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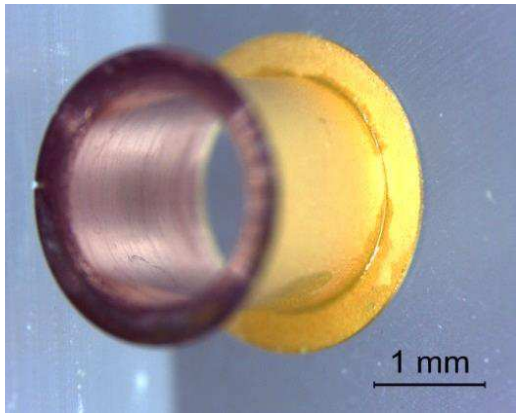
THIN METALLIC LINERS FOR HOHLRAUM



S. LE TACON, K. MOLINA, G. DE DEMO, R. BOURDENET, R. CALAND, R. BOTREL, C. CHICANNE, M. THEOBALD

23th Target Fabrication Meeting |

23-26 April 2019

OUTLINE

I. CONTEXT

II. LINERS FABRICATION

III. RESULTS

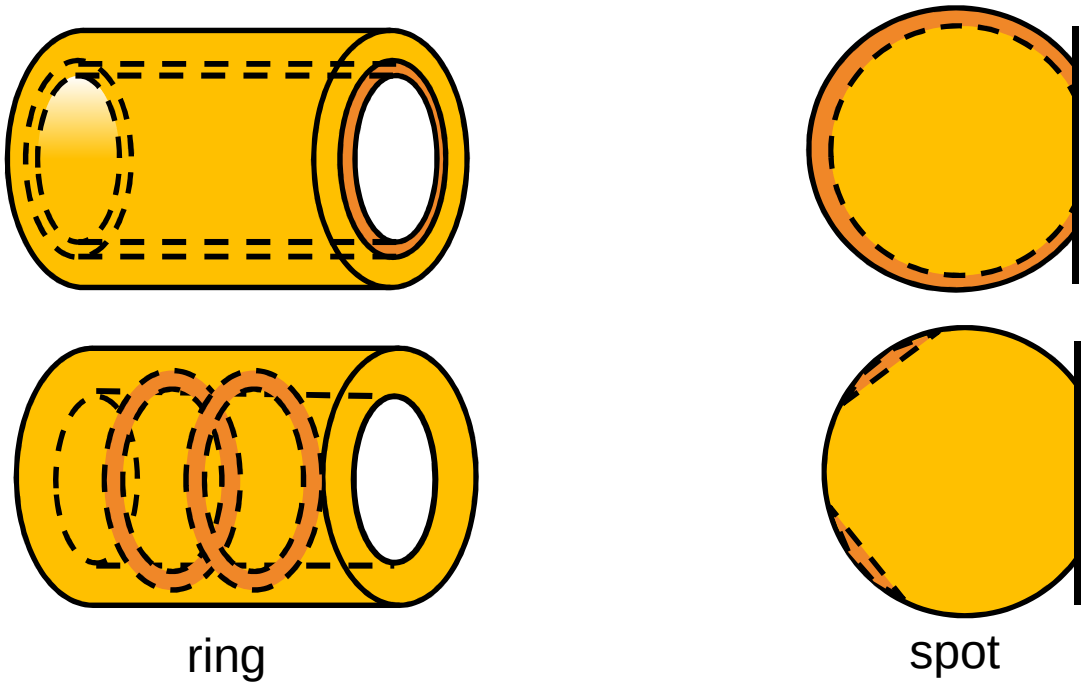
IV. CONCLUSION

CONTEXT

CONTEXT: Change hohlraum albedo (completely or locally)

CONFIGURATIONS STUDIED: CYLINDRICAL OR SPHERICAL

- *FULL*
- *LOCALIZED*



ring spot

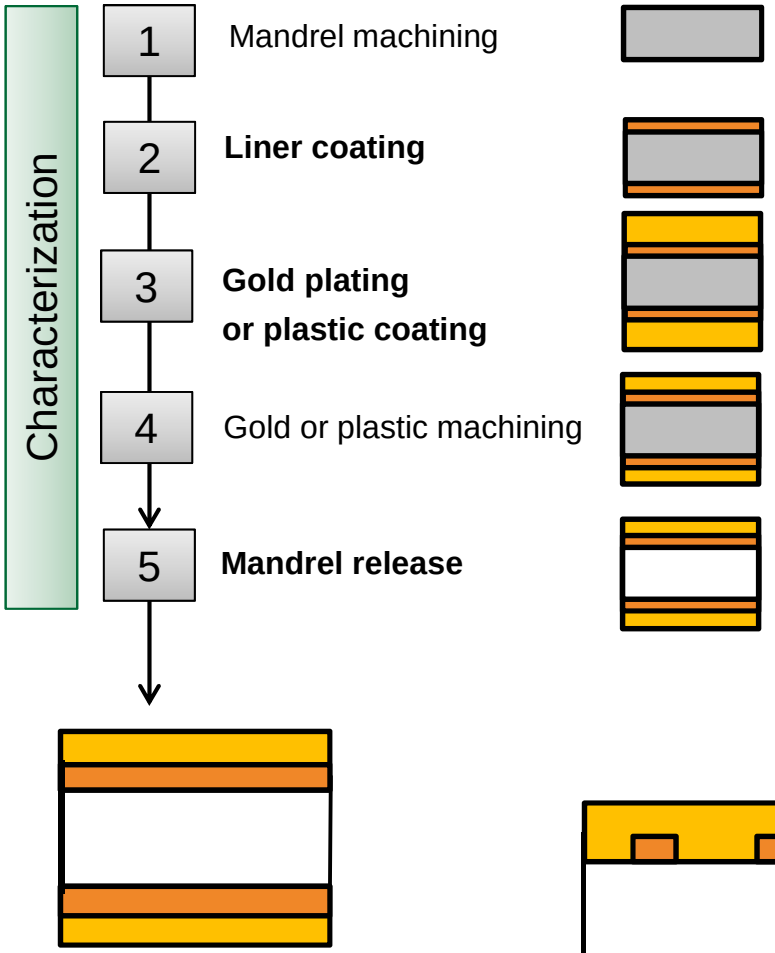
LINER: COPPER OR TITANIUM

HOHLRAUM: GOLD OR PLASTIC (CHON)

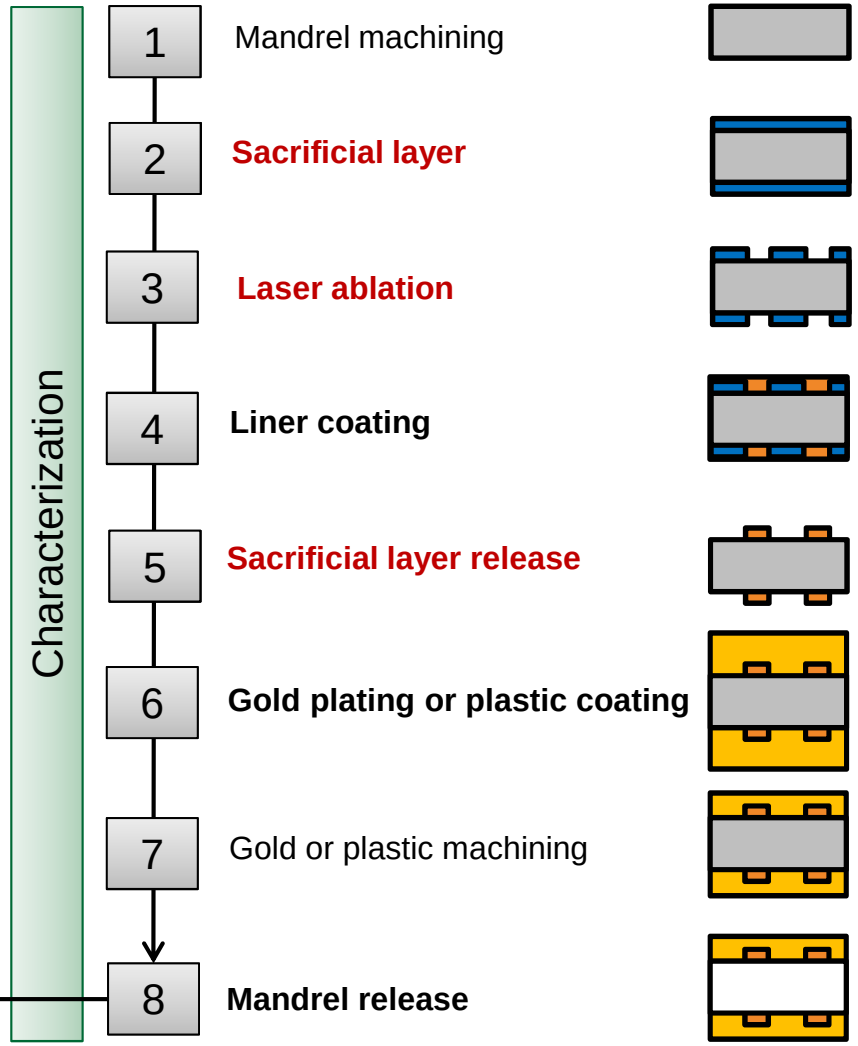
STUDY OF NEW KIND OF HOHLRAUM

FABRICATION SYNOPTIC

FULL LINER



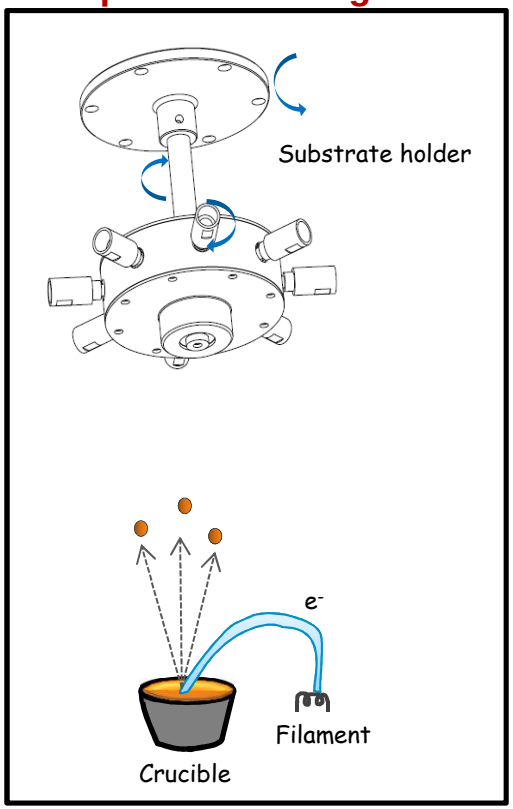
LOCALIZED LINER



LINER COATING

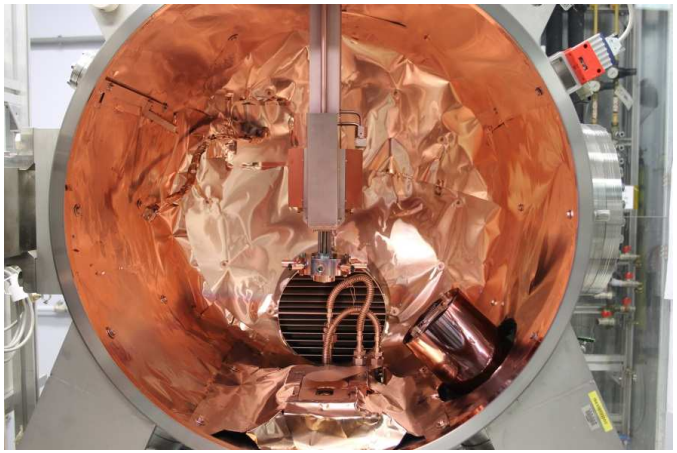
ELECTRON BEAM EVAPORATION OR MAGNETRON SPUTTERING

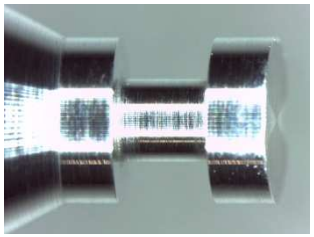
Evaporation configuration

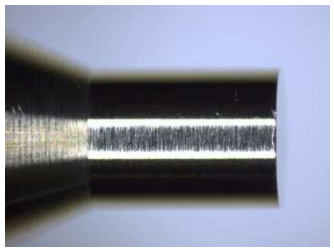


Evaporation is well adapted for material with low vapor pressure (e.g. **copper**)

Evaporation chamber

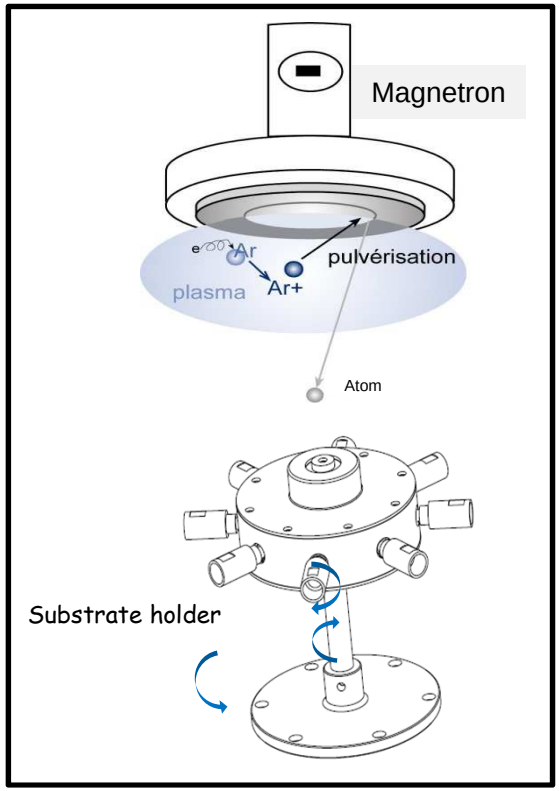






Examples of aluminum and brass mandrels

Sputtering configuration

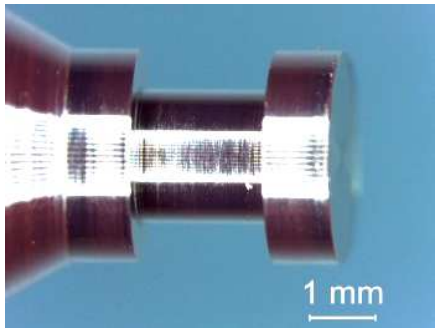


Sputtering is useful for material with high vapor pressure (e.g. **titanium**)

THIN METALLIC COATING FROM 1 µm TO 3 µm ON METALLIC MANDREL

FULL LINER

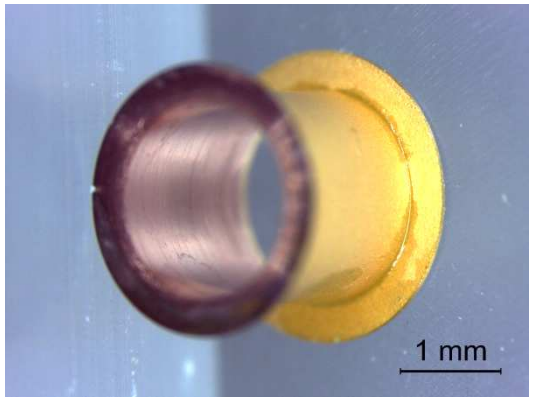
❑ COPPER LINER IN GOLD HOHLRAUM



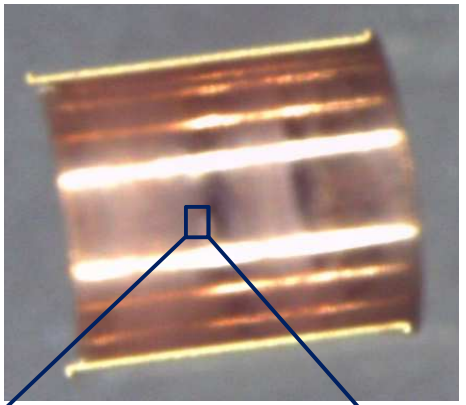
Copper (1.5 µm) on Al mandrel

Gold plating (30 µm) and aluminum chemical attack →

After Al release



After laser cutting



❑ MICROSTRUCTURE AND THICKNESS CONTROLLED BY FIB-SEM

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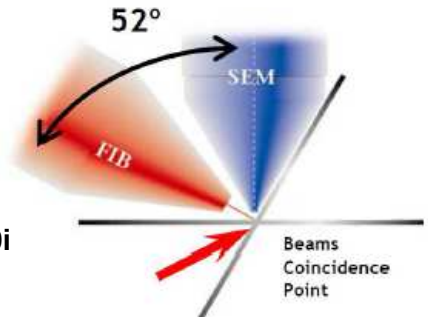
MIMENTO

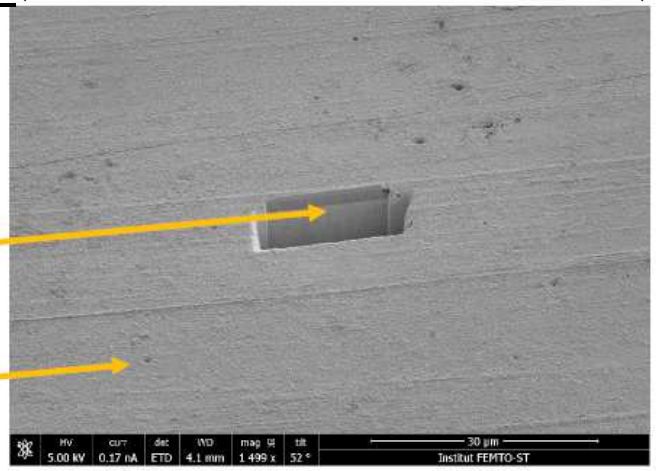
Technology Center

Equipment : FEI Helios Nanolab 600i



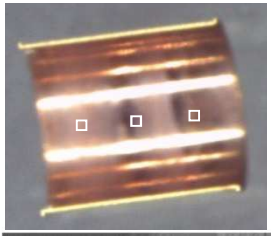
Ablation zone

Liner surface



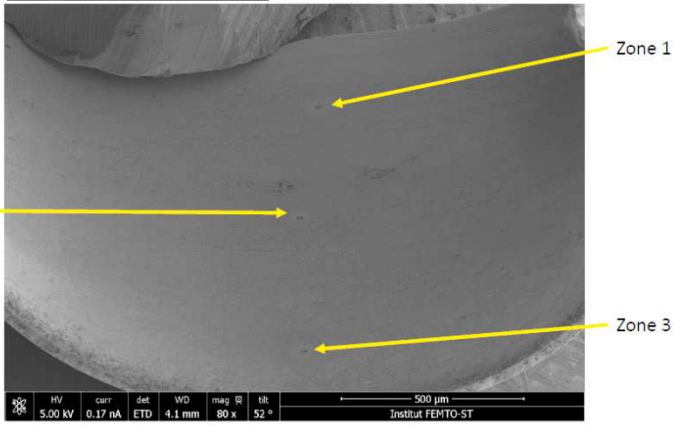
FEASIBILITY OF COPPER FULL LINER IN GOLD HOHLRAUM IS DEMONSTRATED

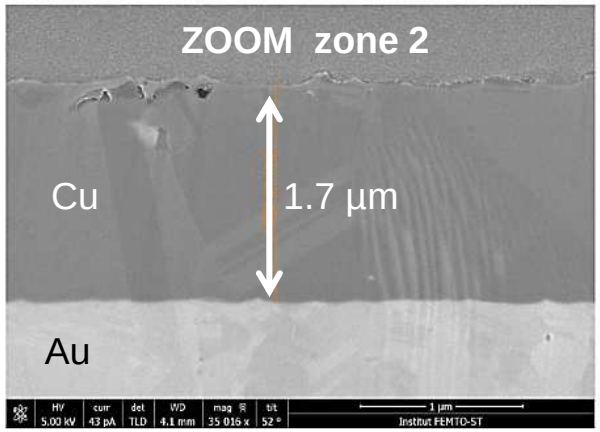
COPPER FULL LINER RESULTS

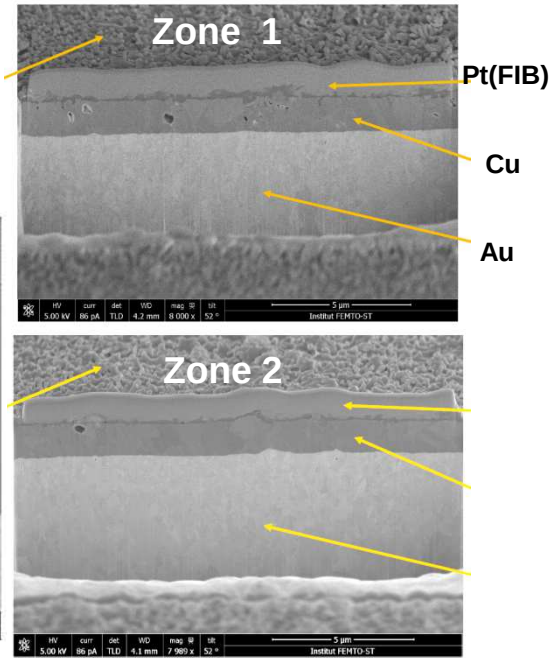


FIB preparation allows control

in 3 different areas along the hohlraum

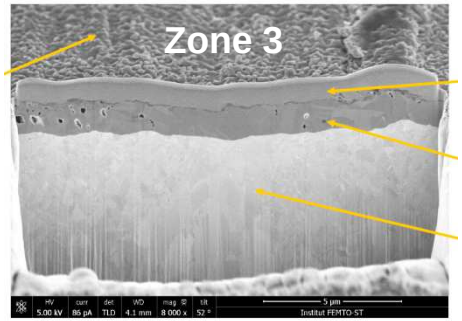






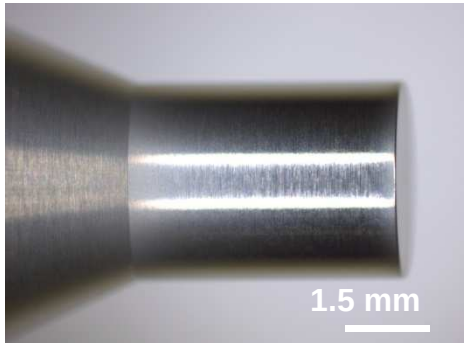
Observations:

- **few porosities are observables in zone 1 and 3 (shadow effect)**
- **microstructure is well dense in zone 2**
- **thickness is well uniform: 1.7 µm ± 0.2 µm (12%)**



FEASIBILITY OF COPPER FULL LINER IN GOLD HOHLRAUM IS DEMONSTRATED

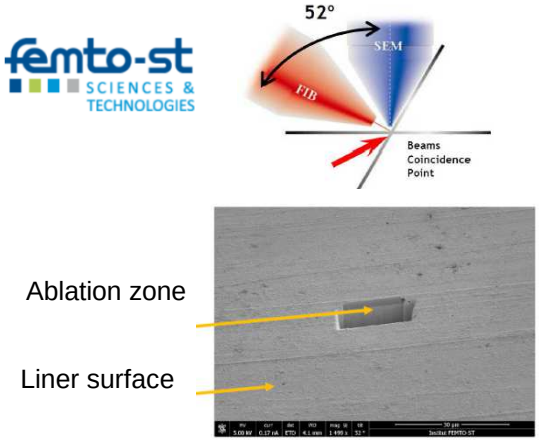
TITANIUM FULL LINER RESULTS

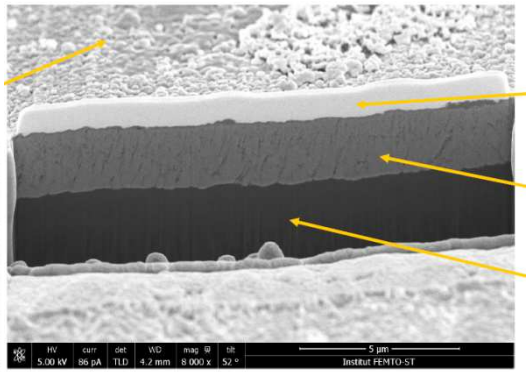


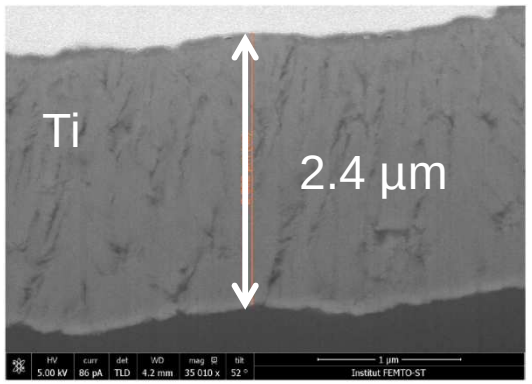
Titanium (2.5 µm) on brass mandrel

CHON coating and mandrel chemical attack

Ti liner in CHON hohlraum







Ti cross section (FIB-SEM)

Ti coating is well dense and thickness is uniform along the hohlraum

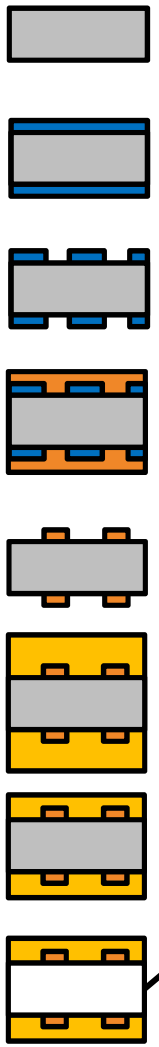
FEASIBILITY OF TITANIUM FULL LINER IN PLASTIC HOHLRAUM IS DEMONSTRATED

LOCALIZED LINER

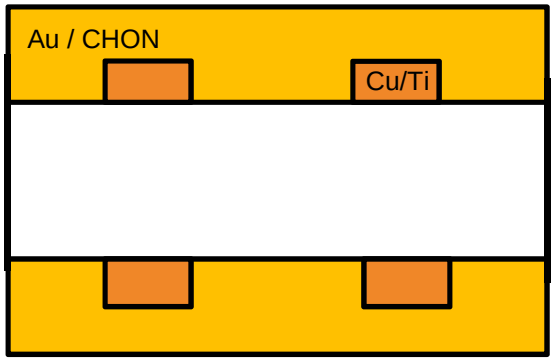
FABRICATION SYNOPTIC

Characterization

1. Mandrel machining
2. **Sacrificial layer**
3. **Laser machining**
4. Liner coating
5. **Sacrificial layer release**
6. Gold plating or plastic coating
7. Gold or plastic machining
8. Mandrel release



Laser setup

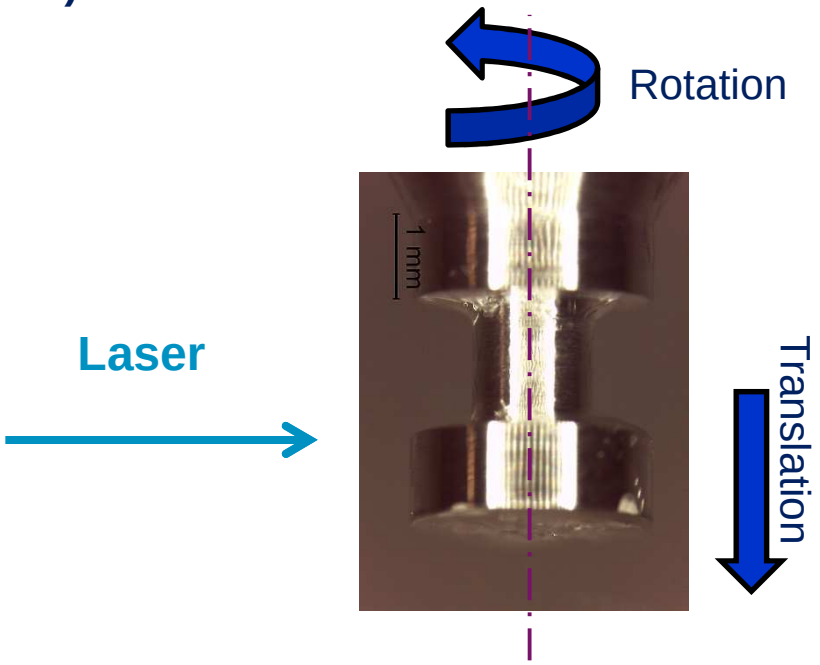


HOHLRAUM WITH LOCALIZED BURIED LINER

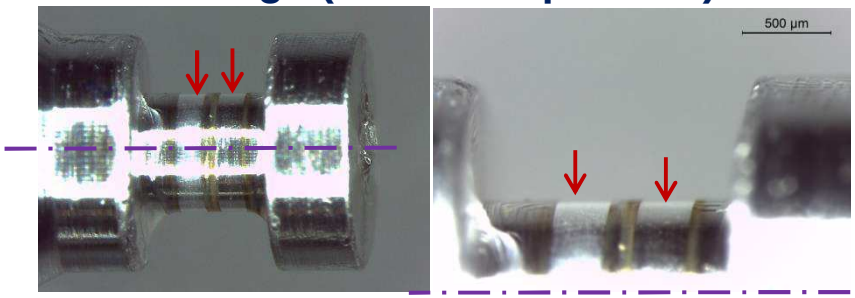
LASER SET-UP

Excimer ArF laser (193 nm, 350mJ/pulse, rate 50 Hz)

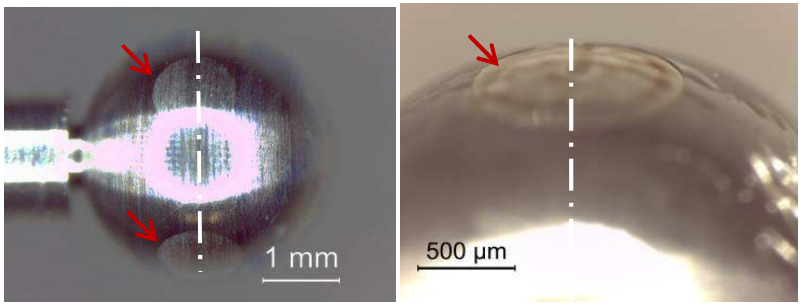
4 motorized axis (X,Y, Z, Θ)



2 rings (width~400µm/360°)



4 spots (∅ 800µm) on the equator

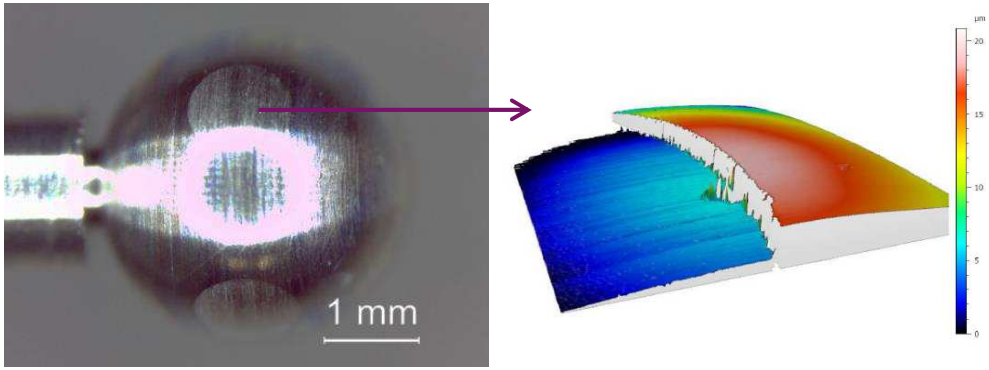


SELECTED ABLATION OF SACRIFICIAL POLYMER LAYER

LOCALIZED LINER RESULTS

CONTROL OF STEP HIGHER BY OPTICAL INTERFEROMETRY

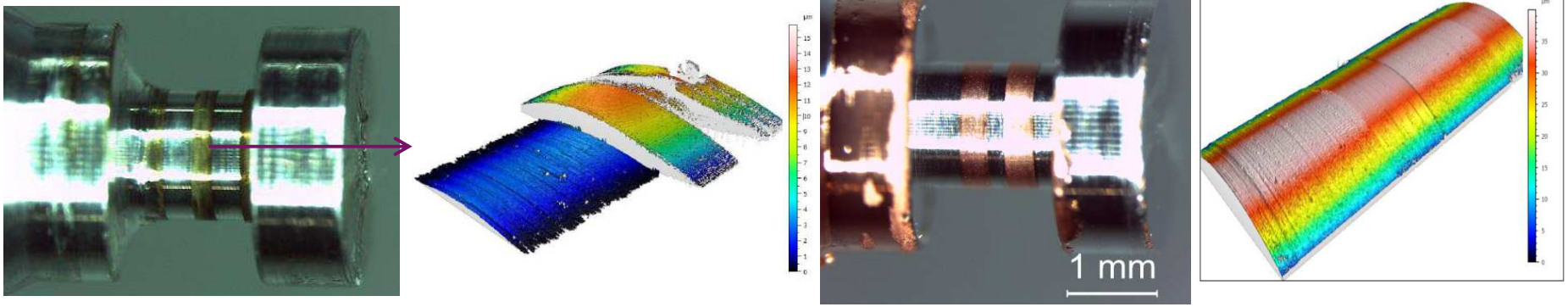
Al mandrel with localized polymer **3D cartography**



Polymer thickness > 10 µm

Initial roughness of mandrel is observable (i.e. polymer is completely ablated)

After liner coating and polymer removed



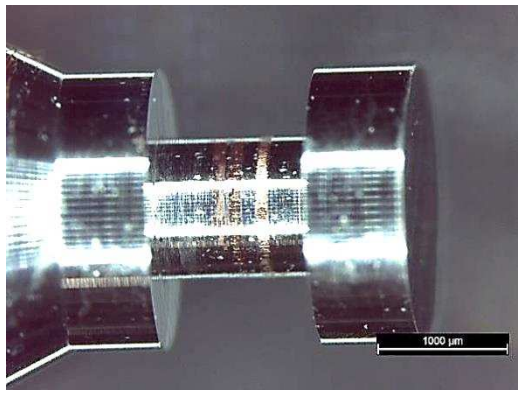
(polymer is lightly colored)

COPPER RINGS ARE COMPLETE (w=400µm and t=1.6µm)

CHARACTERIZATION OF LOCALIZED LINER IS NOT A PROBLEM

LOCALIZED LINER RESULTS

Cu rings on Al mandrel

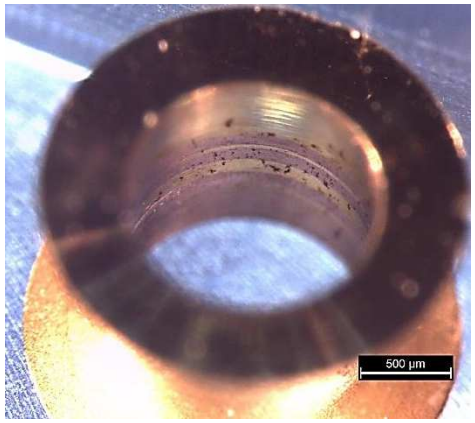


(w=130µm/360°)

Gold plating (30 µm)

and

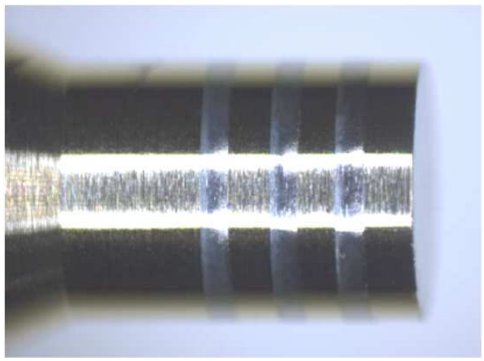
aluminum chemical attack



Localized rings of Cu in Au hohlraum

« copper rings still present but partially dissolved »

Ti rings on brass mandrel



(w=400µm/360°)

CHON thermosetting resin
and
mandrel chemical attack

Localized rings of Ti in CHON hohlraum

« Ti rings are well transferred but a weak adherence is observed at Ti/CHON interface»

CONCLUSION / PERSPECTIVES

FEASIBILITY OF FULL LINER IS DEMONSTRATED:

- **Cu 1.7 µm thick in Au hohlraum:** *yield 30%*
- **Ti 2.5 µm thick in CHON hohlraum:** *yield 100%*

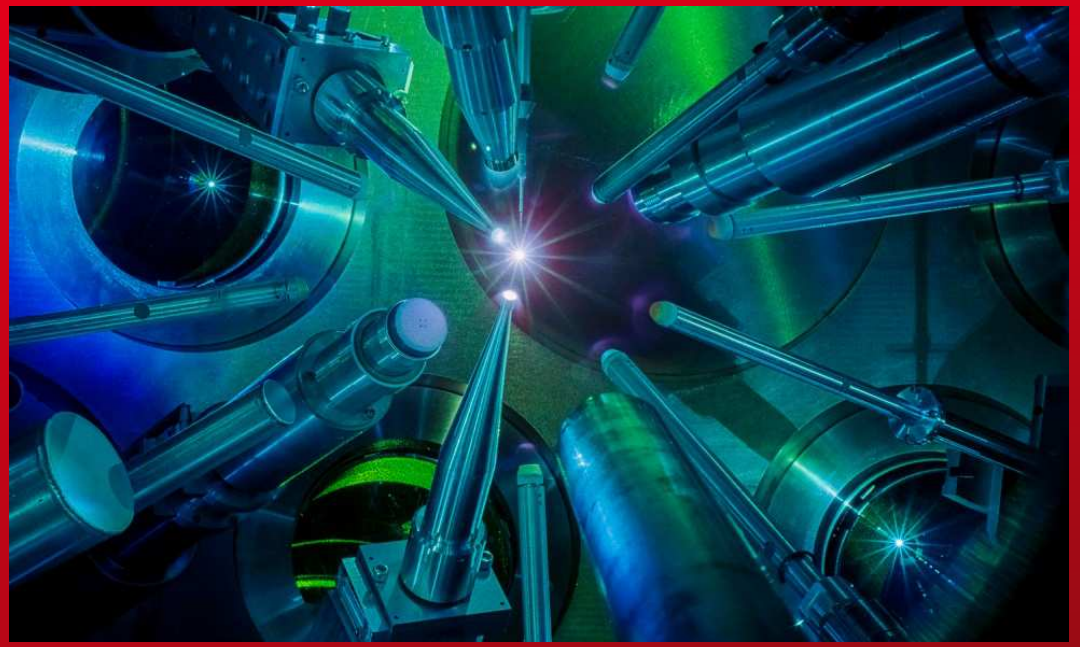
FEASIBILITY OF LOCALIZED LINER HAVE TO BE CONSOLIDATED:

- **Cu in Au hohlraum:** *partially dissolved*
- **Ti in CHON hohlraum:** *partially peeled-off*

PERSPECTIVES:

- **Increase yield in case of copper:** [HCl], T°, mandrel nature, …
- **Improve adhesion at Ti/CHON interface:** stress, ion gun treatment, primer coating, …
- **Development of a non-destructive method to control liner:** X-ray tomography, …
- **Aging and environment stability studies**

Thank you !



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