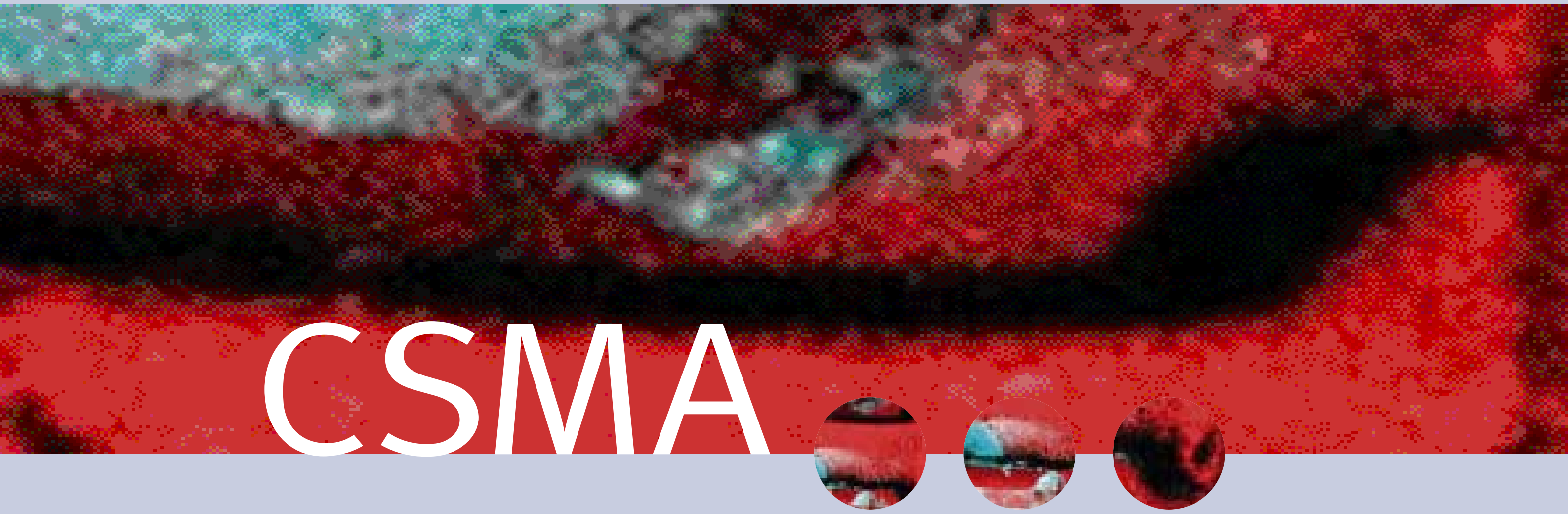
# TOTAL SOLUTIONS FOR THE ELECTRONICS INDUSTRY — MOUNT



# CSMA

One of the main tasks of the failure analysis engineer in the semiconductor industry is to find rapidly the cause of device failures so that necessary remedial actions can be implemented in the production line. Available in-house analytical equipment is, however, not always suitable or specific enough to fully characterise defective components where high spatial resolution, low detection limits and molecular information are required to solve the problem.

CSMA's surface analysis techniques, such as XPS (X-ray Photoelectron Spectroscopy), ToFSIMS (Time-of-Flight Secondary Ion Mass Spectrometry) and DSIMS (Dynamic Secondary Ion Mass Spectrometry) readily provide this information as illustrated in the case studies below.

### BENEFITS TO CUSTOMER

- Cost effective - causes of failure can often be identified in less than a day
- Rapid information for reduced downtime and improved yields
- Recommendations for improvement of processes/product

CASE STUDY ONE

## Analysis of a White Residue on a Circuit Board Connector

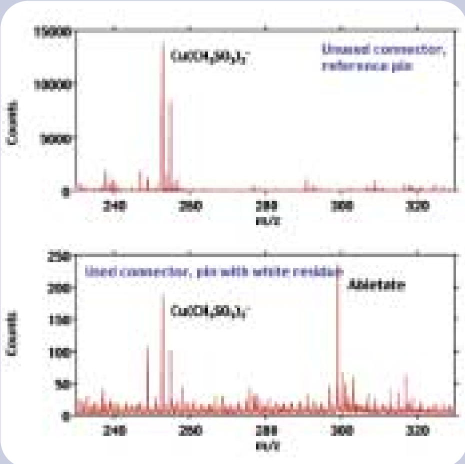
Populated circuit boards were supplied with SCSI connectors showing a white residue on most of the connector pins. It was suspected that this residue might be associated with solder flux or mould release from the connector housing itself. Surface analysis was carried out on the contaminated pins and compared to the pins of an unused connector using both XPS and ToF-SIMS.

SURFACE CHEMICAL COMPOSITIONS (FIGURES ARE IN At%) FROM XPS

| Sample | C | O | Au | Sn | Cu | Si |
|---|---|---|---|---|---|---|
| Unused connector, good pin | 41.8 | 29.3 | 19.2 | 4.8 | 4.9 | - |
| Used connector, bad pin with white residue | 79.5 | 17.6 | 1.0 | 0.3 | 0.4 | 1.1 |

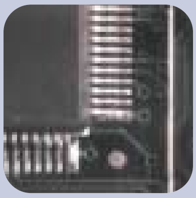
XPS showed that the levels of metallic species on the bad pins were quite low compared to the good pins. Concomitantly, the high carbon levels on the bad pins suggested an organic cause for the contamination. Examination of the carbon functionality by high resolution analysis showed that aromatic-type species were present on the contaminated surface.

In agreement with XPS, ToF-SIMS analysis showed that the good pins presented a more metallic surface whereas the surface chemistry of the bad pins were dominated by organic species. In particular, aromatic hydrocarbon and carboxylate (abietate) signals were detected on these contaminated surfaces. Research into the composition of the solder flux indicated that it was based on a rosin containing mainly a mixture of carboxylic acids of the abietic type (see ToF-SIMS spectra right). This strongly suggested that the white contamination corresponded to solder flux residue where, in view of the sample's thermal history, the aromatic hydrocarbon reflected a partial degradation product of the original component based on a rosin.



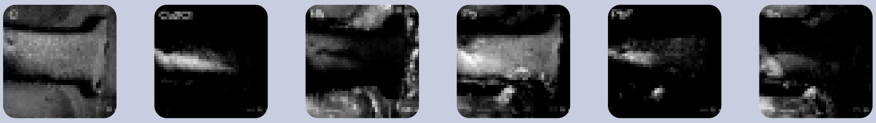
CASE STUDY TWO

# Investigation of Corrosion Regions on Printed Circuit Boards (PCBs)



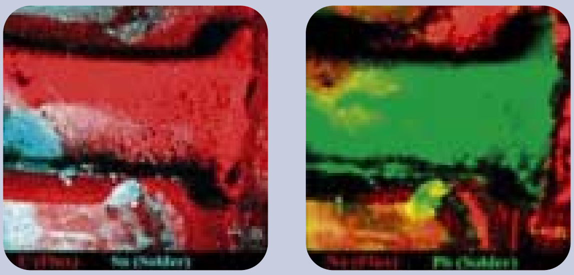
The purpose of this analysis was to identify the cause of corrosion appearing between integrated circuit contacts, resulting in circuit breakdown and board failure. The problem was mainly experienced in overseas installations where prevailing climatic conditions impose high levels of heat and humidity on the PCBs. Accelerated humidity testing reproduced the corrosion problem where corrosion product was appearing particularly between the legs of narrow pitch SMT Integrated Circuits *(see typical pictures right)*.
In addition, on boards which failed inspection tests, there was evidence of white staining and dendritic growth features on bare areas away from solder points and contact areas.

Combined XPS and SIMS analyses were carried out on a corrosion area between the SMT legs. These showed the presence of a complex mixture of inorganic ionic salts, organic residues and elements such as sodium, calcium, etc. The ionic salts included copper chloride, tin fluoride, lead fluoride, calcium fluoride and also oxy-halide species of tin and lead. The organic species were suspected to correspond to flux residues. The lateral distribution of selected species in a space between SMT legs are shown in the SIMS images below.



*SIMS images of a space area between SMT legs (contact areas on top and bottom of images)*

The presence of significant levels of elements such as sodium, calcium, fluorine, chlorine, tin and lead in the space between the SMT legs remaining after board production were believed to provide a basis for chemical processes resulting in the formation of the corrosion products described above. With the presence of water (acting as an electrolyte) from high humidity levels and heat (either from ambient conditions or generated in circuitry), the corrosion process may have proceeded through different ways such as redox reactions, galvanic processes, electrolysis via applied e.m.f between IC contacts, atmospheric oxidation, ionic salt formation or ion transport. The detection of copper in the corrosion product suggested ion transport ($Cu^{2+}$) from the IC contacts or an underlying PCB track.



*Overlay of SIMS images*

CSMA provides a complete surface analysis service to industry to accommodate every level of demand:

- rapid turnaround analysis (24 hours)
- problem solving and failure analysis
- litigation and expert witnesses
- training courses
- reverse engineering and competitor analysis
- materials and product development
- patent registration / infringement

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