Enhanced thin film production capabilities in the Target Fabrication Laboratory

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Introduction

With varied requests for thin films in a range of materials commonplace from the user community a strategy of having a good R&D coating facility that is equipped to provide a number of complimentary coating processes is an essential part of the target fabrication capability. Over the last few years there has been a significant investment into coating plants in the Target Fabrication Laboratory with purchases of both externally and on-site manufactured systems. This expansion has enabled an increase in the already high quality coating capabilities available enhancing the on-going continuous delivery programme of high specification high quality targets. Investment in plant has been strategically balanced to accommodate both changing trends in high power laser target design as well as future laser programmes such as Astra Gemini. This paper presents the main coating capabilities that the laboratory provides.

Thermal Evaporation – Single Material Thin Film Coatings for Targets and Filters

Single layer coatings for filter (see figure 1) and target components are a frequent and high volume deliverable often with requests for materials and thicknesses changing on a day to day basis. In order to respond to this regularly changing demand the laboratory has two thermal evaporation thin film coaters. These provide a relatively simple and effective way of producing high numbers of coatings to a high specification and allow response to user requests within a very short timescale. This rapid turnaround capability enables the laboratory to quickly adapt to unforeseen experimental condition changes that often occur during experiments. Materials that are evaporated vary but gold, aluminium and copper thin films are commonly produced with the ability to coat a wide range of other materials such as bismuth and samarium to name but a few.

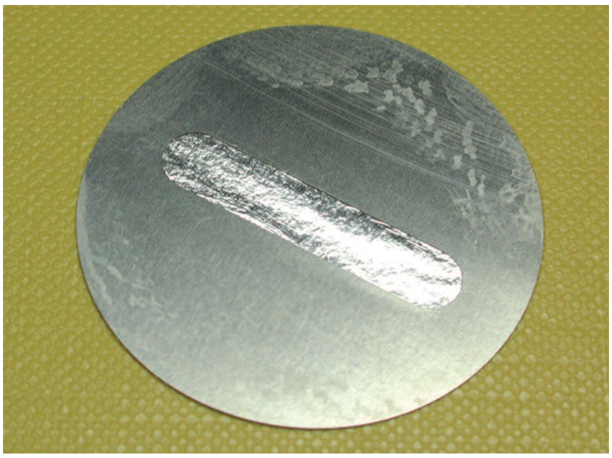

Figure 1. Aluminium flat field filter.

Sputter Coating – Single-layer, Multi-layer and Co-deposit Coatings

The Target Fabrication Laboratory has an R&D sputter coating system. It has been designed for the wide-ranging requirements of the user community and is capable of producing high quality high specification thin films of both metals and dielectric materials. It is equipped with two 2" sputter heads driven by a configurable combination of two DC and one RF power supplies. This allows single layer, multi-layer and co-deposits to be produced. The system is also capable of coating mirrors up to 250mm in diameter and has been used to coat the copper electrode side of adaptive optics [1]. Recently a dual layer chromium/gold deposit was coated to act as the reflective side of an adaptive optic. The dual head set-up is shown in figure 2 ready to coat onto a slide suspended from a rotating top plate.

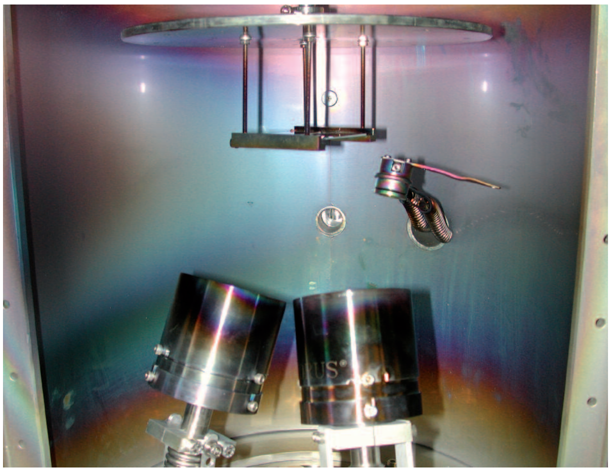

Figure 2. The dual head set-up of the sputter coater.

Electron-Beam Deposition– Single-layer and Multi-layer Coatings

A recently purchased electron beam (e-beam) deposition system has enabled the laboratory to significantly increase the quality and scope of its coating capabilities. The system has $4 \times 4\text{cm}^3$ crucibles that are independently computer controlled to enable the production of complex multilayer films of up to four differing materials. The system can also use four pockets of the same material to produce thick films. Thick layered materials are of great interest to the user community and have been shot in recent experimental campaigns on the Vulcan laser. E-beam is also ideal for the production of microdots by coating through masks and this process was used to provide "dot" targets fielded on a heated target mount [2]. The inside of the e-beam chamber is shown in figure 3.

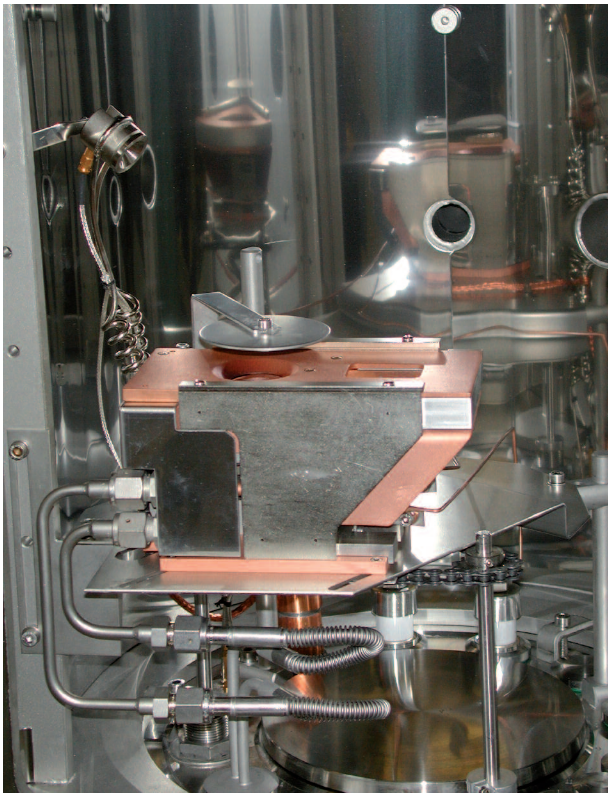

Figure 3. The e-beam hearth inside the coating chamber.

Coating Thickness Characterisation

All of the physical vapour deposition plants are equipped with film thickness monitors which enable real-time deposition analysis of coatings. Shutters fitted in all of the plants ensure that by providing sharp beginning and end points to deposition runs the thickness measurements taken are well defined. Calibration runs are carried out for every material and results are cross-checked with characterisation data obtained from the Alpha-Step thin film thickness profiler. Results are logged to ensure all R&D processes are recorded for future use. A sample measurement from a 100μm diameter coated dot is shown in figure 4.

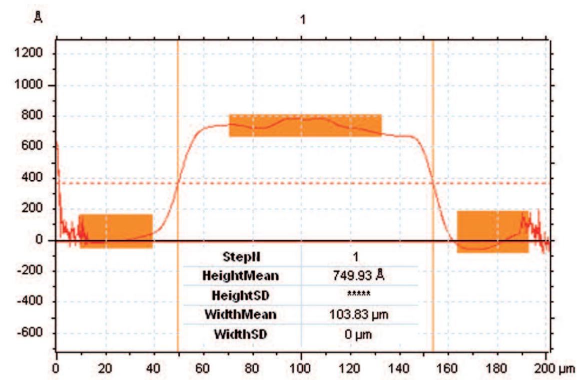

Figure 4. Height profile of an e-beam deposited dot.

The deposition chambers on all of the physical vapour deposition plants are equipped with a rotary work holder which improves the coating thickness uniformity over larger substrates.

Plastic Coatings

Plastic coatings of a wide range of thicknesses are also required for experiments and the laboratory has two dedicated plastic coating facilities. The most heavily used is a parylene coater. It has the ability to provide highly conformal coatings from 50nm to 25 microns thickness in N (hydrocarbon), C (mono-chlorinated) and D (di-chlorinated) forms. Coatings made by the plant are used as thin film filters, supports for metallic filters or as laser target components either as a single parylene film or as part of multilayer film. Thickness measurements made with the Alpha-Step surface profiler have been taken from a large number of calibration runs to enable precise control of coating thicknesses. This is mainly achieved by controlling the exact weight of dimer with which the plant is charged at the start of every coating run. Typically the thickness of a deposit is also directly measured at the end of the process to ensure that the coating is to exact specifications. Figure 5 shows the parylene coater.

Figure 5. The parylene coater.

A second technique that is available for producing plastic films employs a heated press to produce disks of materials such as deuterated plastics, typically for use as laser targets. This technique tends to be used for the production of plastic films that are thicker than those which can be produced by coating processes. The disks are typically in the range of 25-250μm thick. Not only have "simple" CH and CD thick films been fabricated but films consisting of varying ratios of CD/CH have been produced.

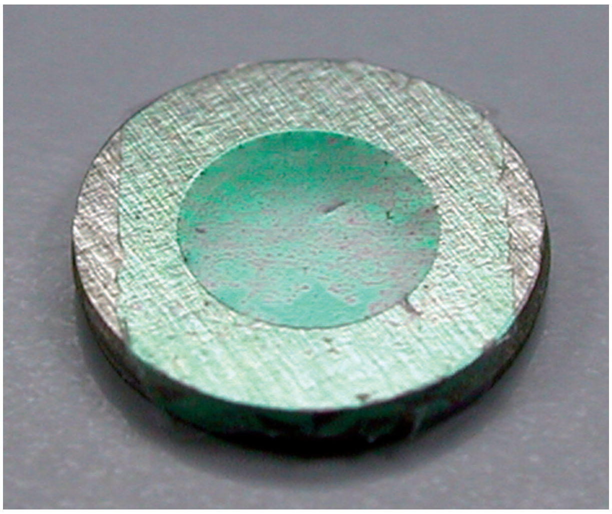

Figure 6. Plastic (parylene) filter on a support.

Low Density Coatings

There is also the capability to produce low-density structured metallic coatings and an R&D programme is ongoing into such coatings. More information can be found in the accompanying annual report article "Structured low density coating studies leading to a novel coating plant design".

References

1. C. J. Hooker, J. L. Collier and C. Spindloe, *CLF Annual Report 2001-02* p201
2 R. J. Clarke et al., *CLF Annual Report 2004-05* pp245-247