New characterisation capabilities in target fabrication

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Introduction

Over recent years there has been a significant investment into the Target Fabrication Laboratory in the CLF. A large proportion of the funding has been used to increase the available characterisation capabilities to enhance the ongoing production of high specification high quality targets. Investment has been carefully planned to meet both the anticipated trends in high power laser target design and also the needs of future laser programmes such as the Astra Gemini project that is due online in 2007. The investment has been into four main characterisation types; contact step-height measurement, automated non-contact measurement, high resolution optical microscopy and electron microscopy. This paper discusses the main characterisation capabilities that the laboratory offers.

Thin-Film Measurement

Thin-film thickness measurements have in the past been made using an interferometric microscope and this technique has the ability to characterise films down to a thickness of approximately 50nm (but with significant error in the 50nm range). However, for a number of recent projects it was essential to have accurate height measurements in the sub 50-nm range and to address this need an *Alpha Step IQ* surface profiler was purchased. This system is a touch probe system with a low contact force (to ensure that samples are not damaged). It has a range of measurement modes including step heights, surface roughness and form. A typical readout is shown in Figure 1. The system also has the capability to measure a number of pre-located sites. The surface profiler can measure to sub-nm resolution and this capability has significantly increased the thin film characterisation capability in the Target Fabrication Laboratory bringing great benefit to both internal and external groups.

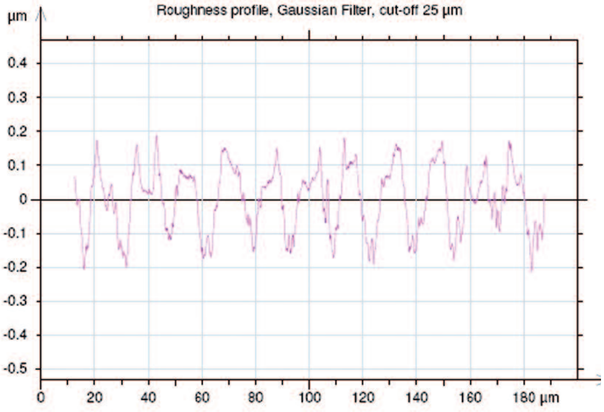


Figure 1. Surface scan readout of a rippled target feature.

Automated Characterisation

The Target Fabrication Group has been actively pursuing R&D programmes in both automated characterisation and automated assembly. The driver has been twofold; partly because increasing numbers of microtarget subcomponents are being manufactured using mass production techniques and partly to meet the increased target number requirements anticipated when Astra Gemini comes online. The purchase of an *OGP SmartScope ZIP 250* optical co-ordinate measuring machine (CMM) has enabled the characterisation of large numbers of identical targets to be carried out in a short space of time. Writing single programmes to be run many times reduces the characterisation time significantly and has improved the productivity of the laboratory. The machine has micron accuracy in x and y. It is also fitted with a laser probe for enhanced accuracy in z enabling topographical mapping of surfaces with sub-micron accuracy.

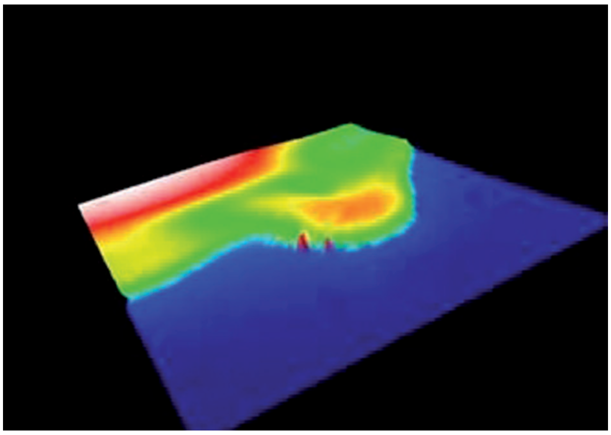
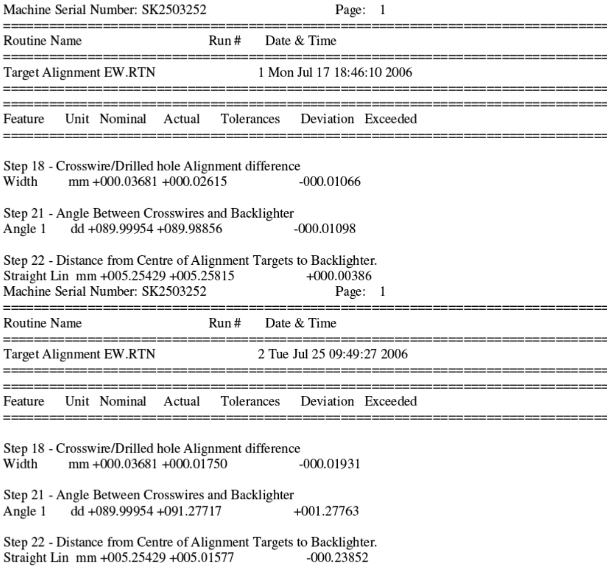


Figure 2. CMM laser probe surface scan of part of a 1p coin. (Blue to white range = 150 µm.)



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======================================================================
======================================================================
Feature    Unit  Nominal    Actual     Tolerances     Deviation  Exceeded
======================================================================

Step 18 - Crosswire/Drilled hole Alignment difference
Width       mm +000.03681 +000.02615                 -000.01066

Step 21 - Angle Between Crosswires and Backlighter
Angle 1      dd +089.99954 +089.98856                -000.01098

Step 22 - Distance from Centre of Alignment Targets to Backlighter.
Straight Lin  mm +005.25429 +005.25815                 +000.00386
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Feature    Unit  Nominal    Actual     Tolerances     Deviation  Exceeded
======================================================================

Step 18 - Crosswire/Drilled hole Alignment difference
Width       mm +000.03681 +000.01750                 -000.01931

Step 21 - Angle Between Crosswires and Backlighter
Angle 1      dd +089.99954 +091.27717                +001.27763

Step 22 - Distance from Centre of Alignment Targets to Backlighter.
Straight Lin  mm +005.25429 +005.01577                 -000.23852
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Figure 3. CMM metrology data (part set) obtained from automated run displayed in text format.

High Resolution Optical Microscopy

With targets becoming increasingly complex and with tolerances becoming tighter the addition of a high specification optical characterisation microscope has been another augmentation of the laboratory's characterisation capability. The *Zeiss M1m Axio Imager* is a fully motorised very high resolution microscope with a wide range of magnifications and contrast techniques. Fully linked to image capture and analysis software the microscope has provided images and invaluable data on targets which was not previously available. The microscope has the capability to mosaic images and also z-stack slices through a sample. The system software is also adaptable to run image processing on files taken using other characterisation equipment thereby extending their capabilities.

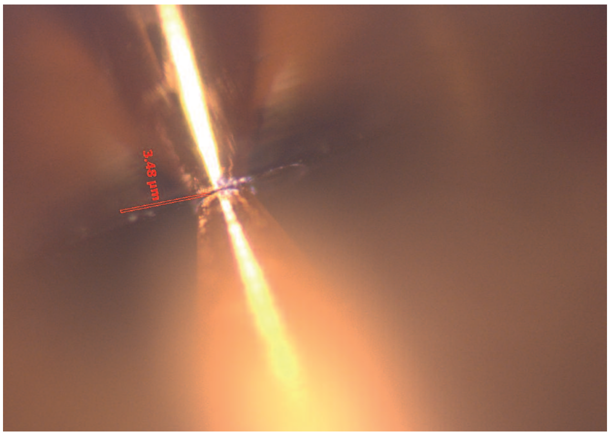

Figure 4. Brightfield image of a thin glue layer applied to the tip of a cone (reflected in a lapped foil).

Electron Microscopy and Element Analysis

A *Topcon SM200* Scanning Electron Microscope fitted with a *Röntec Quantax QX2* Energy Dispersive X-ray Spectrometer (giving element analysis) and secondary electron detection has also been installed in the laboratory. This is providing highly informative characterisation data from high (down to 5nm) resolution images and x-ray elemental analysis giving extensive insights into the production processes of microtargets. It is also proving to be an invaluable analysis tool in understanding the processes of thin film deposition. The machine is becoming increasingly accessed by other departments at RAL. Figures 5, 6 and 7 show electron micrographs and element analysis data.

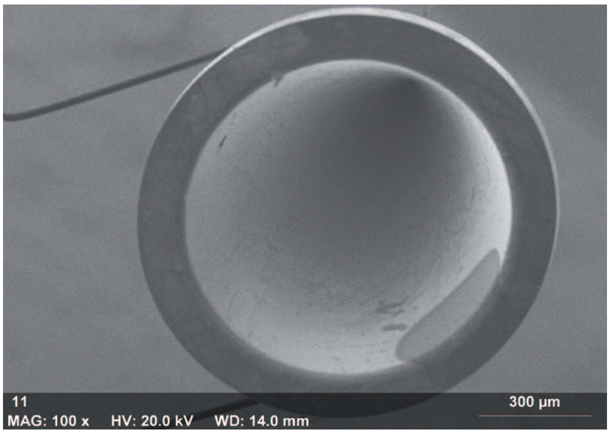

Figure 5. SEM image of the entrance end wall and inside of a metal (aluminium) cone.

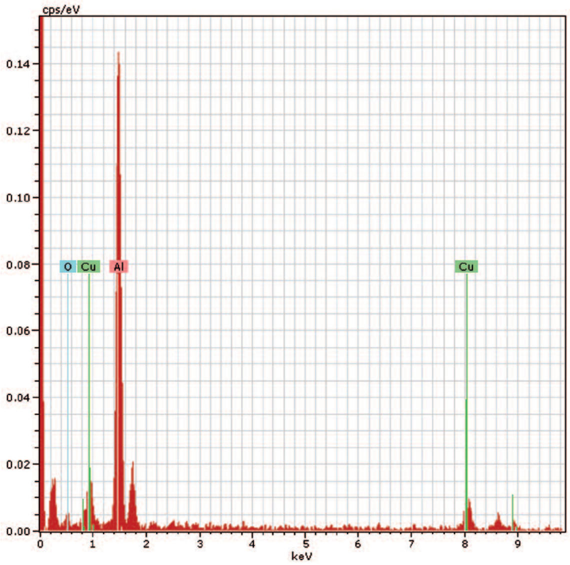

Figure 6. Spectrographic element analysis of cone interior.

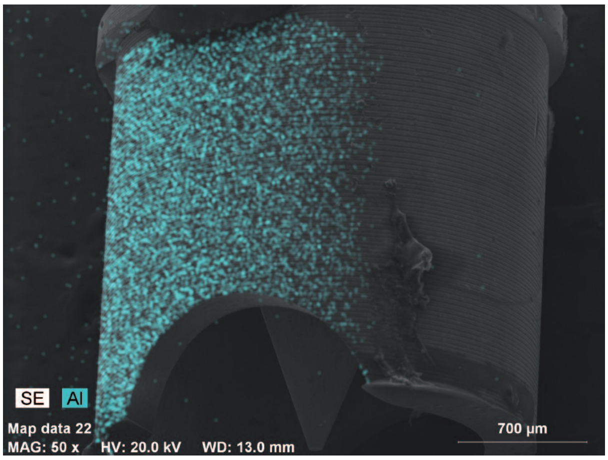

Figure 7. Element analysis data superposed on electron micrograph.

Conclusion

There have already been two areas of benefit brought about by introducing a combination of complimentary high performance characterisation techniques.

1) A deeper understanding of microfabrication and coating processes has been enabled which both improves microtarget quality and also indicates how production techniques might be extended.

2) Extensive characterisation data for individual targets can be supplied to experimentalists to assist with results analysis.