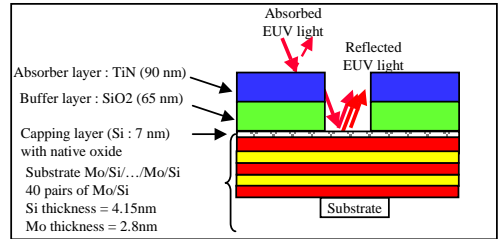


In the frame of "EXTUMASK", a MEDEA+ program, CEA/LETI is involved in the design and in the fabrication of the absorber stack for Extreme Ultraviolet (EUV) mask. Masks with a TiN/SiO<sub>2</sub> buffer stack have been completed. In order not to damage the (Mo/Si) multilayer, the temperature during the different processes must not exceed 150°C. Standard resist stripping processes are done in high temperature (around 250°C) downstream plasma asher. A different approach was studied, using an oxygen biased plasma low temperature process. The performances of various stripping processes were compared. Characterizations like SIMS analyses, thickness measurements, roughness and reflectivity measurements were carried out. All these analyses enabled us to choose a stripping process which limits modifications of the TiN, SiO<sub>2</sub> and Silicon layers and to define a new technological process sequence.

### Structure of the mask



### Criteria for selecting the best stripping process

- Temperature < 150°C in order not to damage the (Mo/Si) mirror
- No modification of the TiN layer (roughness, thickness)
- No modification of the SiO<sub>2</sub> layer
- No modification of the Silicon capping layer
- No contamination
- No resist residues left

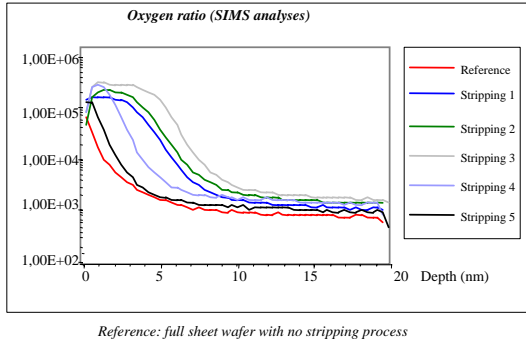
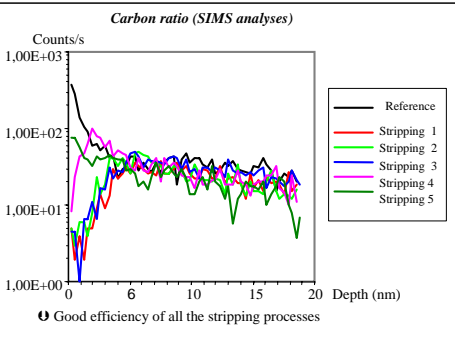
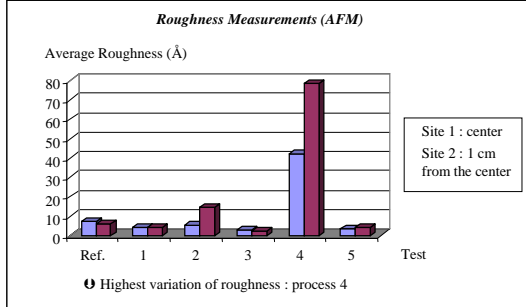
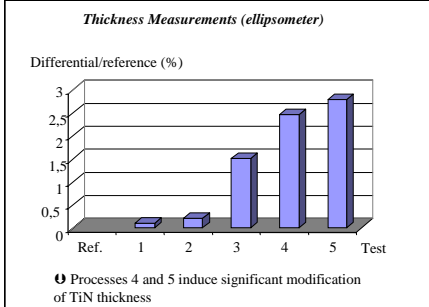
### Presentation of various stripping processes

- 3 types of tools are used :
- A : a dry stripping tool (RIE)
  - B : a wet stripping tool
  - C : a dry etching tool

The process named "α process" is an O<sub>2</sub>/Ar/CF<sub>4</sub> based-process

Trial	Tool	Process	Total time of process	Maximum temperature measured
1	A	α process	190 s.	< 60°C
2	A	α process	117 s.	< 60°C
3	C	pure O <sub>2</sub>	40 s.	< 90°C
4	A	α process modified (higher percentage of CF <sub>4</sub> )	154 s.	< 60°C
5	A + B	α process + EKC 265	170 s. + 10 min.	< 70°C

### Impact of the stripping processes on the TiN layer



### Choice of the stripping processes

- Processes 4 : highest roughness level
- Process 3 : highest oxidation rate on the TiN surface
- Process 5 : the wet stripping process removes Ti<sub>2</sub>O<sub>3</sub> (see thickness and oxidation measurements)

←  
Selected Processes : 1 and 2

### Impact of the process 1 on the SiO<sub>2</sub> and Si layer

#### On SiO<sub>2</sub> :

- Little thickness modification (variation less than 2%)
- Little roughness modification (less rough)

#### On Silicon :

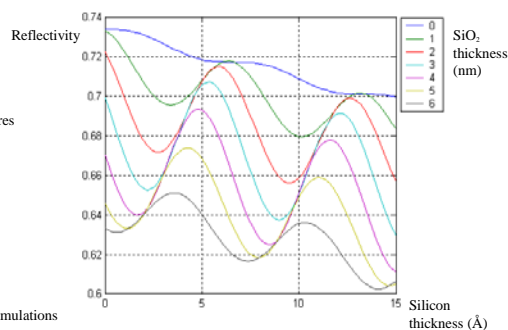
Strong oxidation due to stripping process : tests on SOI structures

Thickness (Å)	Before stripping	After stripping (process 1)
SiO <sub>2</sub>	12,68	84,82
Si	2081,66	2 054,65
SiO <sub>2</sub>	3977,25	3 982,37

Impact of oxidation of the silicon capping layer : assessed by simulations

An oxidation of 50Å induces a reflectivity loss of about 10%

● The stripping step must be carried out before the complete etching of the absorbing stack.



### Conclusions

- A specific stripping process was developed: it is an oxygen biased plasma low temperature process.
- The performances of various stripping processes on TiN, SiO<sub>2</sub> and Si were compared; characterizations were carried out and enabled us to choose the most appropriate stripping process.
- Due to ion bombardment, this best stripping process produces an oxidation of the silicon layer of about 50 Å. So the stripping step must be carried out before the complete etching of the absorbing stack: a new technological process sequence was defined.

### Acknowledgments

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