KrF laser beam fluency characterization on PLD ablation target

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Introduction

PLD or Pulsed Laser Deposition is a process to allow the production of a variety of thin films (metal, oxide, organic...) and of various thicknesses, from a few nm to a few µm.
PLD consists in focusing an intense laser beam on a target, and if fluency (or energy by surface units) is superior to the material ablation level, we obtain a material ejection under plasma morph.
A substrate is placed in parallel to the target, the matter deposits on the substrate; deposition features of the thin film depend on various experimental parameters. The object of our study is the fluency control.

Experimental procedures

To know the fluency of a laser beam, it is necessary to know the dimension and the energetic profile of the beam in laser exit and before enclosure deposition (figure 1). In this perspective, an experimental mounting allowed cutting full or part of a beam was used. A derivation calculation allows the beam profiles to access two dimensions. As expected, measures performed in laser exit had shown that the beam was not homogeneous in energy (figures 2a and 2b). A rectangular mask (15mmX6mm) was carried out; it was positioned in order to keep the most energetic and homogenate beam fragment. New profiles after mask are presented in figure 3a.

In order to manage laser beam divergence, a telescope (associated lenses) was crafted. A parallel beam in exit was obtained. Profiles of the laser beam after telescope are also presented in figure 3a. To increase fluency at entry of PLD enclosure, a quartz lens was used to focus the beam. After the estimate fluency two techniques were used. First, known target-lens distance, laser pulse impacts on SiO_2-Si target (figure 2b) was realized and measured. Secondly, a laser beam profile was established once again. We deducted that the first method was the easiest to exploit. We extracted lens focal distance from results (36cm, figure 2b). Calibration curve linked fluency to focalization lens position was established with our previous measures, and then these results could be used and still can be used for any energy (figure 3b).

Figure 1: Optic axe schema, we can see the laser, the PLD enclosure, the telescope and the L3 focus lens.

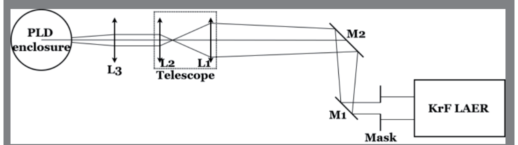


Figure 2: Figure a, Size evolution of laser impact on a silica target in function of lens-target distance. Figure b, photo of a laser impact made for a 34cm distance between lens and target.

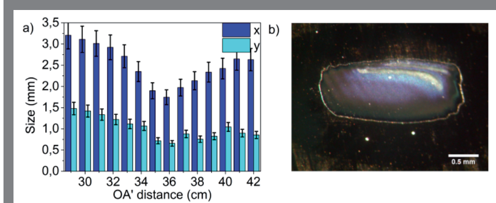
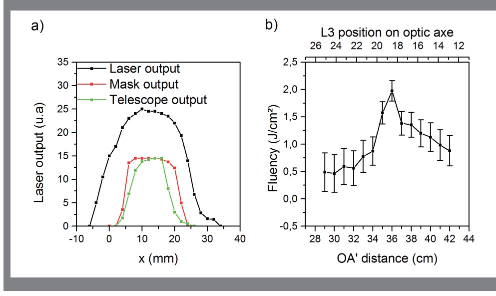


Figure 3: Figure a, laser beam profile in various positions of optic axe. Figure b, Fluency evolution in function of L3 lens positions on optic axe.



Results and discussion

The study of the laser beam fluency allowed putting a base control point for one critical parameter in PLD. An operator can use this work to adjust the receipt target energy and better manage the thin film deposition. This work contributed to ensure a better manipulation reproducibility. However the fluencies results are only acceptable for the used KrF laser (at 248nm wavelength).

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