# Sputter Problem Solving & Target End of Life Determination by SIMS

## Production Process Problem

In the manufacture of batches of a metallic component, a layer of Osmium/Ruthenium (Os/Ru) had to be deposited onto the product surface. This was achieved using an Os/Ru alloy sputter target. Argon ions are fired at this target, in a diode mode, sputtering Os/Ru onto the products (see fig. 1).

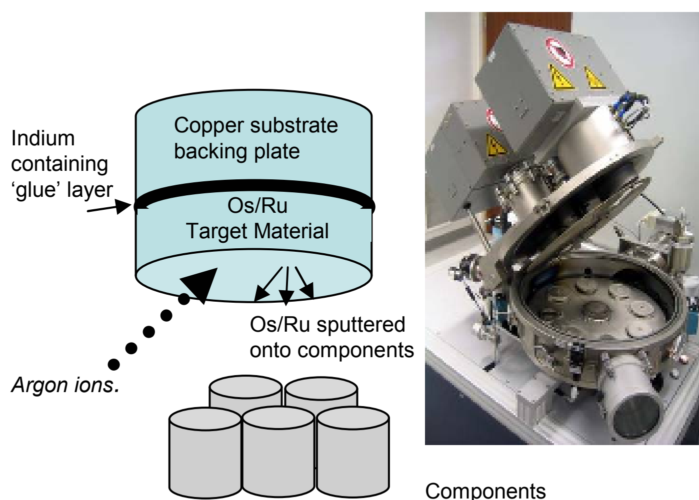


*Fig.1. Schematic of sputtering regime, alongside a photograph of production sputtering tool.*

In the diode sputtering the target has been found to wear preferentially in the middle. Knowing the rate of wear and hence safe life of the target is vital for the effective preventative maintenance of the sputtering process. The sputter tools target usage is logged by computer to warn operators when the target needs changing.

Electrical performance tests and CUSUM data suggested a probable change in the quality of the sputtered layer.

SIMS was used both to explore the root cause of the problem and also to measure the extent of the process excursion.

## Surface Analysis Technique and Approach

SIMS (Secondary Ion Mass Spectrometry) is a powerful surface analysis technique which uses gallium ions to sputter ions and molecules from a sample's surface. These secondary ions are separated according to their mass/charge ratio by a quadrupole mass spectrometer. SIMS has a huge dynamic range of chemical sensitivity (PPM and PPB) and can be used to produce both surface spectra and surface chemical maps.

(SIMS) was performed on the poorly performing components with respect to normal 'good' product as a simple paired comparison.

Once candidate systematic differences had been found between 'good' and 'bad' samples, more samples across the time frame of the problem were analysed to help contain the issue in house, as well as quarantine unfinished products. This took advantage of the laboratory's instrument rapid sample throughput.

## Problem Solving with Surface Analysis

A paired comparison of 'good' and 'bad' components, initially comparing chemical images (fig.2) then later SIMS spectra (fig.3), showed that copper and indium were present only in the 'bad' components. The source of both of these elements could be attributed to wear out of the target, as they are both present on the backing plate of the sputter target. Copper made up the majority of the backing plate for cooling purposes and indium to glue on the target material. It transpired that due to a software glitch, the target counter life automatically had been reset to zero midway through its life, so operators had not been given the warning to change early enough.

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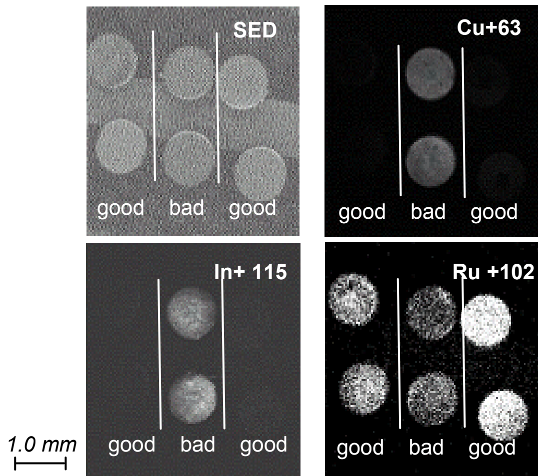


*Fig.2. SIMS chemical maps of 3 sampled batches immediately distinguishing 'good' and 'bad' components.*

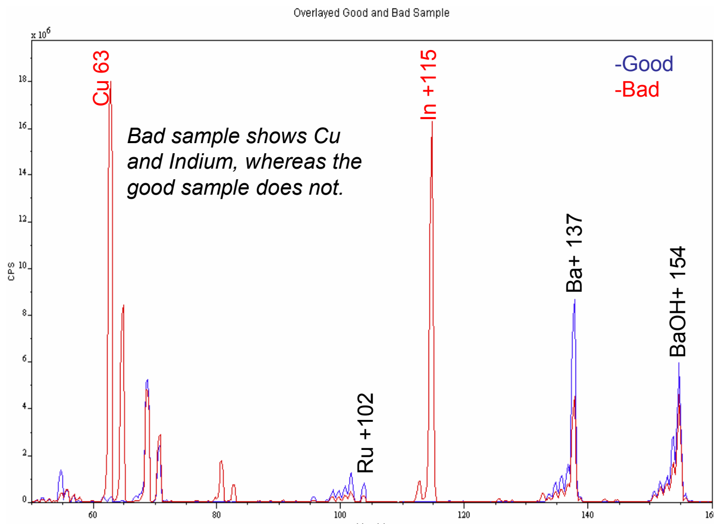


*Fig.3. Overlay of 'good' and 'bad' sample SIMS spectra.*

Whilst it was possible to pick out the worst affected batches using the electrical test, the quality department demanded all affected product must be quarantined, whether they were finished product or partially assembled.

Removal of the affected sub-assembly batches before full assembly was prudent in some circumstances. As indium is the first material that will have been deposited from a wearing out target. Fig.4. shows SIMS peak intensity ratios in sputter batch order to find the switch on batch. All products from batch 9 onwards were quarantined and subsequently scrapped to protect the customer.

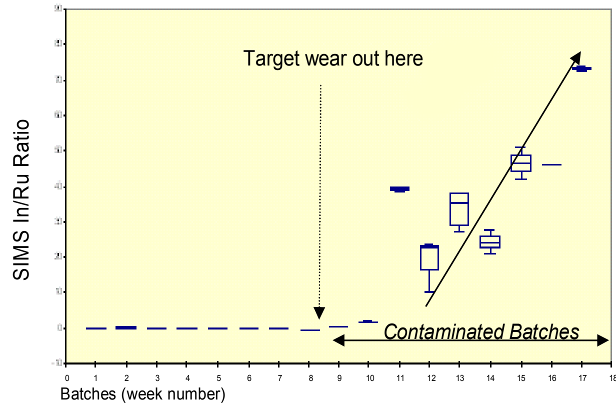


*Fig.4. Boxplots of In/Ru peak ratio to determine the onset of the problem.*

As several sputter tools are run in parallel, where batch traceability was suspect, the batch also were screened using SIMS.

## Problem Solution

The sensitivity and the high sample throughput of SIMS meant that containment and root cause of this problem were rapidly achieved.

Target wear out issues were avoided by regular recording of the target life as part of the sputter tool's maintenance history.

Following this issue, whenever suspicious electrical performance results were seen, SIMS was immediately carried out to check the target's health.

These measures resulted in no more process excursions and the possibility of regular SIMS measurements to more accurately determine target life and thus extend the very expensive target's safe life period to save money.

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LPD Lab Services
Phone: +44 (0)1254 676074
E-mail: enquiries@lpdlabservices.co.uk
Web: www.lpdlabservices.co.uk


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