Biological & Chemical Technology

Advanced Analysis for the Microelectronics Industry

With over 30 years of experience in supplying analytical services to the engineering and construction industries, SETSCO now provides a comprehensive range of analytical capabilities to support the needs of the microelectronics industry. SETSCO recognises that the microelectronics industry is unusually demanding, in terms of the range of analysis techniques, the sensitivity and precision needed. To fulfill these demands it has partnered with the Institute of Microelectronics (IME) the pre-eminent Microelectronics Research laboratory in South East Asia.

Many different techniques are needed to characterize materials, processes, chemicals, devices and products to support quality control, reliability assurance, yield improvement, and failure analysis. Whether the techniques used are simple, such as light microscopy, or state of the art spectrometric analysis, SETSCO is committed to excellence in delivering world class quality with fast turn-round time. Having the right equipment is not enough. Well-educated scientists and engineers, with years of experience in analytical technologies, failure analysis, materials and process characterization, enable SETSCO to provide the depth of understanding and interpretation that is essential in today's competitive world.

Cleanroom Microcontamination

Contamination of cleanroom consumables, equipment or incoming materials can have a devastating impact on yield in manufacture of semiconductor devices, displays or hard disk drives. Sources of contamination include surfactant residues, solvents, plasticisers, mold release agents, lubricants, adhesives, lapping slurries, wear debris, latex gloves and human contact, SETSCO has a dedicated Class 100 cleanroom for cleanliness testing and can provide the following analytical services:

- Ionic contamination by ion chromatography
- Extractable metallic contamination by ICP
- Organic contamination by GC-MS and/or FTIR
- Outgassing test by Static Head Space (SHS) or Dynamic Head Space (DHS)
- Condensible Volatile Residue (VVR) and Non Volatile Residue (NVR)
- Liquid Particle count (LPC) to 0.1
- Ultra sonic Liquid Particle Count (USLPC)
- Particulate analysis by microscopic FTIR and/or SEM/EDX

Ion Chromatograph

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Airborne Molecular Contamination (AMC)

It has been recognised for many years that particulate contamination must be minimised to achieve high yields in wafer manufacturing but with the advent of 0.1 µm feature sizes and copper interconnect, non particulate AMC poses a major threat to yield. AMC can lead to: reduced yields; shortened tool life; process-related problems such as corrosion, hazing, resist poisoning, uncontrolled doping; and to reduced long-term device reliability. SETSCO can analyse cleanroom air or gas supplies in accordance with SEMI standard F21-95 and BS EN ISO14644. Diagnostic tools include: ICP-OES, TD-GCMS-MS, LPC, SEM-EDX.

TD-GC-MS for Organic Contamination Analysis

AMC Tests include:

- Molecular Acids & bases, eg fluoride and sulphate, amines etc.
- Molecular Dopants, eg boron, phosphorus, arsenic etc.
- Molecular Condensables & Organics
- Molecular Metals such as metal particle identification

SETSCO is also able to carry out AMC baseline studies and identify AMC effects on wafers through witness wafer analysis.

Trace Analysis of High Purity Water and Chemicals

Ultrapure water and chemicals are essential ingredients in the operation of advanced microelectronics manufacturing. Both need increasingly high levels of purity for the latest generation devices. SETSCO can provide detailed analysis in accordance with ASTM standard D5127. Tests include:

- Total organic carbon (TOC)
- Analysis of organics by GC-MSD
- Total residue
- Total dissolved and suspended solids (TDS & TSS)
- Carbonate and bicarbonate
- Dissolved silica and Bacteria count
- Trace metals by ICP-MS/GFAAS/ ICP-OES
- Ions (Cl^-,$SO4^{2-}$,$NH4^+$,etc.) by ion chromatography
- Moisture content of non-aqueous chemicals
- Particles (particle sizes≧0.1
- Particle analysis by SEM/EDX

SEM/EDX for Particle Analysis

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RoHS Compliance Testing

The European Union RoHS Directive 2002/95/EC prohibits the sale of new electrical and electronic equipment containing more than designated maximum allowable levels of lead, cadmium, mercury, hexavalent chromium, polybrominated biphenyl (PBB) and polybrominated diphenyl ether (PBDE) flame retardants.

The directive came into operation July 1, 2006 and applies to all countries in the EU and all products except for a small number of exceptions. China is implementing RoHS legislation which will start coming into force in March 2007. In some respects this appears even more stringent than the EU directive. Japan has legislation which require the presence of these substances to be labelled on products but has not banned them.

SETSCO can verify compliance of components and assemblies. A cryogenic miller is first used to convert the parts into a fine powder. The sample is then analysed as follows:

- Lead, cadmium and mercury. Dissolved using Microwave Digester. Analysis by ICP-OES according to US EPA specifications 3052, 3050B or 6010B

- Hexavalent Chromium analysed using UV-VIS spectrometry according to US EPA specifications 3060A or 7196A

- Polybrominated biphenyl (PBB) and Polybrominated diphenyl ether (PBDE) are solvent extracted and analysed using GC/MS/MS with Thermal PolarisQ Ion Trap in accordance to in-house protocol.

PBB & PBDE Analysis
by GCMS

There can be many challenges in the switch from conventional technology to RoHS compliant technology. RoHS compliant, lead-free, solders require significantly higher processing temperatures which in turn can affect yield and reliability.

The use of pure tin finish on components instead of lead-tin has caused the resurgence of the tin whisker problems thought to have been eliminated in the 1970's. SETSCO can support you in materials and failure analysis to solve these problems.

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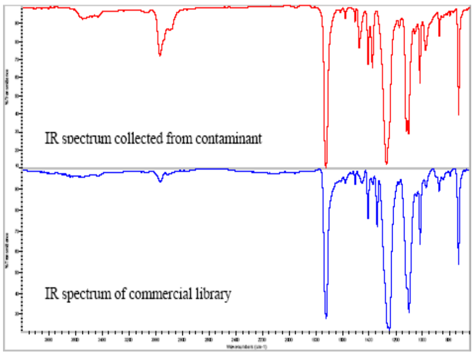
Polymer and Organic Material Characterisation

While the heart of the microelectronics device may be a semiconductor, a wide range of polymers and organic compounds are used during packaging and assembly at chip, module and board level.

The performance of these compounds can have a huge impact on device performance yield and reliability. Tests include:



FTIR, Comparison of unknown Spectrum to Library

- Differential Scanning Calorimetry (DSC) to determine glass transition temperature (Tg), phase changes, degree of cure and other thermal properties of polymers.
- Thermogravimetric analysis (TGA) to determine absorbed moisture, and residual solvent/volatile residues and polymer degradation temperatures.
- Fourier Transform Infrared (FTIR) spectrometry and Gas Chromatography – Mass Spectrometry (GCMS) to analyse unknown organic compounds such as adhesives, coatings, lubricants, fluxes etc. Depending on the requirement, the technique can be used in several modes. For example FTIR can characterise microscopic droplets only 10 µm across or very thin coatings by attenuated total reflectance.

Surface Analysis

Many important materials properties depend on surface characteristics rather than those of the bulk. Examples include chemical reaction, diffusion barrier performance, adhesion/stiction, etching behaviour, surface electrical states and solderability. Among the techniques available to analyse surfaces are:

- Scanning Electron Microscopy/Energy Dispersive X-ray analysis (SEM/EDX). Although not a true surface analysis technique, since it provides information from the top micrometre or so of the surface rather than the top few nanometres, its speed and ease of use make it a useful technique to try before other more surface specific ones.

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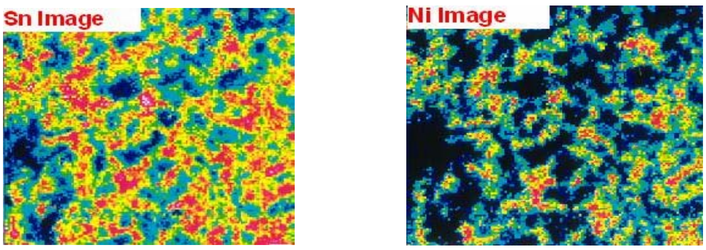
- Auger Electron Spectroscopy (AES) provides analysis elemental analysis of the top few nanometres with sub-micrometre lateral spatial resolution. It is ideal for conducting samples such as leadframes, electroplated components and semiconductor devices. AES can provide elemental maps and depth profiles.

- X-ray photoelectron spectroscopy (XPS) provides similar elemental information to AES but with additional chemical information, eg it can differentiate between Cr(VI) and Cr (III). XPS is suitable for non-conducting samples but lacks the spatial resolution of Auger.

- Atomic Force microscopy provides nanometre resolution surface images. It is widely used in the semiconductor, display and hard disc industries to measure surface texture and roughness of deposited layers.

- Time of Flight Secondary Ion Mass Spectrometry (TOF-SIMS) is particularly suitable for analysing very thin surface layers of organic compounds. TOF-SIMS can provide maps and depth profiles of specific atomic and molecular mass numbers. Quantification and interpretation of TOF-SIMS data can be challenging.

- Dynamic Secondary Ion Mass Spectrometry (D-SIMS) is mainly used to determine the concentration of dopant elements in semiconductors with very high sensitivity and accuracy.



Auger Maps of Tin and Nickel on Fracture Surface between BGA and PCB

ESD Testing

Damage due to **electro-static discharge (ESD)** in the microelectronics industry is estimated to result in the loss of billions of dollars, and accounts for about **20%** of total device failures. **ESD** problems become more severe for miniaturized devices with new technologies and processes.

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ESD capabilities are:

- JEDEC JESD22 – A114B Human Body Model (up to 8000 Volts)
- JEDEC JESD22 – A115A Machine Model (up to 2000V)

For ESD environmental protection, SETSCO offers several test capabilities in accordance with ESD Association. Standards:

- Measurement of surface resistivity (EOS/ESD S11.1)
- Volume resistivity (EOS/ESD S11.12 & ASTM D257)
- Static Decay test FTMS 101C Method 4046.1
- Triboelectric charge accumulation measurement.

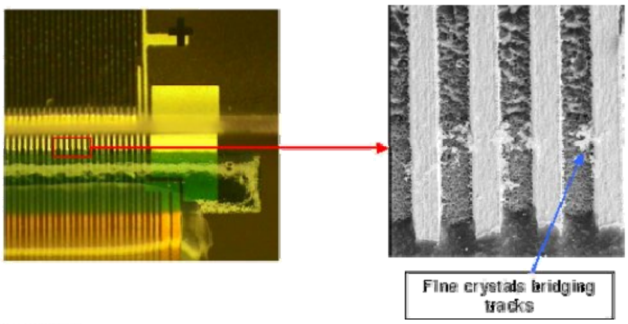
Static Decay Test in Humidity Chamber for Testing under Controlled Environmental Conditions.

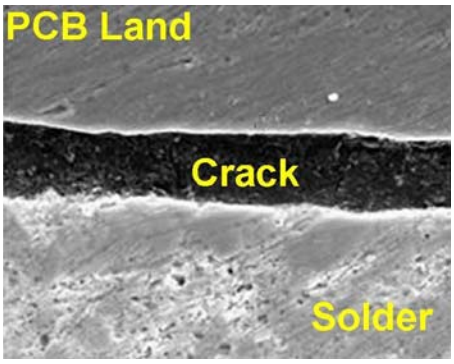
Device and Package Failure Analysis

The key to successful analysis to determine the root cause of failure is a methodology designed to extract maximum information with minimum destruction of the device at a realistic cost. The particular procedure will depend on the nature of the device and the mode of failure.

Typically the procedure will start with electrical characterisation to verify the mode of failure followed by non-destructive investigations such as optical microscopy, X-ay imaging or scanning acoustic microscopy. Only then, will destructive analysis such as chemical decapsulation or mechanical cross-sectioning followed by SEM/EDX or FIB be considered. Since each stage of analysis may depend on the results of the previous investigation the customer will be kept informed throughout so that decisions on the next step can be agreed on mutually.

Crack between Solder and PCB Causing Open Circuit Failure





Identification of Corrosion Product causing High Leakage Current on Flexible Interconnect to Liquid Crystal Display (LCD)

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