

[P2.17] Comparative study of the picosecond laser surface texturing of YSZ and CGO on YSZ films for electrochemical cells applications

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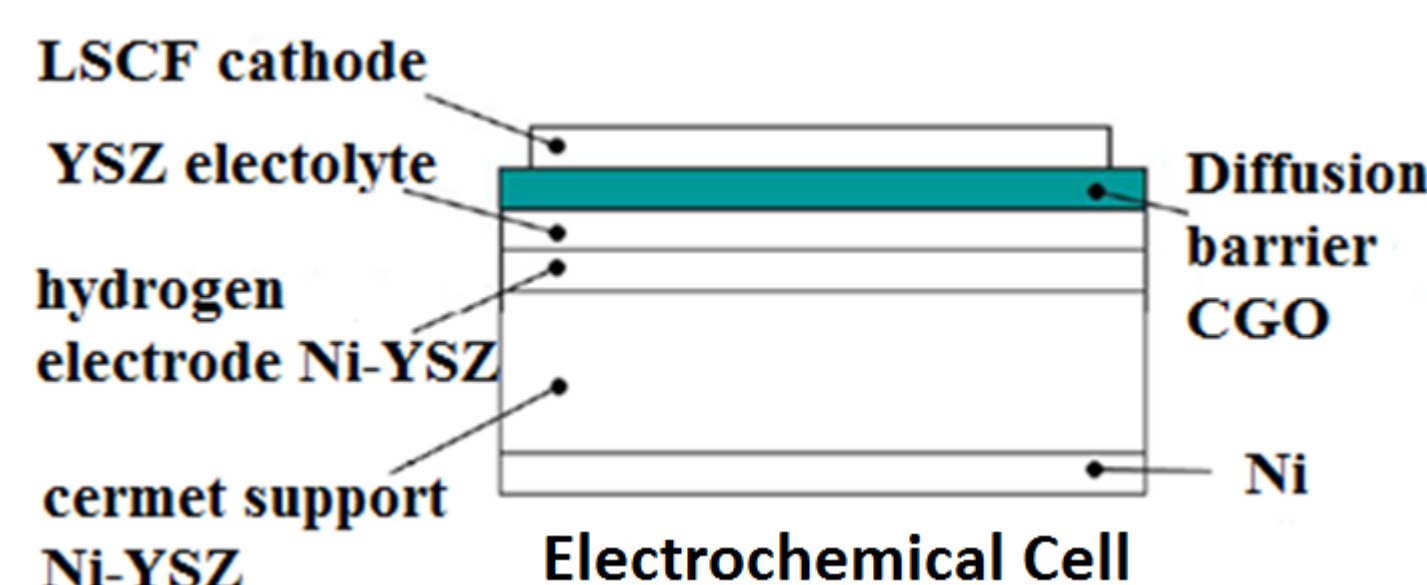
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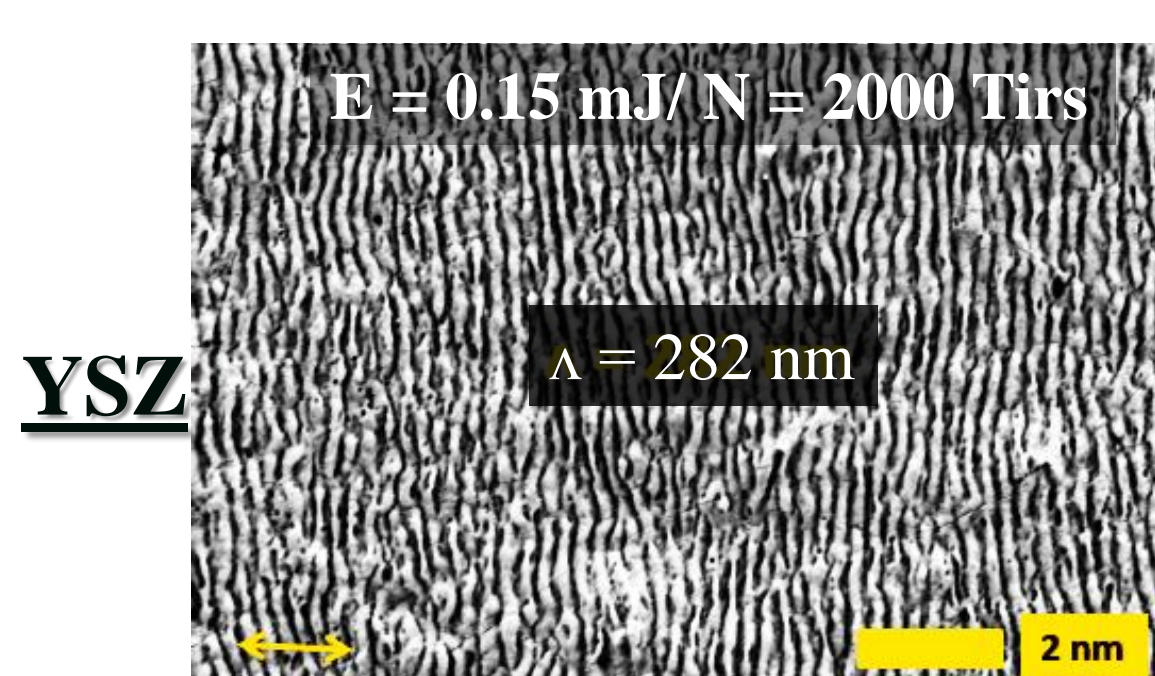
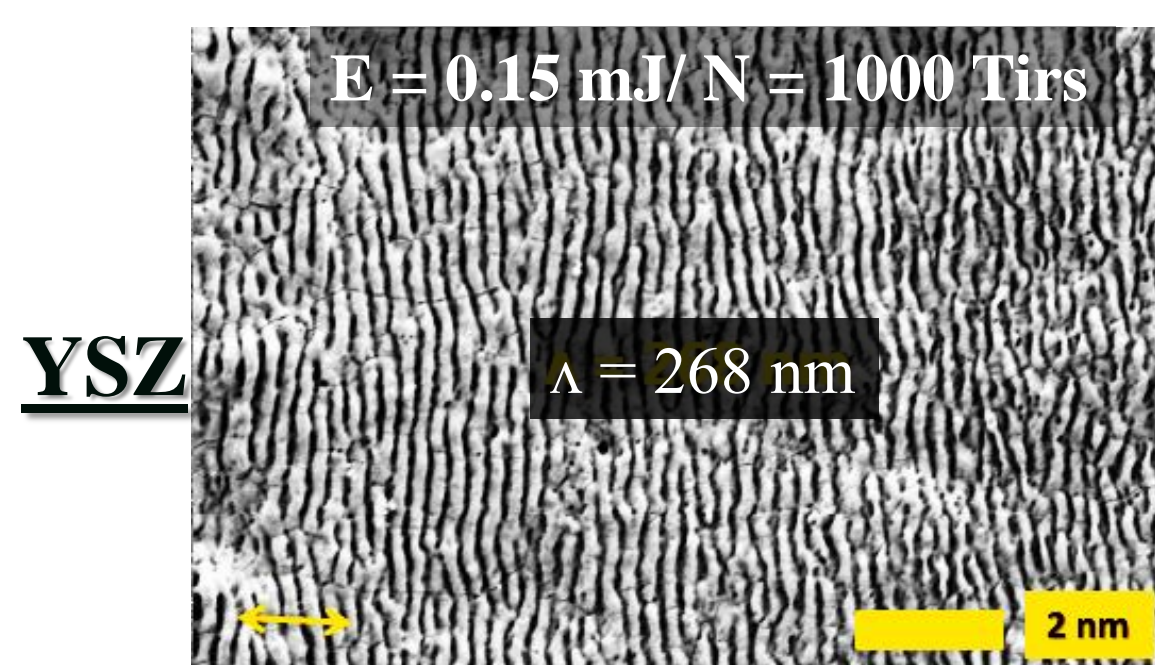
1. Context & objectives

- Develop a thin layer of cerine doped gadolinium (CGO) between the lanthanum strontium cobalt ferrite (LSCF) cathode and the yttria-stabilized zirconia (YSZ) electrolyte of solid oxide fuel cells (SOFC) which allows to :
 - Avoid the formation of insulating phases not envisaged
 - Improve cell aging
 - Achieve high performance levels
- Apply two approaches for laser structuring to increase the specific surface of the electrodes as follows:
 - Texturing of the CGO layer deposited on YSZ by magnetron sputtering
 - Direct texturing of YSZ electrolyte before CGO deposition
- Determine the ablation threshold fluence for the two materials CGO and YSZ in order to optimize the formation of the laser induced periodic surface structures (LIPSS) that can be classified as Low Spatial Frequency LIPSS (LSFL) or High Spatial Frequency LIPSS (HSFL) [1-3].

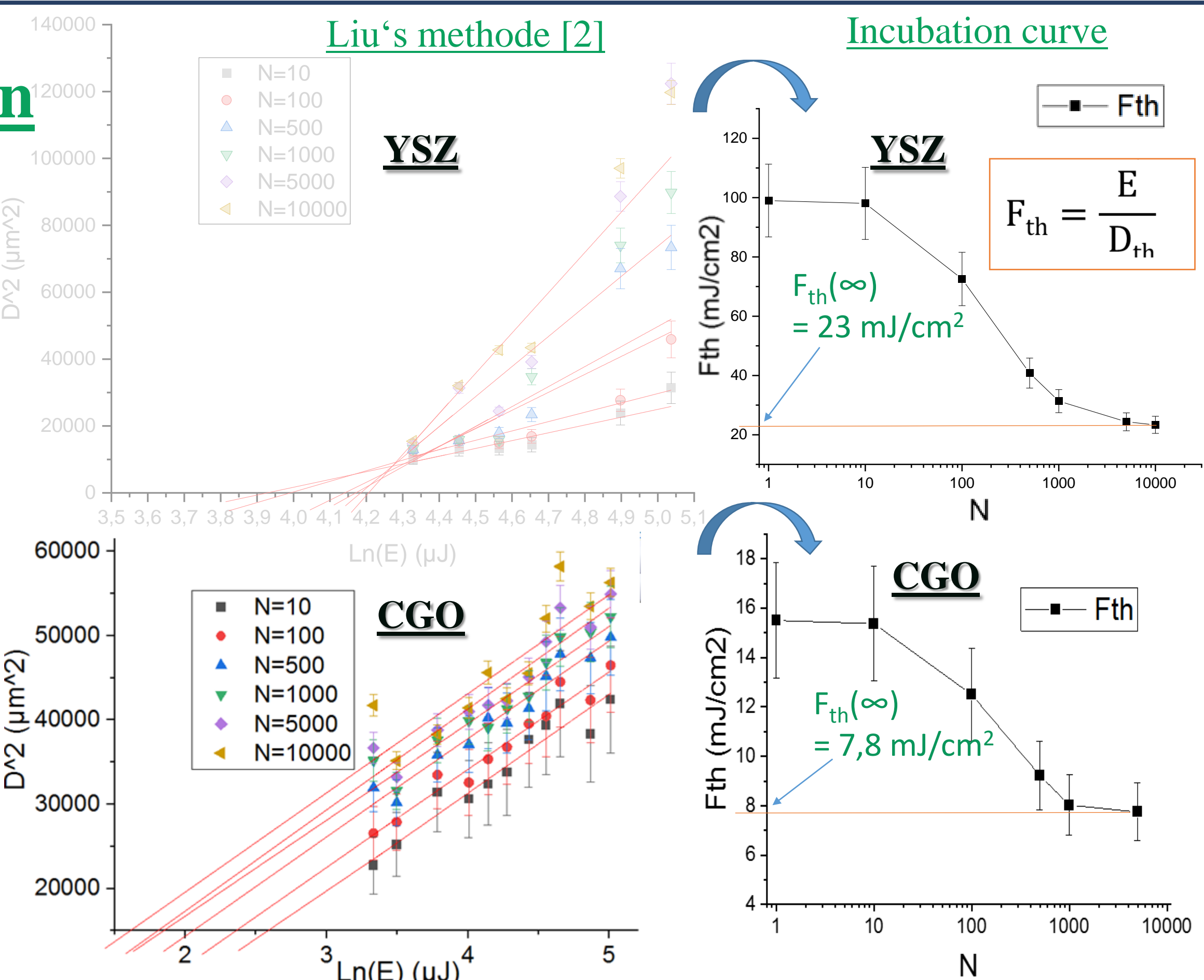


3. Results & Discussion

Static Mode : $D_{th} \approx 275 \mu m$



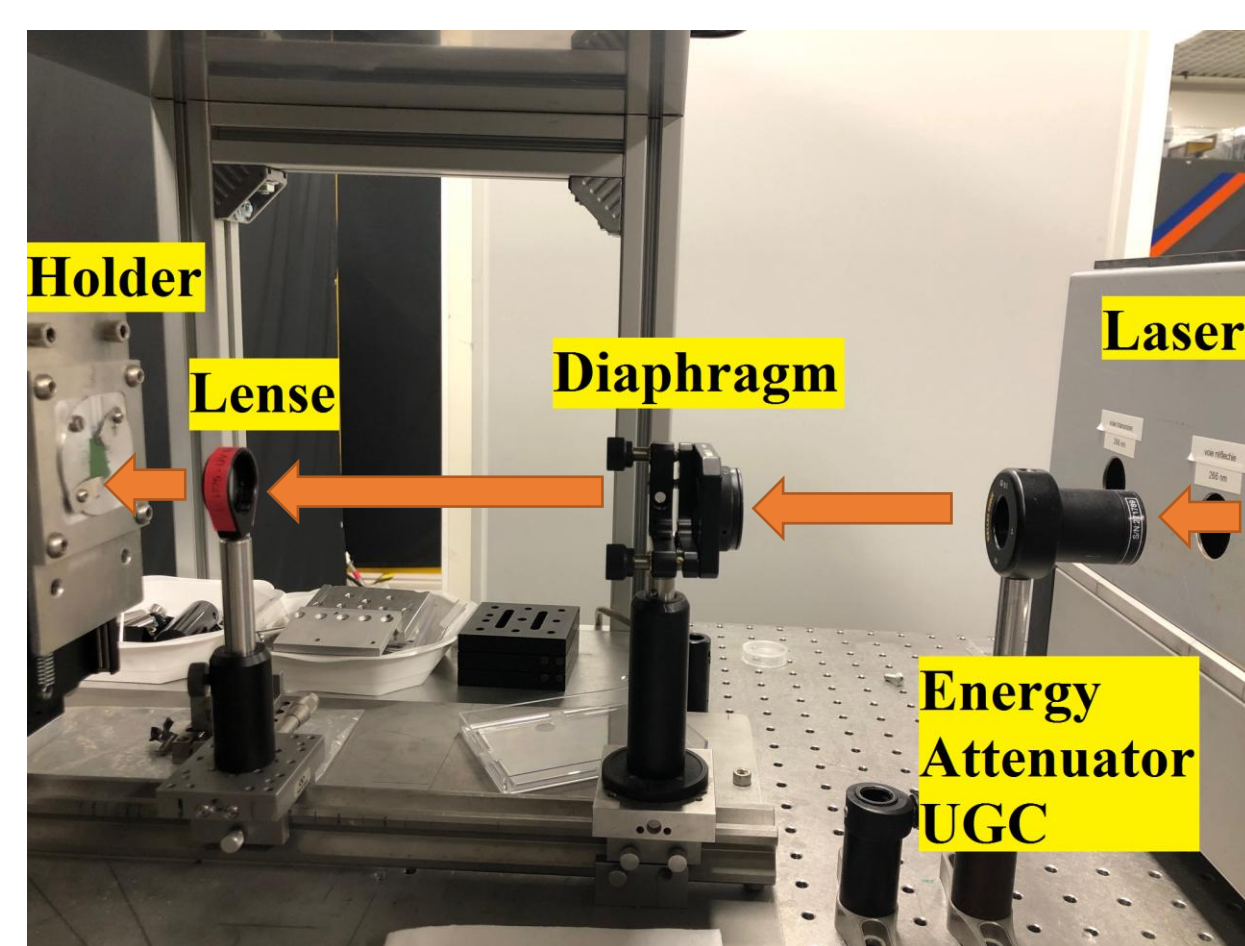
$N \nearrow \rightarrow$ Spatial period $\Lambda \nearrow$



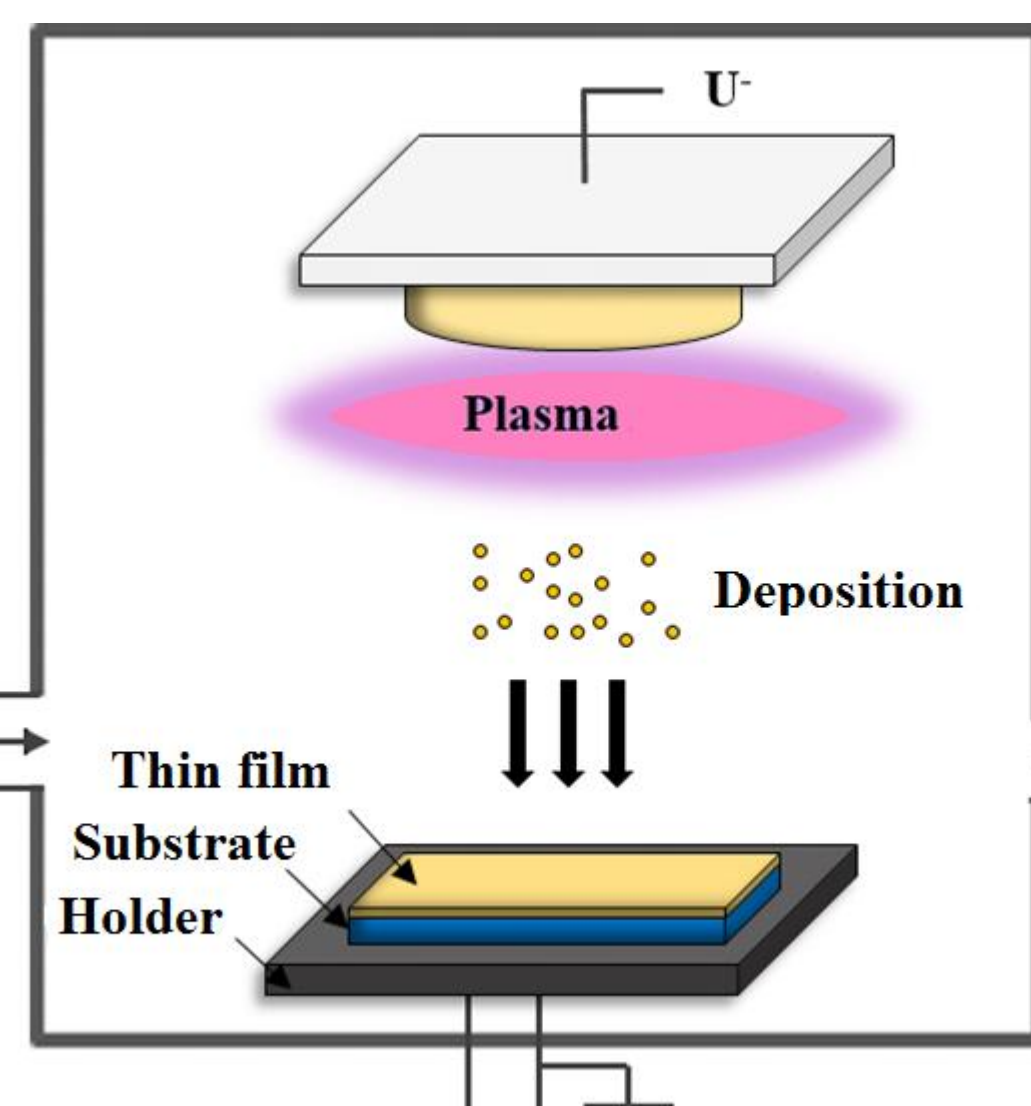
2. Materials & Experimental setup

- In this work, a picosecond Nd: YAG laser operating at its third harmonic ($\lambda=355$ nm) is used to irradiate the surface of both materials.

characteristics	Nd: YAG laser picosecond
Wavelengths (nm)	266, 355, 1064 et 532
Wavelength used (nm)	355
Polarization	Linear
Pulse frequency(Hz)	10
Pulse duration (ps)	40

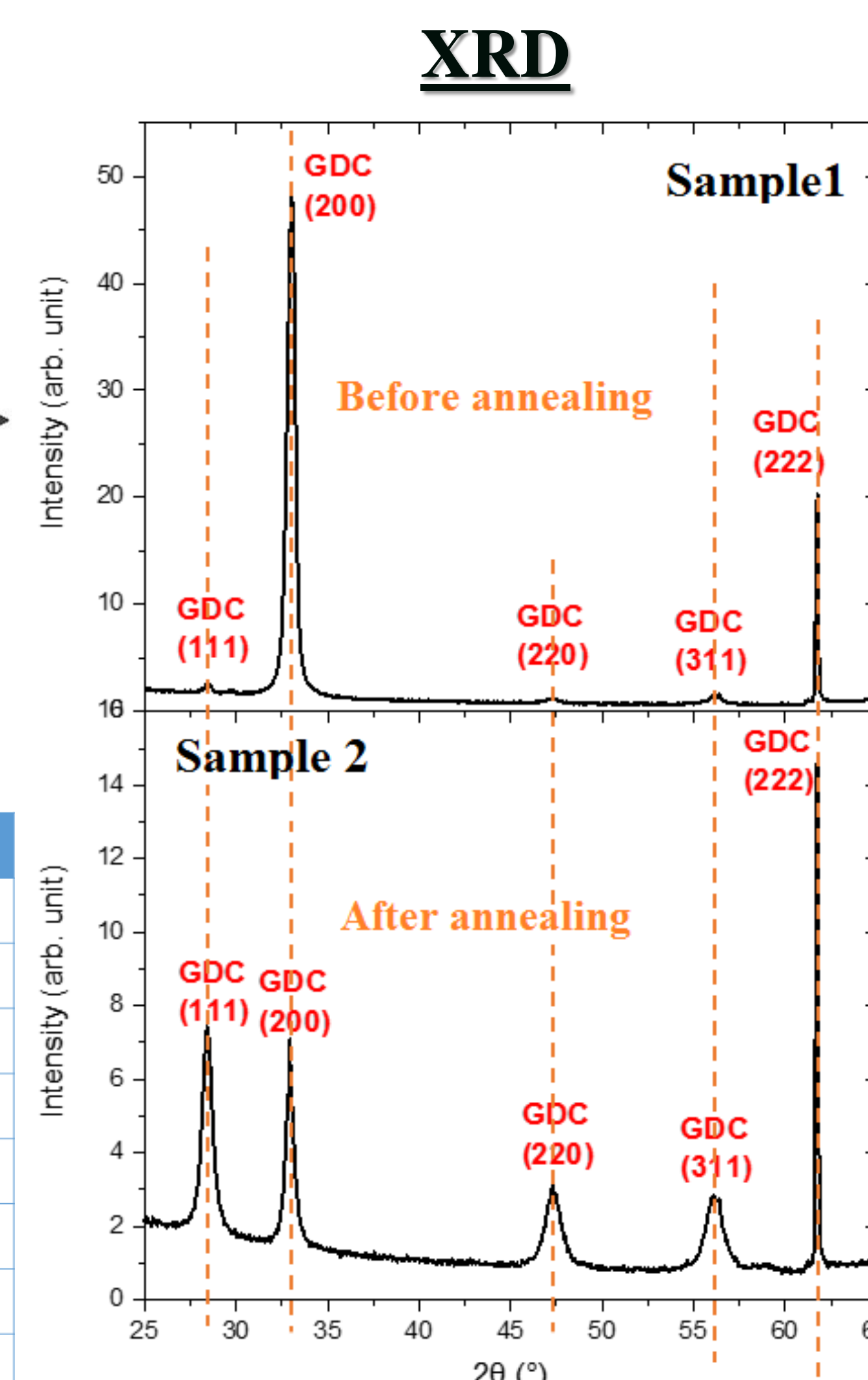
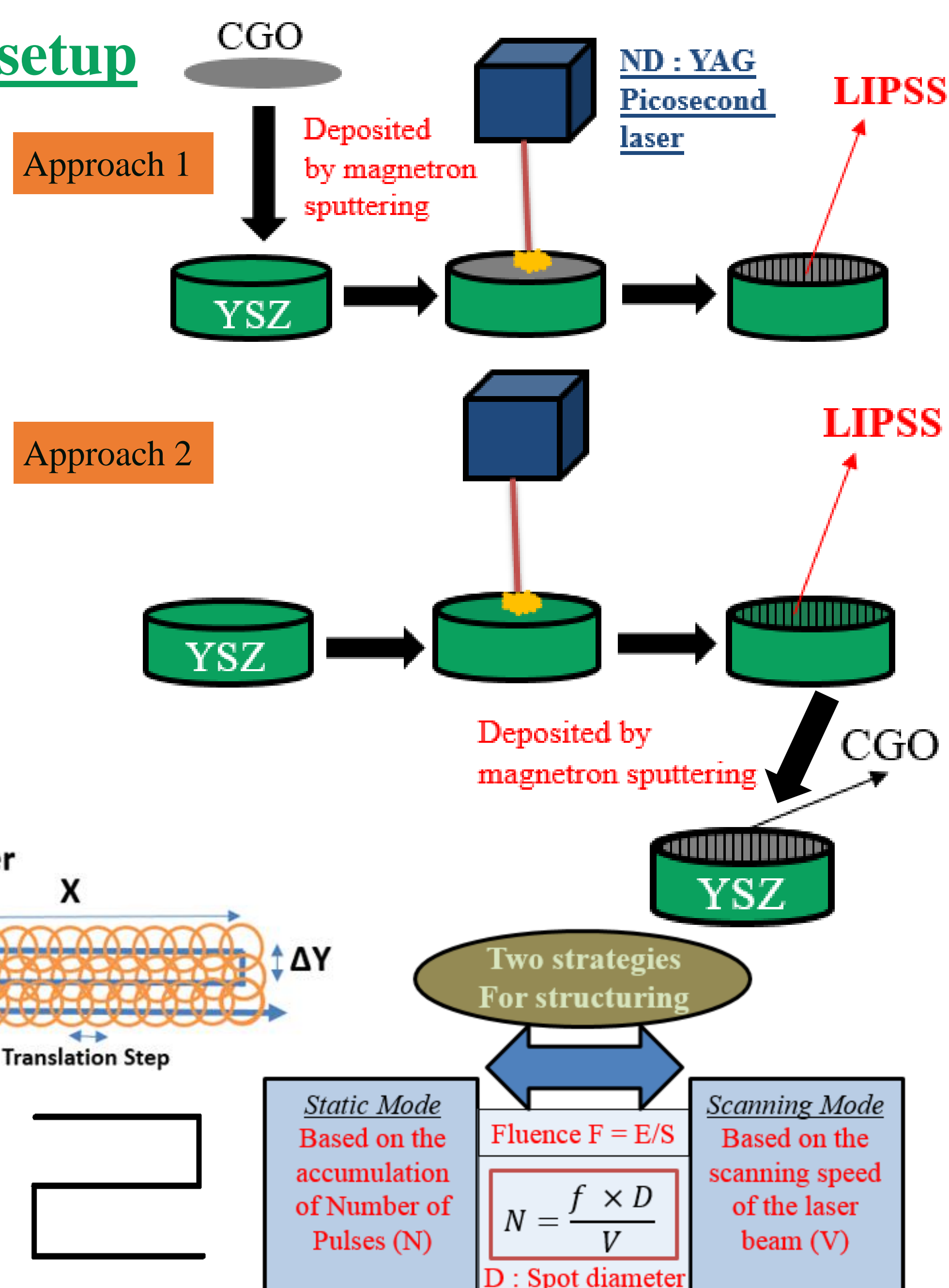


- The magnetron sputtering technique is used to deposit the intermediate thin layer of CGO

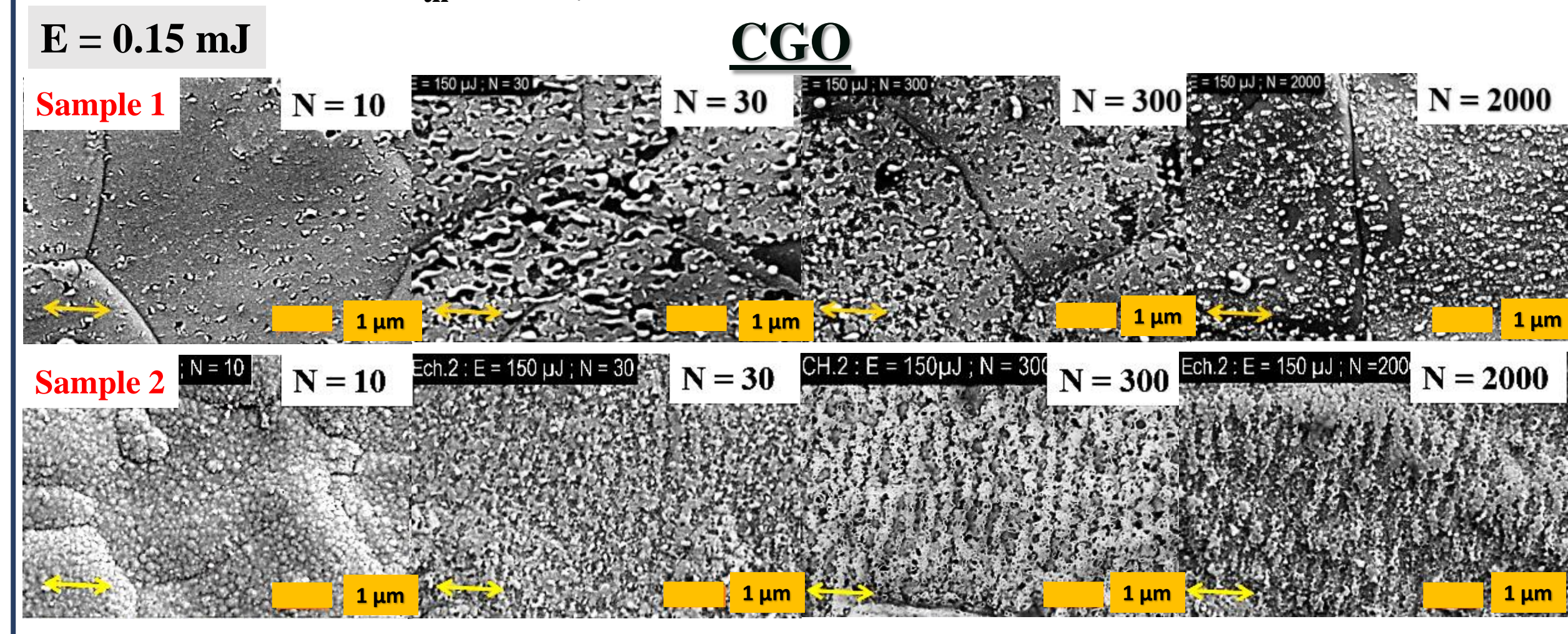


- There are two conditions for the deposit of CGO on which the laser structuring was carried out

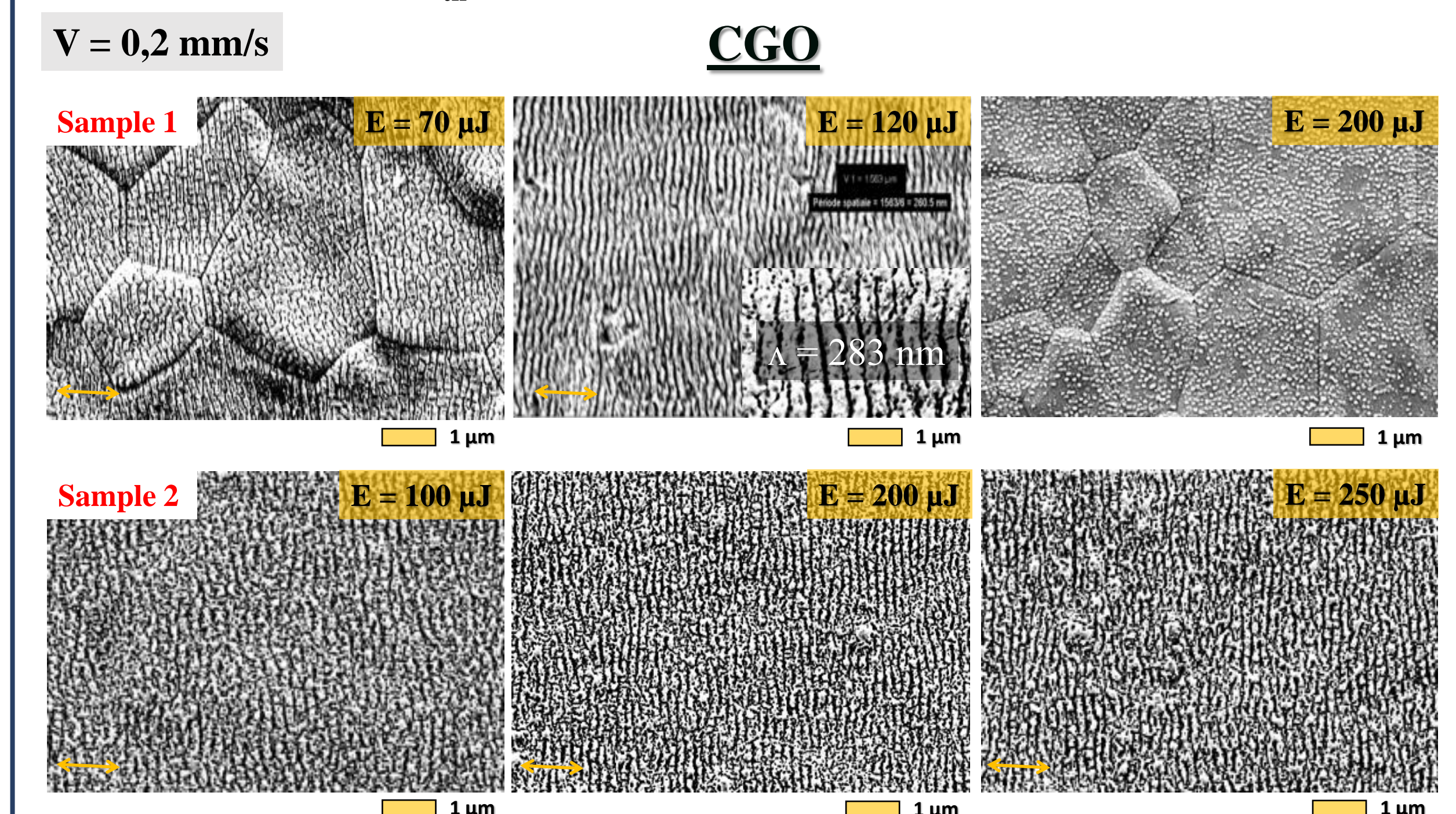
Parameters	Sample 1	Sample 2
Base Pressure	6.9e-6 mbar	6.9e-6 mbar
Ar Flow	20 sccm	20 sccm
Ar Pressure	1 Pa	1 Pa
Frequency	50kHz, 5μs t_off	50kHz, 5μs t_off
Current	1A	1A
Target-substrate distance	16 cm	12,7 cm
O2 Flow	3 SCCM	2 SCCM
Annealing at 500°C	Before	After



Static Mode : $D_{th} \approx 220 \mu m$



Scanning Mode : $D_{th} \approx 220 \mu m$



Conclusions & Outlook

- We achieved finally to find the conditions suitable for the formation of LIPSS.
- We have applied the LIU's method on both materials in order to calculate the threshold fluence of ablation F_{th}
- It is also necessary to continue the work on YSZ whether in static or dynamic mode (Approach 2) before the deposition of CGO layer
- Optimization of LIPSS training with femtosecond laser for the next step

References

- [1] : J. Bonse, A. Rosenfeld, et J. Krüger, « On the role of surface plasmon polaritons in the formation of laser-induced periodic surface structures upon irradiation of silicon by femtosecond-laser pulses », J. Appl. Phys., vol. 106, no 10, p. 104910, nov. 2009, doi: 10.1063/1.3261734.
- [2] : J. M. Liu, "Simple technique for measurements of pulsed Gaussian-beam spot sizes", vol 7, no 5, 1980–1982, 1982.
- [3] : A. Talbi et al. «Femtosecond laser irradiation of titanium oxide thin films: accumulation effect under IR beam», Appl. Phys. A, vol. 126, doi: 10.1007/s00339-020-03568-5