Advanced Workshop Series

17 (Thu) & 18 (Fri) June 2010

Micro Analytical Techniques for the Characterisation of Surface Contamination and Materials

Abstract

The yield, quality and reliability of Semiconductor Devices are greatly affected by the properties and surface conditions of the materials used, and the impurities that may be un-intentionally sneaked in during the processing. As devices are getting miniaturized, more advanced micro-analytical tools are part of the essential support to enable the understanding of the problems, hence, a more rational solution to improve the overall process. Surface techniques such as Auger Electron Spectroscopy (AES), Electron Spectroscopy for Chemical Analysis (ESCA), time-of-flight Secondary Mass Spectroscopy (tof-SIMS) are presented, with case studies. For the completion of the materials characterization, peudo-surface techniques (FTIR, EDX and WDX) are also introduced as complementary and essential tools.

This course would enhance their knowledge of analytical methods and their understanding on how these methods can help problem solving and new product development. It also teaches the selection of effective analytical method(s) to get the maximum return of the analysis. Delegates will also increase their understanding on the impact of surface conditions (chemistry and contaminants).

Who Should Attend?

- FA Engineers
- Process Engineer
- Quality Control
- Engineers
- Reliability Engineers
- Material Engineers
- Lab Engineers
- Instrument Suppliers
- Managers

REGISTER ONLINE @

http://www.shimadzu.com.sg

Date:
17 (Thu) & 18 (Fri) June 2010

Registration Fee:
SGD $500.00/person (Inclusive of GST)

Venue:
Shimadzu (Asia Pacific) Pte Ltd
Customer Support Centre
79 Science Park Dr. #02-01/08
CINTECH IV, Science Park 1
Singapore 118264

Organized By:

Pre-registration for the workshop is necessary. Seats are available on a first-come-first serve basis

Workshop Agenda- Day 1

Course Instructor: Dr. A. C. Tan

8.15 AM: Registration & Coffee
9:00 – 10:30 AM

- **SURFACE**
- **MICRO-ANALYSIS AND SAMPLES**
- **SURFACE TECHNIQUES, WHY NEEDED?**
- **COMMON SURFACE TECHNIQUES**
  - Electron Spectroscopy for Chemical Analysis (ESCA)
  - Auger Electron Spectroscopy (AES)
  - Time of Flight –Secondary Ion Mass Spectrometry (tof-SIMS)

- **PSEUDO SURFACE TECHNIQUES**
  - Fourier Transform Infra Red
  - Energy Dispersive X-rays
  - Wavelength Dispersive X-rays

- **VACUUM REQUIREMENTS**
- **ELECTRON-SPECIMEN INTERACTION**
- **ELASTICALLY SCATTERED ELECTRONS**
- **INELASTICALLY SCATTERED ELECTRONS**
- **HOW DO CHOOSE A METHOD?**
  - Best data with minimum cost (time and $)

- **ESCA**
  - Theory
    - Ionization energy
    - Photoelectric effects
    - Binding energy and kinetic energy
    - Typical spectrum
    - Secondary structure in ESCA spectrum
    - Why it is a surface technique?

10.30 – 10.45 AM: Morning Break

- **INSTRUMENTATION**
  - X-rays source
  - Sputtering ion gun (Ar,)
  - New sputtering material (polyatomic)
  - Neutralizer
  - Energy analyzer
  - Sampling chamber

  - Ideal Spectrum
    - Peak position, half width, area

  - Actual Spectrum, Primary Structure In Esca
    - Impact of Inelastic Electron scattering

  - Factors Resulting The Actual Spectrum
    - Broadening
    - Coupling effects
      - JJ coupling
      - L-S coupling (Russell-Sander coupling)
      - Shake up peaks
  - Extrinsic Satellites (discrete loss structure)

12.30 – 1.30 PM: LUNCH

- **CHEMICAL SHIFT**
  - Theory
  - Applications
  - Examples : Si, Cu, Sn, Al oxides, polymers

- **QUANTIFICATION CAPABILITY**
  - Sensitivity factor
  - How to measure Intensity peak?

- **DEPTH PROFILING CAPABILITY**
  - Applicable to conductive and semi-conductive samples (why?)
  - Destructive and non destructive profiling
  - Example : oxide thickness of Al, Cu, Sn, Si

- **AUGER ELECTRON PEAKS SEEN IN THE ESCA SPECTRUM, ITS SIGNIFICANCE**
- **DE-CONVOLUTION**
- **MAPPING CAPABILITY (IMAGING)**

3.30 – 3.45 PM: Evening Break

- **APPLICATIONS**
  - Bond pad problems
    - Non-stick
    - Tarnished surface
    - Oxide thickness

  - Silicon Dies
    - Passivation layers
      - PO, polyimide

    - Silicon backside
      - Surface contaminations

  - Corrosion of common Engineering metals
    - Copper
    - Tin
    - Iron
    - Aluminum

  - Solder balls (non wetting)
  - Delamination
  - Tarnished leads

SUMMARY

5.00 PM: END OF DAY 1

Workshop Agenda- Day 2

Course Instructor: Dr. A. C. Tan, Co-Instructor: Tan Teck Beng

8.15 AM: Registration
9:00 – 12:30 PM (Dr. A.C. Tan)

- **AUGER PROBE (AES)**
  - Theory (Auger process)
    - The auger process and relaxation
    - Ionization
  - Electron distribution curve
  - XRF as a relaxation method
  - Why Auger probe is a surface technique?
  - Typical spectrum
  - Qualitative (Elemental analysis) and quantification capability
- **INSTRUMENTATION**
  - Electron gun
  - Sputtering ion (Ar +)
  - Sample chamber
  - Energy analyser
  - Vacuum requirements
- **SENSITIVITY & RESOLUTIONS**
- **CHEMICAL SHIFT**
  - Limited applications
- **SAMPLE LIMITATIONS**
- **APPLICATIONS**
  - Depth profiling
  - Micro-spot analysis
  - Oxide thickness
- **SUMMARY OF OXIDE THICKNESS MEASUREMENT, USING DIFFERENT TECHNIQUES (ESCA, AUGER, TEM, ELLIPSOMETRY, RBS),WHAT CAN WE DEDUCE?**
- **SUMMARY**

10.30 – 10.45 AM: Morning Break

- **INTRODUCTION : SIMS AND IMMA**
- **ION SPUTTERING PROCESS**
- **TWO MAIN TYPES OF SIMS**
  - Static SIMS
  - Dynamic SIMS
- **STATIC SIMS AS A SURFACE TECHNIQUE**
- **QUALITATIVE & QUANTITATIVE ANALYSIS**
- **IMAGING CAPABILITY (ION IMAGE)**
- **TOF- SIMS**
- **BASIC INSTRUMENT SETUP**
  - Vacuum requirement
  - Ion source
  - New ion source (C60)
  - Dual ion beam
- **LIMITATIONS OF TOF-SIMS**
- **APPLICATIONS**
  - Mold compounds
  - Organic contaminants on a silicon wafer
  - Dopant profiling
  - Thin films
  - Delamination of a device
  - Polysiloxane confirmation
  - Contaminations (example, molding compounds)

12.30 – 1.30 PM: LUNCH

1.30 – 5.00PM (Tan Teck Beng)

- **EDX/WDX/EPMA/SEM**
- **INTRODUCTION**
- **ELECTRON-SPECIMEN INTERACTION**
- **ELASTICALLY SCATTERED ELECTRONS**
- **INELASTICALLY SCATTERED ELECTRONS**
- **SEM**
- **EPMA**
- **FAMILIES OF X-RAYS LINES**
- **EDX**
- **WDX**
- **INSTRUMENTATION**
- **QUALITATIVE AND QUANTITATIVE ANALYSIS**
- **COMPARISON BETWEEN EDX & WDX**

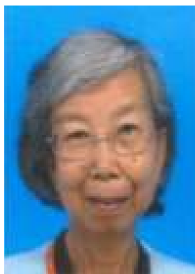
3.30 – 3.45 PM: Evening Break

- **WHAT IS THE DIFFERENCE BETWEEN AUGER PROBE AND THE EDX/WDX?**
- **SAMPLE PREPARATION**
- **APPLICATIONS**
  - Contaminations
  - Tarnished leads
  - Inter-metallics layer composition
  - Corrosion
  - Tin whiskers
  - Non wetting of solder balls
  - Gold wire bonding
    - Al pad
    - Pd/Cu pad
  - Copper wire bonding
  - Solderability
    - Observed at the Assembly
    - Customer returns
  - Tips for trouble-shootings
    - Data and understanding
    - FA techniques (if required)
- **Grand summary of the methods**

Q & A

5.00 PM: END OF WORKSHOP

Workshop Leader



Dr. A.C. Tan
Senior Consultant

"Semiconductor Device Soldering"
Author : Dr. A. C. Tan
Publisher : World Scientific Publications, Singapore (1988)

"Tin and Solder Plating: A Technical Guide"
Author : Dr. A. C. Tan
Publisher : Chapman & Hall, London, (1996)

Dr. A. C. Tan earned her B.Sc (Hons) in Chemistry University of Canterbury, Christchurch and her PhD in Chemistry from the University of Auckland, Auckland, New Zealand. Prior to her retirement, she was a Senior Member of Technical Staff
(SMTS) and Principal Chemist of Texas Instruments (Singapore) and Micron Semiconductor Asia, and the Chairperson, Technical Council of both companies for more than 10 years.

She has published numerous technical papers, two books* (on Plating and soldering), one chapter in ASM Handbook (Vol 13C, 2006, Corrosion : Environments and Industries) and has given technical lectures/talks/trainings to the local professional societies and institutions (example, IEEE Singapore, Singapore Surface Finishing Society, Singapore Polytechnics, Chemistry Department, National University of Singapore and has conducted in-house technical courses.
Her areas of interest are the lead finishing processes (soldering and plating), surface techniques (Auger Electron Spectroscopy and XPS/ESCA), Fourier Transform Infra Red spectroscopy, Applications of polymeric materials for the assembly of IC devices and corrosion in Microelectronics. Before retirement, she has served as an Industrial Advisor to the Materials Engineering School, National University of Singapore for 3 years. She has been actively involved in SEMI Singapore , EPTC (technical committee) for many years, and still actively supporting the conferences organized by the Singapore Surface Finishing Society , She is now a free-lance Consultant.

Methodology

The goal for this two-day training program is to help establish a high level of knowledge transfer on the approaches, tools, and processes to achieve better understanding in surface contamination and materials technology for semiconductor industry. The emphasis is on practical applications and learner relevance rather than theoretical details. At the end of the program, participants will have a good understanding of the subject and are ready to apply these techniques to their respective areas of work.

Workshop Co-Instructor

Mr Tan Teck Beng
Shimadzu (Asia Pacific) Pte Ltd

Mr Tan Teck Beng is the Application Specialist for Scientific Instrumentation (XRF, XRD, EPMA, SPM, ESCA) in Shimadzu Asia Pacific. He is actively providing training and developing applications to utilise Shimadzu scientific instrument for surface analysis, materials characterization, R&D, quality assurance and nanotechnology. He graduated from National University of Singapore with MSc in Materials Science.