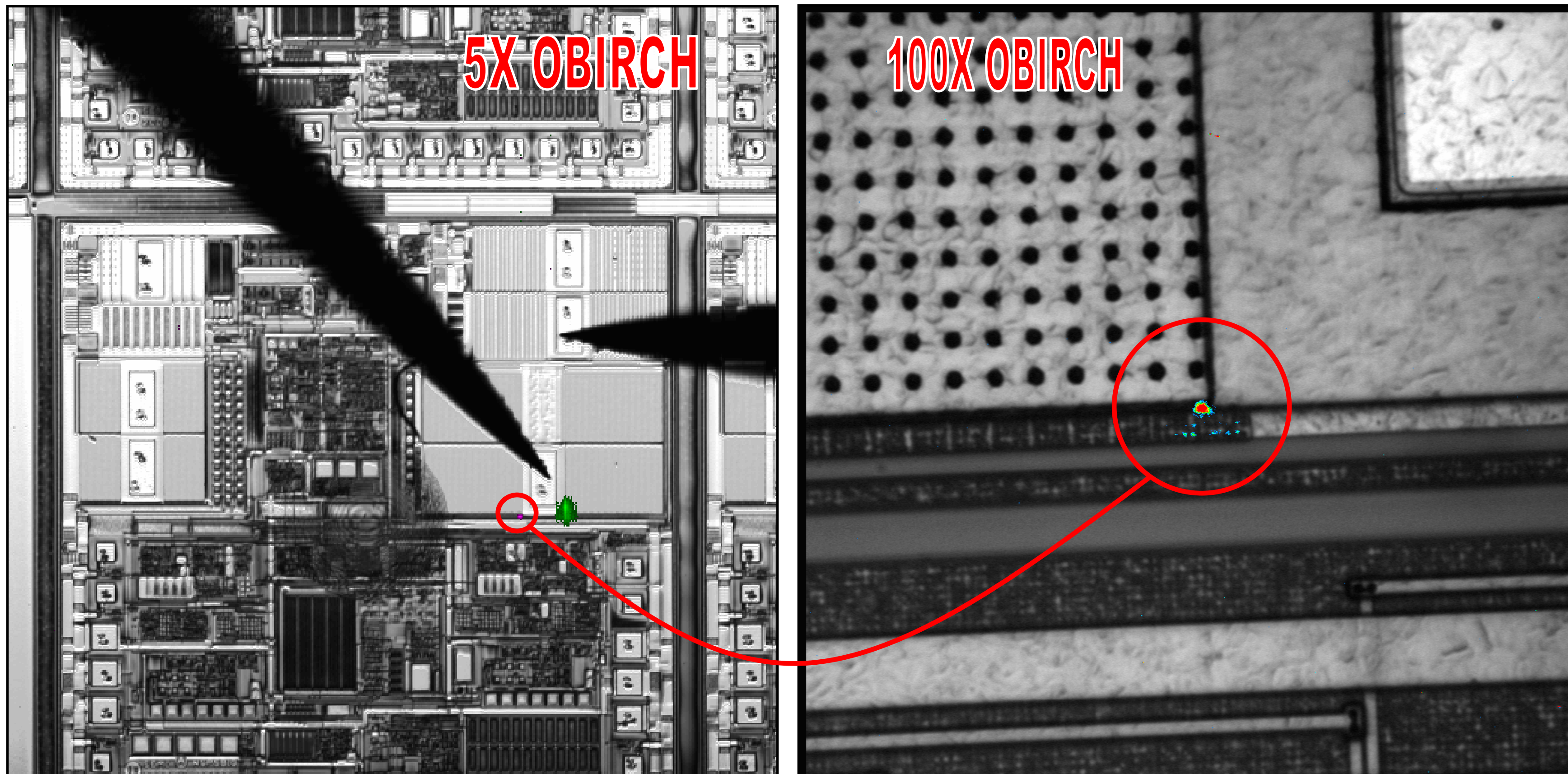
Advantages:

- Thermal laser stimulation (TLS) can precisely localize the physical defect
- No spatial or temporal shift between “hot spot” and laser spot center
- No significant thermal spreading
- EMMI (Emission comes from mechanisms such as high field) is not as precise as TLS

Microscopy are complementary

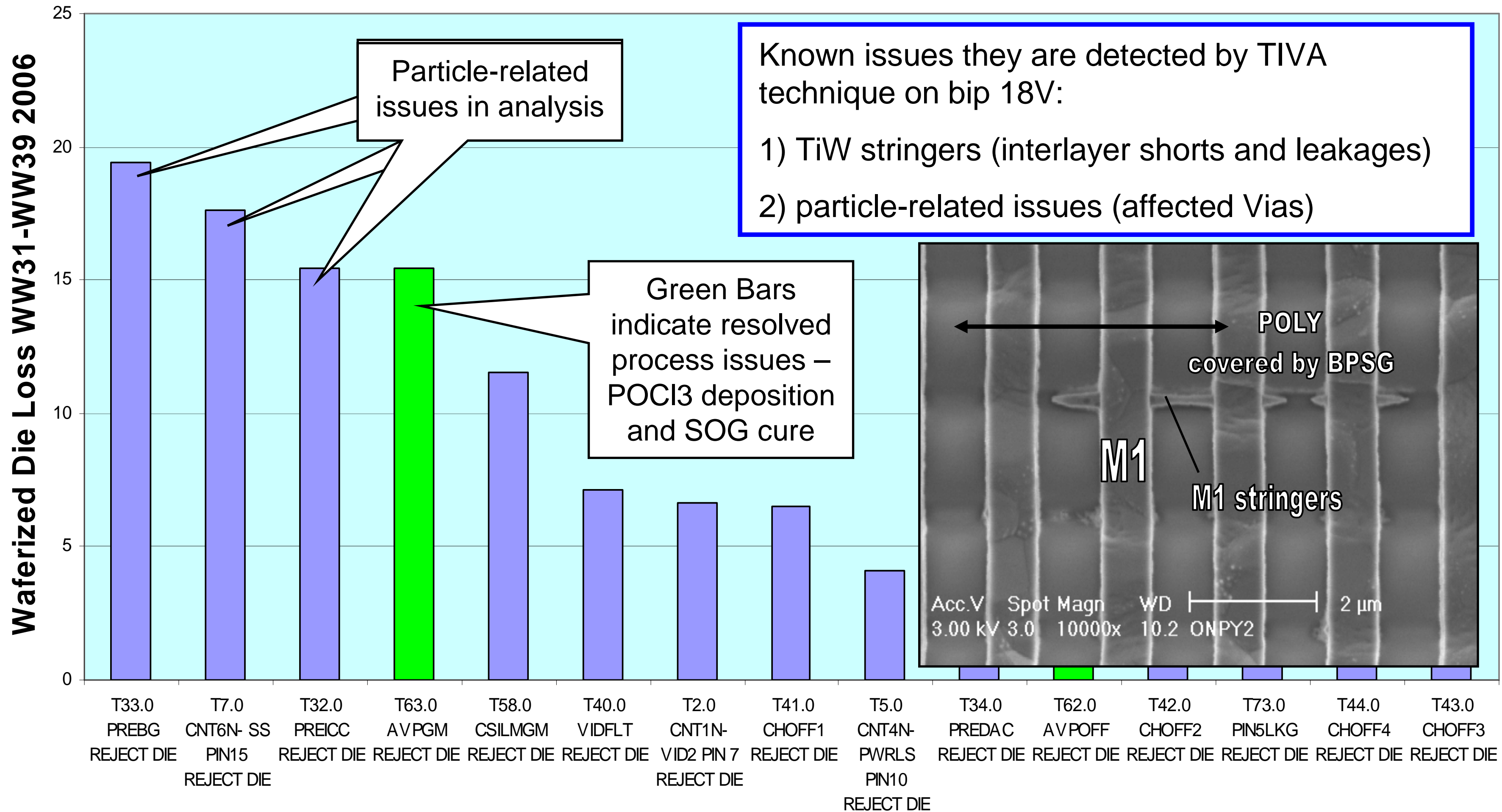
- Emission microscopy and thermal laser stimulation on the same tool is the right way to go

Practical application of OBIRCH (to ONPY rejected NCP5810, using Hamamatsu DEMO tool)



Rejected unit from NPD qual lot NCP5810 was used for investigation (the lot yielded poorly about 30%). OBIRCH clearly localized place where change of the resistance was marginal. In parallel investigation in PAL was on-going. The root cause found by PAL: incomplete removal of the polysilicon which caused a short to Metal1 in INV_PWR_PMOS. Detailed report can be downloaded from:
http://pal.onsemi.com/Reports/Internal_Reports/2006/P060728-001.pdf

Application TIVA/OBIRCH to BIP18V FA



Note: This information was extracted from Yield meeting report for WW40, detailed report on Metal stringers can be found here: \\Chopok\Device_Probe\18V_Bipolar\Analysis\18V BIP NCP5318 stringers\NCP5318 Stringers.ppt

Application TIVA/OBIRCH to PS3 FA

CP/UP OOS Pareto, LT=All, Tech=All, RCL=All

Category	# of wafers
M1 SK OV AH/FRP	194
M1CD	86
ISO Cont. Res	63
ISO RES/SQ	29
Base cont res	24
NSD IN PWL RS	23
NSD/ISO leakage	23
M1/P2/PWL CAP	18
P2/PW CAP BV	10
UVLO	8

Left axis: # of wafers (0, 50, 100, 150, 200, 250); right axis: Cumulative (0%–100%)

Known issue they can be detected by TIVA technique on PS3:

1) HS GS-High side driver leakage Bin10 (observed sensitivity to light), root cause still not found, preliminary report can be found on: \\Chopok\process\PROC_GROUP\PS3\Device_group\PS3_Analyses\AK16-GS_Leakage\HSGSMeasurementData\AK16-HSGSLeakage.ppt

Note: This information was extracted from Yield meeting report for WW40

Application TIVA/OBIRCH to PS5LV FA

Waferized Die Loss WW31-WW39 2006

25
20
15
10
5
0

Red Bars indicate that these failures are likely due to Via Particles

Probecard-dependent frequency issue

T5.0 UVLO START - GNG REJECT DIE
T7.0 VID0 HI RISE THRESH - GNG REJECT DIE
T52.0 G1 FREQUENCY CHECK REJECT DIE
T50.0 4-PHASE DETECT THRESH - GNG REJECT DIE
T4.0 ICC VCC = 12V REJECT DIE
T29.2 VRM11 RDY THRESHOLD - GNG REJECT DIE
T35.0 RSA MIN OUTPUT VOLTAGE REJECT DIE
T1.28 CONTACT VR_FAN REJECT DIE
T26.1 INT OFFSET VOLTAGE (DRP) REJECT DIE
T8.0 VID1 HI RISE THRESH - GNG REJECT DIE
T67.0 FAN LEAKAGE CURRENT REJECT DIE
T1.25 CONTACT VREF REJECT DIE
T29.0 VR10/11 LOWER THRESH- GNG REJECT DIE
T58.0 VR_RDY OUTPUT HIGH LEAKAGE REJECT DIE
T64.0 FAN UPPER THRESH- GNG REJECT DIE

Known issues they can detected by TIVA technique on PS5LV (example on NCP5381):

1) Failures caused by SOG particles (affected Vias, opened Vias, Via poisoning, etc.) ~0.82% yield loss

2) Metal shorting (see next page for details), PS5LV general

3) Vr FAN pin lekage on NCP5381

4) IVCCA on NCP5214 (root cause open Vias)

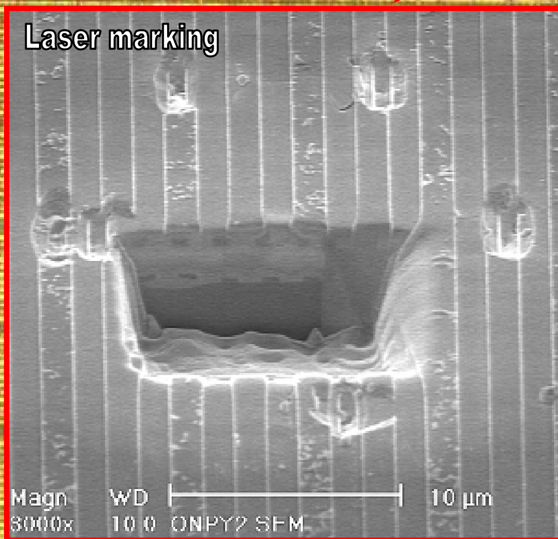
Note: This information was extracted from Yield meeting report for WW40

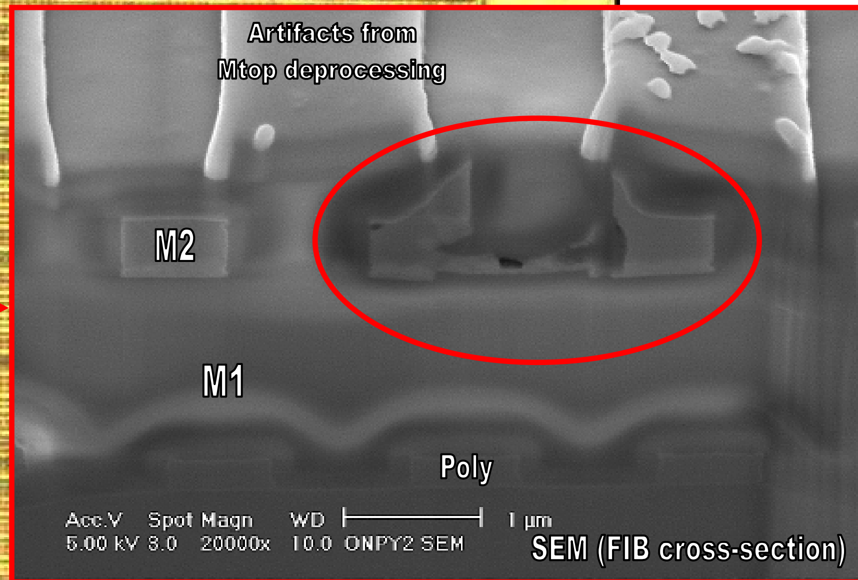
Example of possible application TIVA to PS5LV issue

M2 CMSK AH/FRP shorting

Defect(s) were observed only by optical microscope at highest magnification and lowest aperture. It was necessary to laser mark (by laser cutter) place for FIB cut. *Note: Deprocessed wafer mentioned on page 3 was used in this investigation*

Important: Investigation time can be rapidly reduced by applying TIVA technique, which can easily and fast localize these defects





Note: Detailed report is located: \\Chopok\Device_Probe\Powersense_5LV\Analysis\PS5LV SH23613.1X M2 shorting\NCP5050 M2 shorting.ppt

Conclusion/summary

Laser scanning upgrade advantages

- **substantial improvement of backside pattern images for photoemission detection**
- **thickness of the wafer does not affect pattern image quality - possible to use thicker wafers for back side PE**
- **Extension of PEM by TLS module (Thermal laser stimulation) for precise failure analysis**

TIVA/OBIRCH upgrade advantages

- **Opens new possibility for detection and localizing of metallic, non-metallic (polymer) defects, affected vias and contacts, defects in capacitor dielectrics, gate related defects and others that are not visible by photoemission**
- **Thermal laser stimulation (TLS) can precisely localize the physical defect**
- **No spatial or temporal shift between “hot spot” and laser spot center**
- **No significant thermal spreading**
- **EMMI (Emission comes from mechanisms such as high field) is not as precise as TLS**
- **Microscopies are complementary, Emission microscopy and thermal laser stimulation on the same tool is the right way to go**

Issues and Experiences in ONPY2

- **Capacitor leakages, remaining polysilicon, affected and broken VIAS, leakages, etc...**

Note: Figures and results shown in this presentation were obtained from the demo tool at Hamamtsu area (if not mentioned different) where ONPY2 material was put under investigation. *Acknowledge to Mr. Ortner for his support.*

Summary: As shown above TIVA technique may help to localize many of previously observed defects on all technologies in ONPY2, thus reduce investigation time and reduce FAB scrap.