RESEARCHES RELATING TO THE ESTABLISHING OF THE REFLECTIVE COATING TECHNOLOGY, RESILIENT UNDER HIGH POWER LASER PULSES

Under the second work-package (***Optical coatings***) the activity was focussed on establishing technologies in order to achieve a reliable coating for the mirror. As a first step we made a rough evaluation of several combinations between materials with high and low refractive index in order to see their potential to form a strong interferential package. After these preliminary tests, under which we evaluate by a classic way the adhesion, abrasion and some LIDT made using a Nd:Yag laser, we rapidly eliminate the classic TiO_2 – SiO_2 and ZrO_2 – MgF_2 combinations, finding that HfO_2 – SiO_2 to be strengthen than all others evaluated until that moment. As a consequence, focussing the research on this combination, some variants, from 20 to 24 layers, with, or without a top layer from Al_2O_3 were designed and executed on substrates made from fused silica with diameters of 25 and 62 mm, as it can be seen in the figure1:

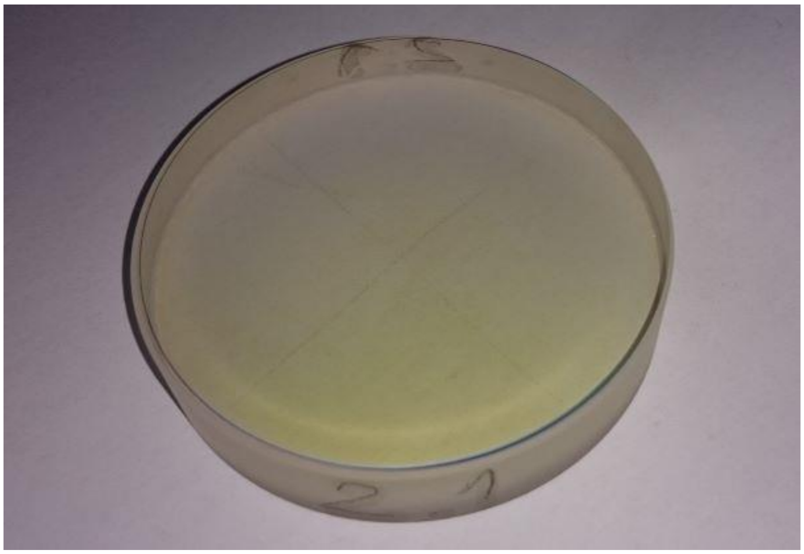

Figure1: A coated sample, ready for testing

The spectral transmission of the coated samples can be seen in the picture below:

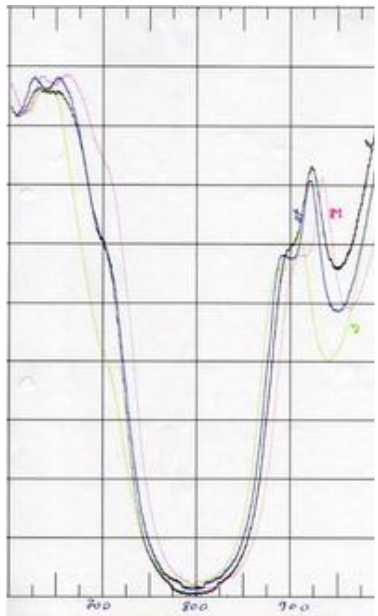

Fig. 2 – spectral transmission of several coated samples at the working angle of incidence of 45deg.

As it can be deducted from the graphic above, the total reflection of a coated mirror is around of R_{avrg} = 98% on the interval from 775nm to 825nm. The total reflection can be easily increased adding new layers on the coating formula. In the next months we have scheduled such improvements as well as an experimental study to determine the influence that the number of layers in a coating has on the laser induced damage threshold (LIDT vs. no. of layers).

Next step was to schedule a test session using a femtosecond laser from CETAL (INFLPR). In this respect we prepared 10 witness plates (Φ = 25mm) to be tested. These were collected from 5 batches (2 from each) that were brought to CETAL for testing. The comprehensive report and results are available on the project's web page but a brief presentation can be seen in the tables below (the witness plates are marked as "v1-st; v1-dr to v5-st; v5-dr"):

Table 2. Results obtained in monopulse regime.

Sigle pulse	**V1-st**	**V1-dr**	**V2-st**	**V2-dr**	**V3-st**	**V3-dr**	**V4-st**	**V4-dr**	**V5-st**	**V5-dr**
5 mJ	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
7 mJ	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
8.5 mJ	ok	ok		ok	ok	ok	ok	ok	ok	ok
9 mJ	+							++		
10 mJ	+	++	++	++	++	++	+	++	++	++
13 mJ	++	++	++	++	++	++	++	++	++	++

Table 3. Results obtained in burst regime (up to 10 pulses)

Burst **- Damage la** **# pulsuri**	**V1-st**	**V1-dr**	**V2-st**	**V2-dr**	**V3-st**	**V3-dr**	**V4-st**	**V4-dr**	**V5-st**	**V5-dr**
5 mJ (**10 pulses**)	ok	ok	ok	ok	ok	ok	ok	ok	ok	ok
7 mJ	ok	ok	+ (**2**)	ok	ok	ok	+ (**10**)	ok	ok	ok
8.5 mJ	+ (**10**)	+ (**2**)		++ (**4**)	ok	+ (**4**)		+ (**4**)	+ (**2**)	+ (**10**)
9.5 mJ	++ (**2**)				+ (**2**)					
10 mJ										
13 mJ										

Legend:

ok – all witness were ok after 10 pulses

+ – superficial damage on the iradiated site

++ – total damage on the iradiated site

(n) – number of pulses at which the site where damaged

We mention that, under similar condition of irradiation, a commercial mirror was totally damaged at energy of 7mJ.

Group Delay Dispersion (GDD) was another important parameter that was considered as a priority for optimization. The measurements were made using a white light interferometer. Below are presented some graphics that shows the GDD on wider and zoomed scales.

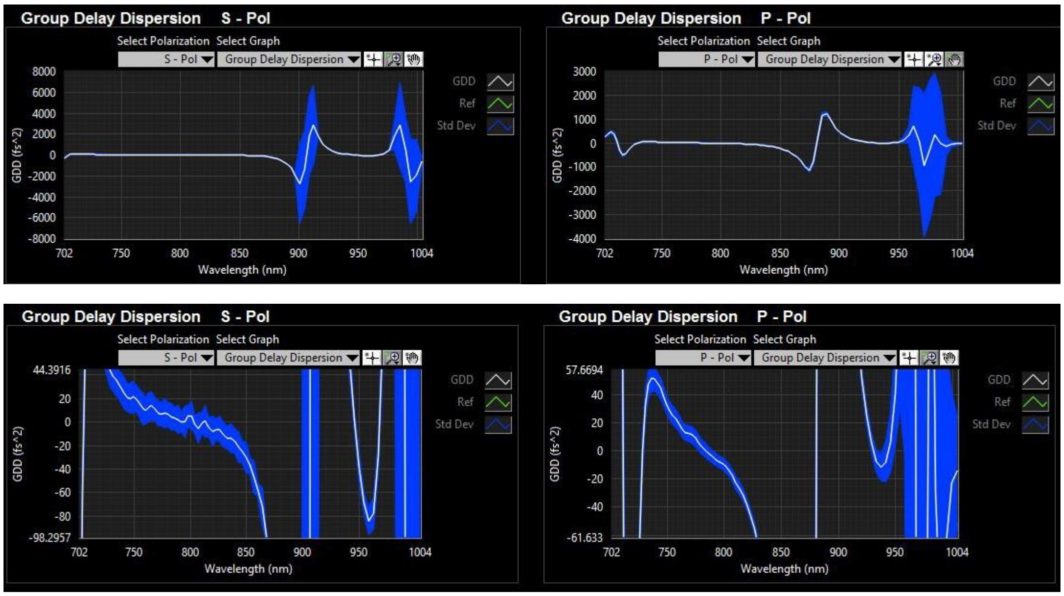

Fig. 3 – Group delay dispersion measured on a white light interferometer

It can be seen that the value do not exceed +/- 50 fs^2 on the interval of 750nm – 850nm.

As a conclusion, we mention that even if the results can be considered at least satisfactory, we intend to test some new coating formulas (now, based on Ta_2O_5 as high index), until decide which one is the best suitable for our propose.