Quality Test Report of the PTP deposition on the Filters: Photon Export and ZAOT

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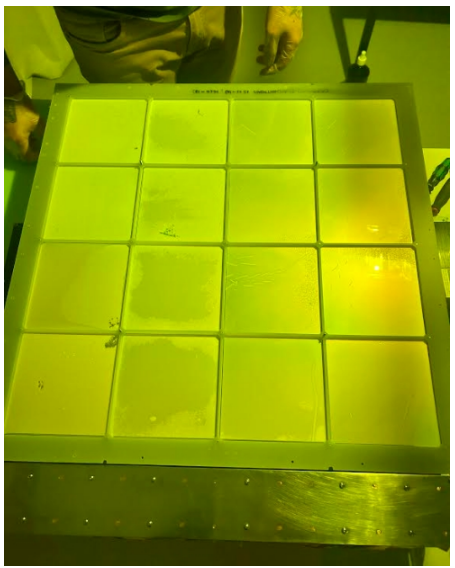
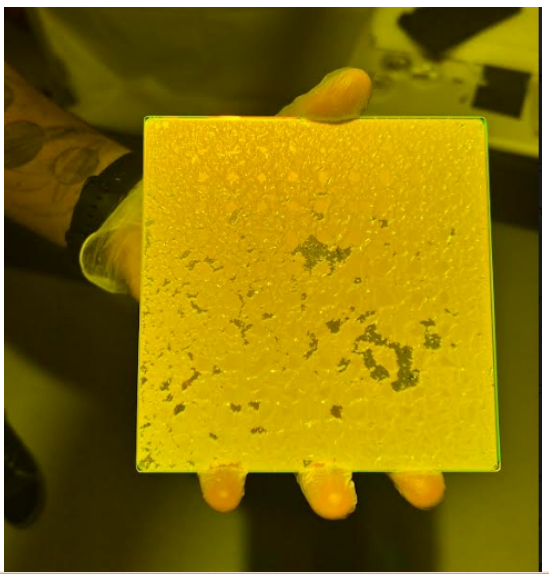
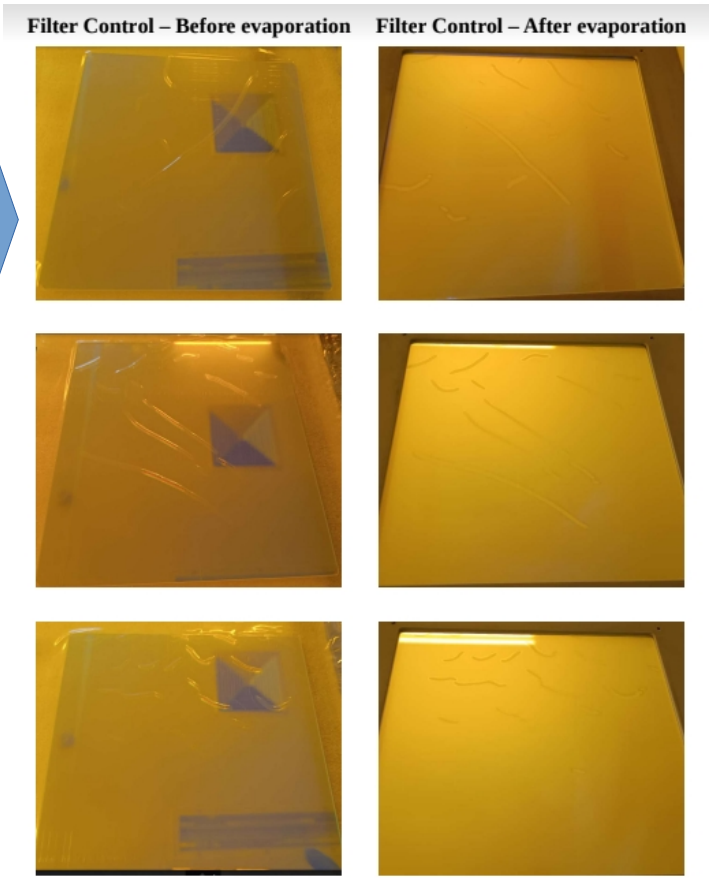
Batch´s: May and December, 2023.
Sent to PROTODUNE

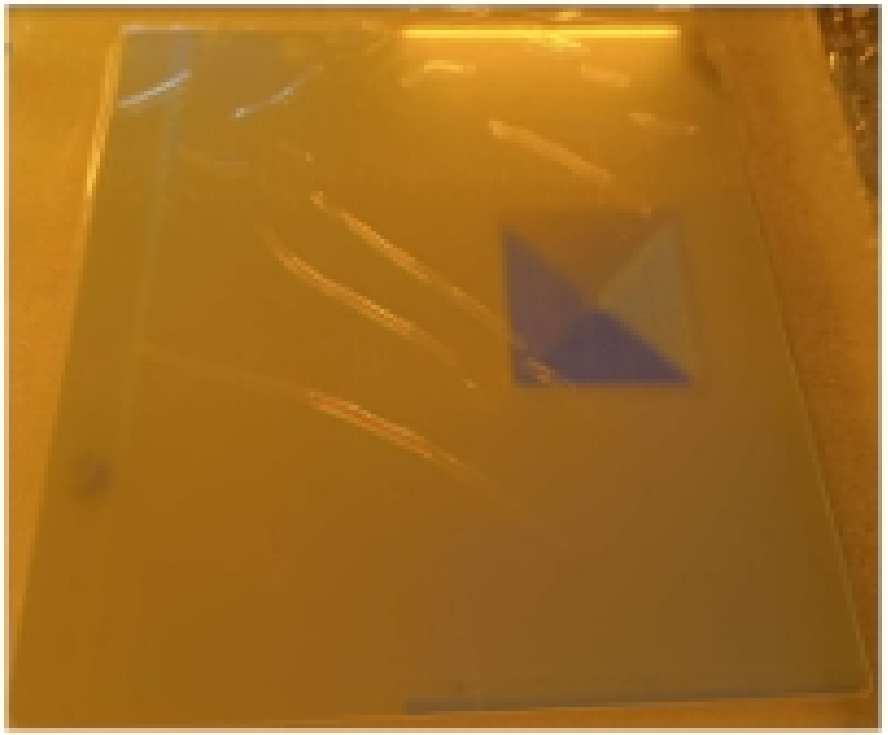
After evaporation, stains were noticed on the film's surface, likely related to interaction between the glass surface and the plastic film used to stack the samples in a box.

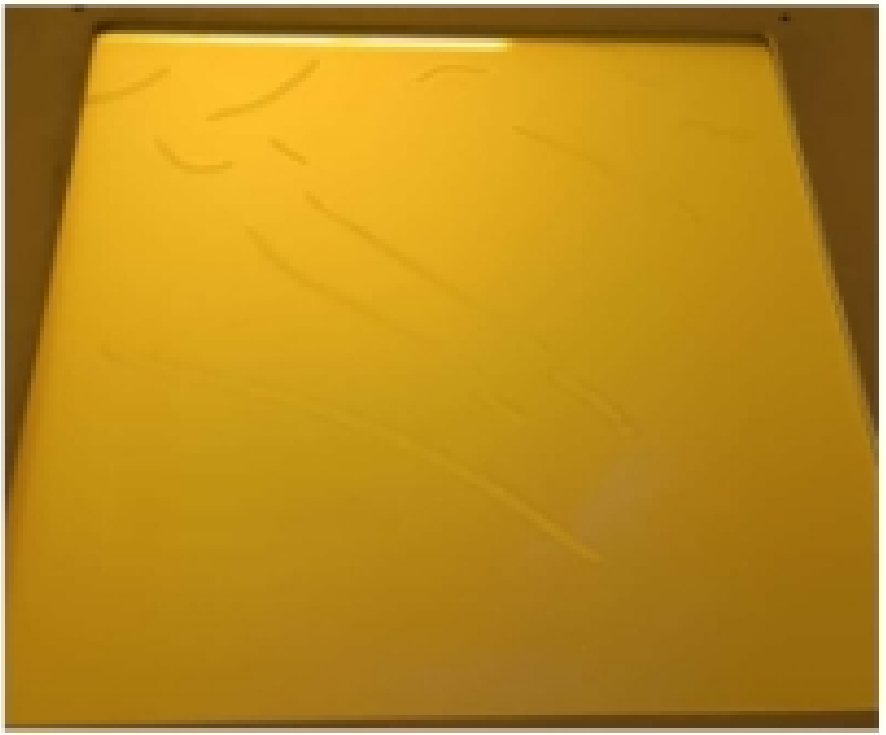






Amplified image of one of the samples





Question:

- Could surface conditions be interfering with the PTP adhesion process?

Suggestion:

- Analyze the adhesion of PTP on the surface of different filters, under the same surface cleaning condition, before deposition.

Organization:

•Two dichroic filters were selected: ZAOT (Lot May 2023), Photon Export (Lot May, 2024);

•The cleaning procedure involves an ultrasonic bath in a 3% Extran solution with deionized water for 10 minutes, followed by rinsing with deionized water, drying with compressed air, and subsequent heat treatment at 100 ºC for 3 hours;

•All filters were arranged in the center of the disk for the vacuum thermal deposition procedure;

•Cryogenic immersion in Liquid Nitrogen (N_2);

•Surface analysis after cryogenic immersion.

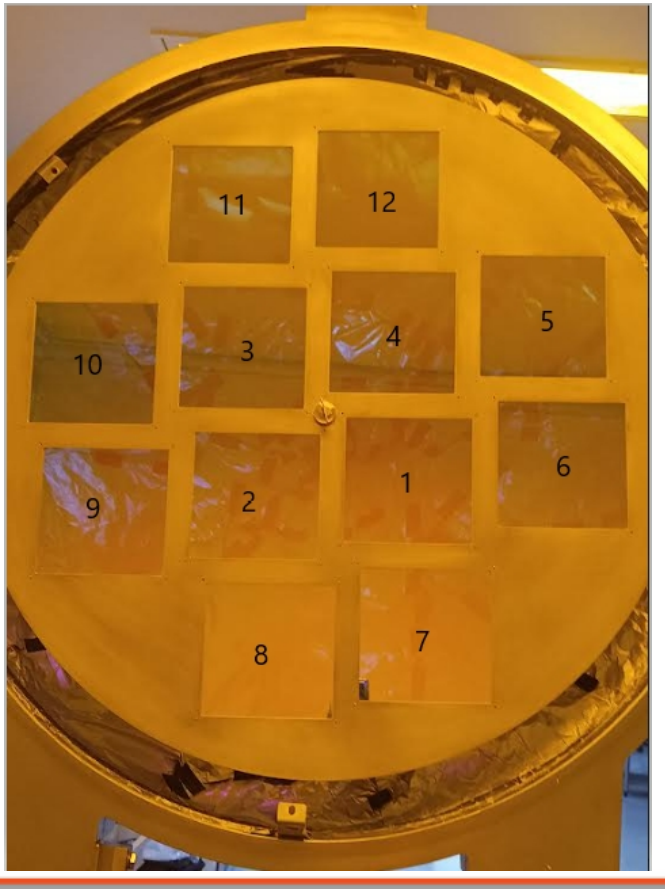
Materials and Methods:

Cleaning Procedure

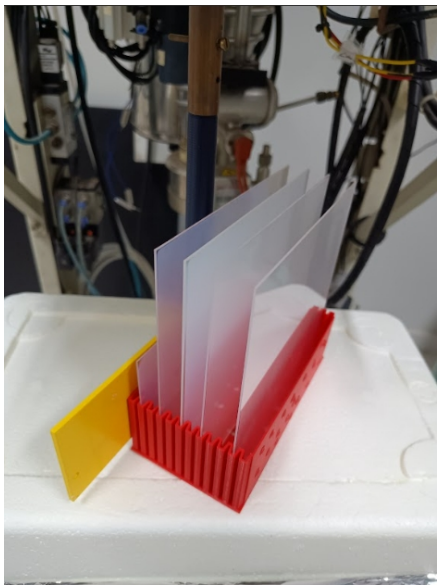
Evaporation Procedure

Note:

Two substrates from ZAOT (without dichroic filter), batch 05/24/2024, were also selected for adhesion and quality control tests, specifically from evaporations 32 (Filter position 9) and 33 (Filter position 4). The positions of each part during evaporation are shown in Figure.



Materials and Methods:



Cryogenic Bath

•The experimental apparatus included a support for the samples, coupled to a stepper motor programmed to descend into the liquid nitrogen (N2) reservoir;

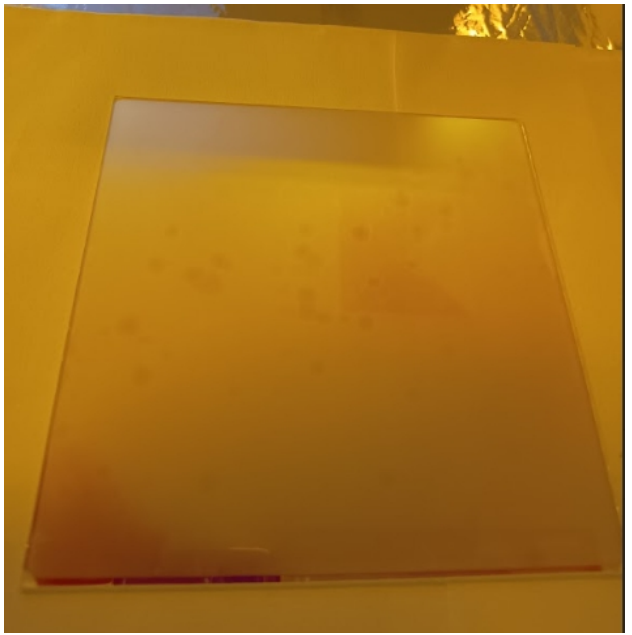
•Half of the thermal reservoir was filled with 18 liters of liquid N2;

•System was closed for 30 min to achieve thermal equilibrium;

•After this time, the sample support was introduced into the nitrogen liquid with speed of 0,67 cm/min until total immersion.

•After 2 hours immersed, the filters were removed following the inverse procedure.

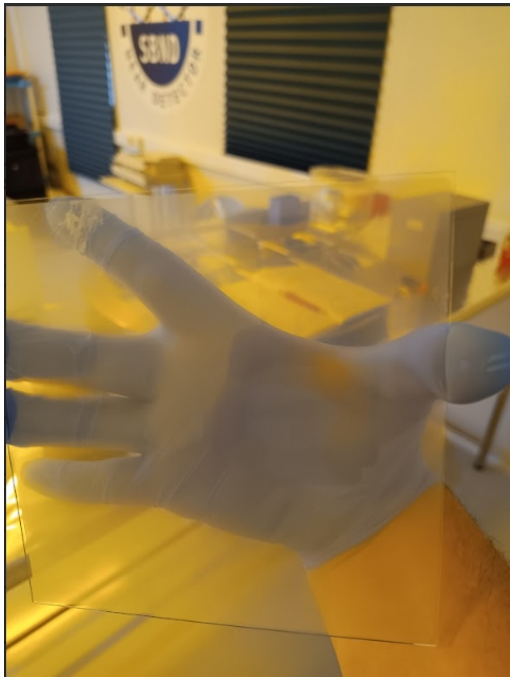
Results: Dichroic filters after evaporation process and before immersion in liquid nitrogen.



ZAOT

Photon Export

Results: Two ZAOT substrates (without dichroic filters) after evaporation process and before immersion in liquid nitrogen.



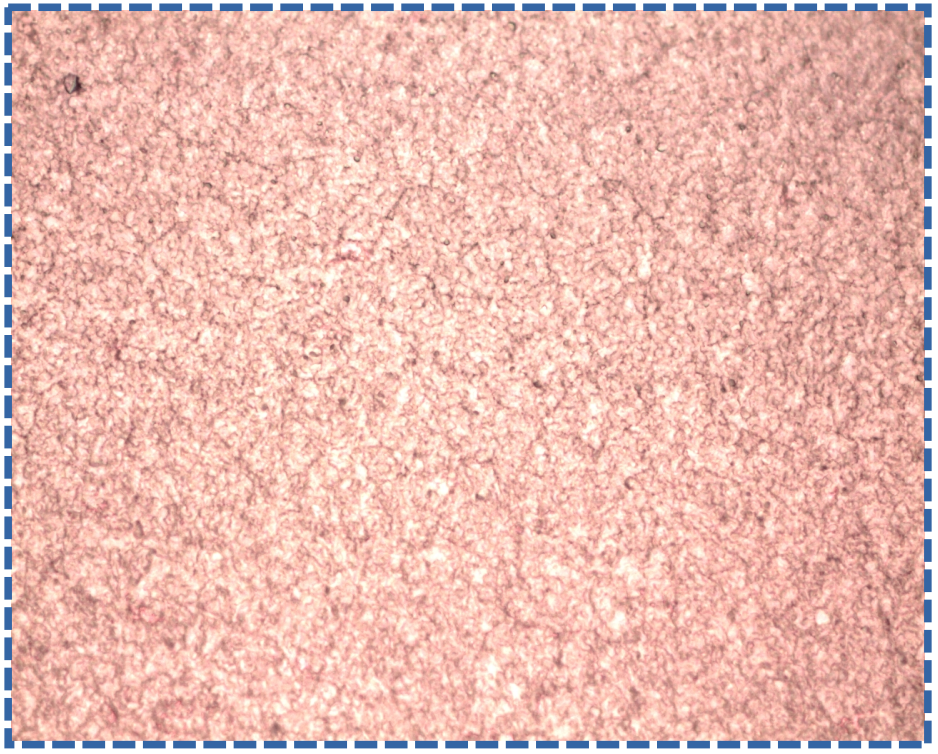
ZAOT **substrates** after evaporation (batch 05/24/2024). Left: Position 4 filter (evaporation 33); Right: Position 9 filter (evaporation 32).

Results: After immersion in liquid nitrogen

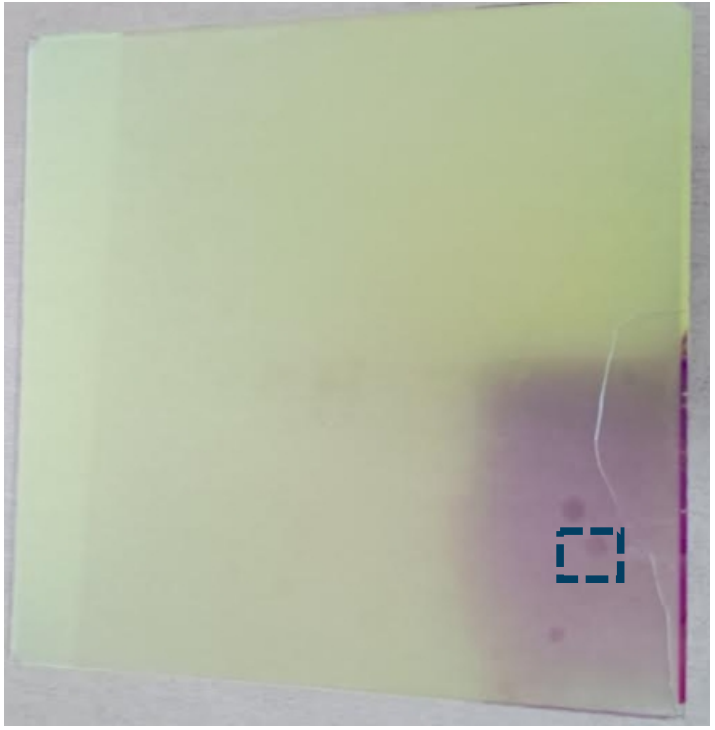
Photon Export **Dichroic Filter**.

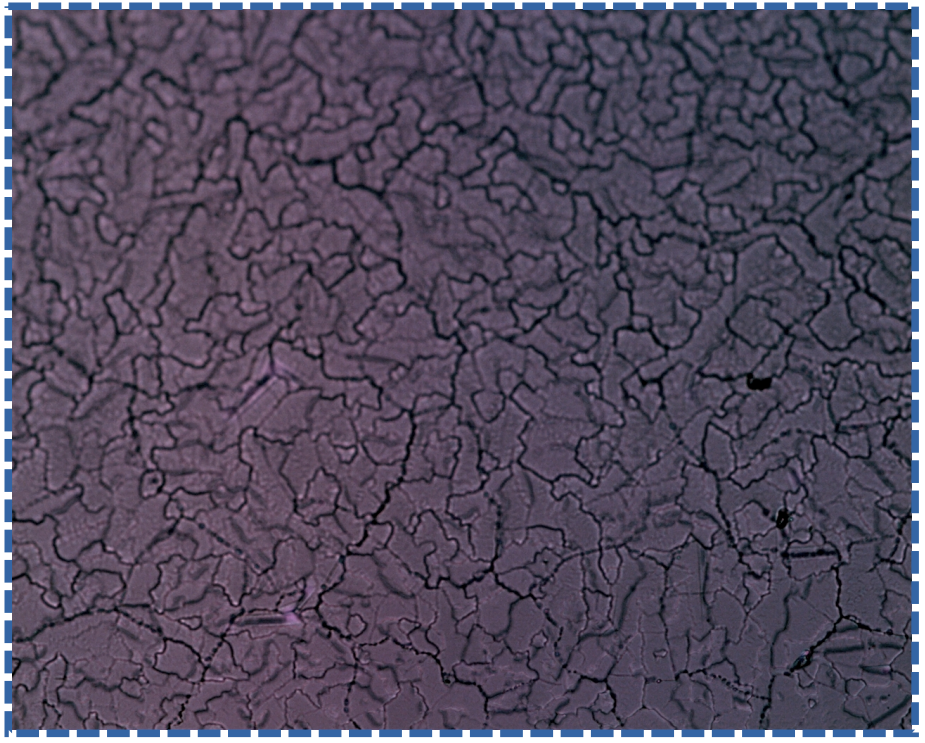
ZAOT **Dichroic Filter**

Optical Microscopic Results: Photon Export



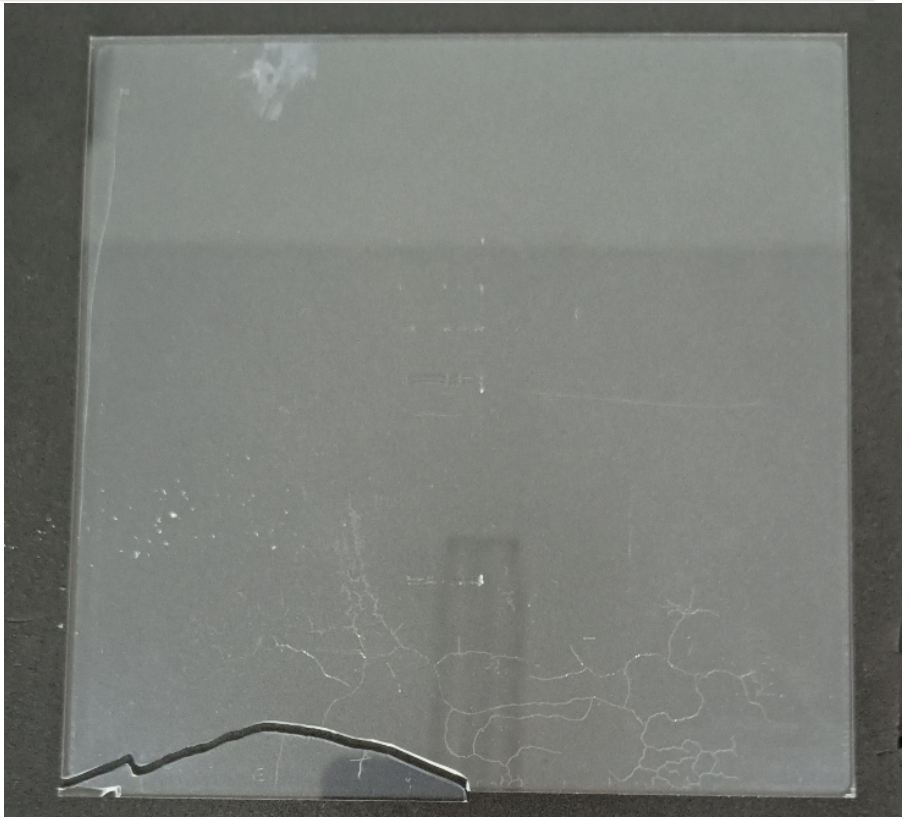
Optical Microscopic Results: ZAOT





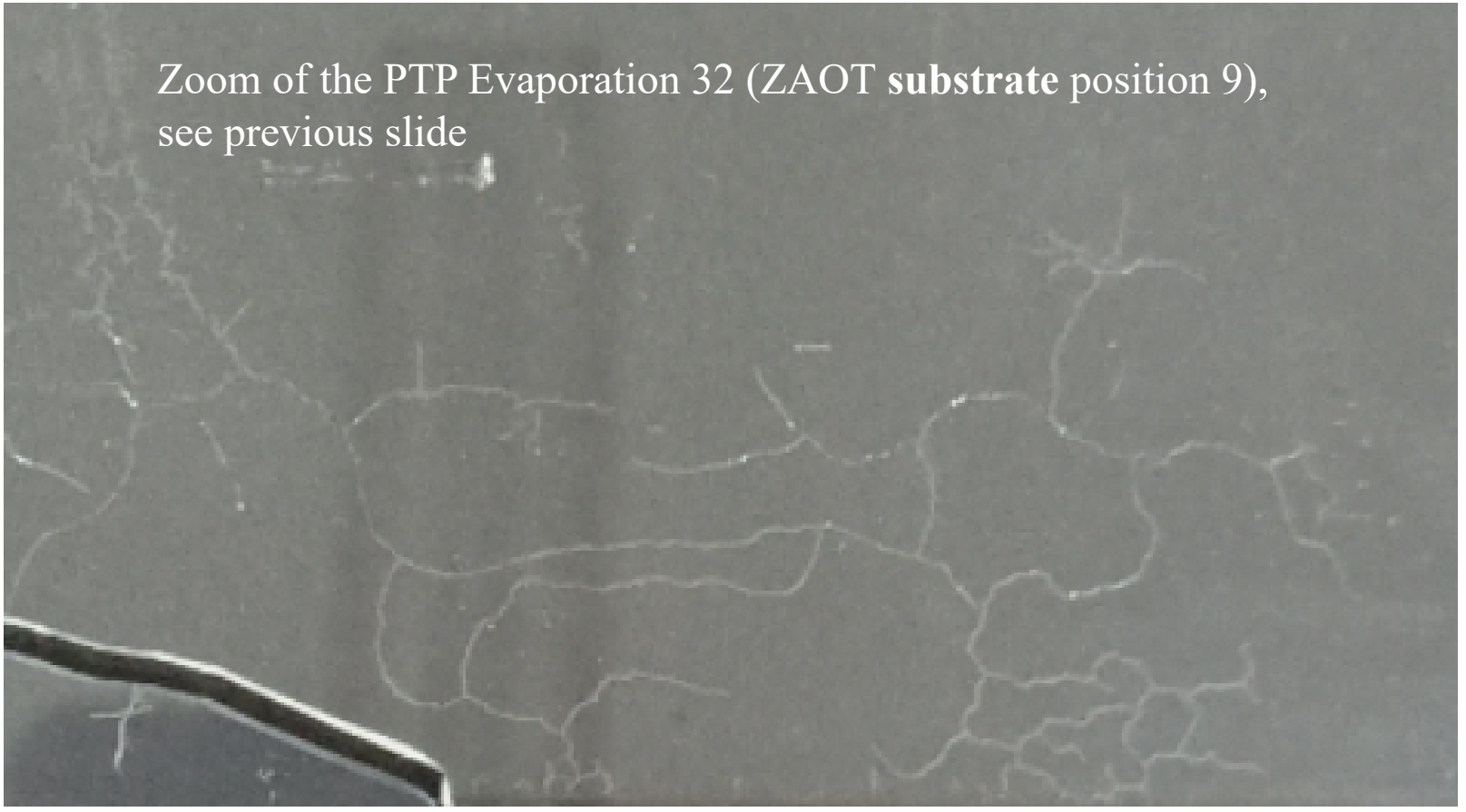
Results:

a) PTP Evaporation 33 (ZAOT **substrate** position 4);



b) PTP Evaporation 32 (ZAOT **substrate** position 9);

Results:


Zoom of the PTP Evaporation 32 (ZAOT **substrate** position 9),
see previous slide

Considerations:

- While the filter from Photon Export (after cleaning at Unicamp) demonstrated good adhesion of the PTP layer and did not exhibit cracking issues after immersion in liquid nitrogen, the filters from ZAOT were susceptible to thermal shock, resulting in immediate cracking upon contact with liquid nitrogen.

- The adhesion issues observed in the PTP layer on the Photon Export batch 12/01/2023 indicate that storage and cleaning methods for the filters should be reviewed and improved to ensure the integrity of the deposition.

- As for the ZAOT filters it seems that the problem could be associated with the glass substrate, since both dichroic filter and glass substrate broken after immersion in liquid nitrogen, or due to some issue related to the system used to test the immersion in liquid nitrogen.

- Since this experiment was performed only once, it is recommend to repeat the immersion test on the ZAOT wafers.

Points for improvement in the experimental setup to establish an appropriate procedure for future quality tests include:

•Seal the styrofoam box system, maintaining a flow of nitrogen gas throughout the immersion/emersion, in order to reduce humidity and prevent the formation of ice on the PTP surface after removing the N_2.

•Controlling ambient humidity.

•Reduce the exposure time of the support in an N_2 atmosphere.

•Testing new immersion speeds to establish an acceptable standard for all filters, thereby avoiding future thermal shock issues.

•Conducting microscopic analysis of filter surfaces before and after cryogenic bath.

•Introduce mechanical vibration in the dichroic filter during immersion.

Thanks!

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