Chamber Walls Coatings During Patterning of Dielectric Damascene Structures With a Metal Hard Mask:

Consequences on Cleaning Strategies

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Outline

- Introduction

- Experimental setup

    - Stack used and etch process flow
    - Etching reactors

- Chamber walls coating and cleaning procedure

    - after metallic hard mask opening
    - after dielectric etching
    - impact of chamber walls material

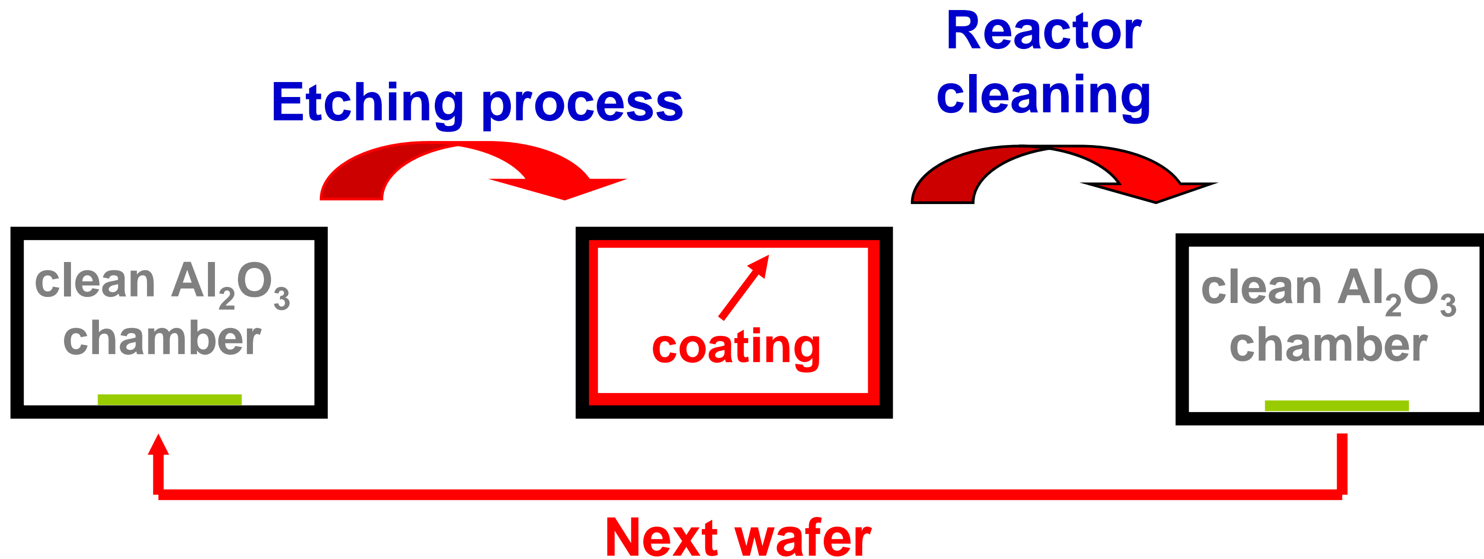
- Conclusion

Introduction (1)

Plasma patterning performances strongly depend on chamber walls stability that can be altered by wafer processing.

- process drifts
- particles formation
- metallic contamination

Today's industrial strategy

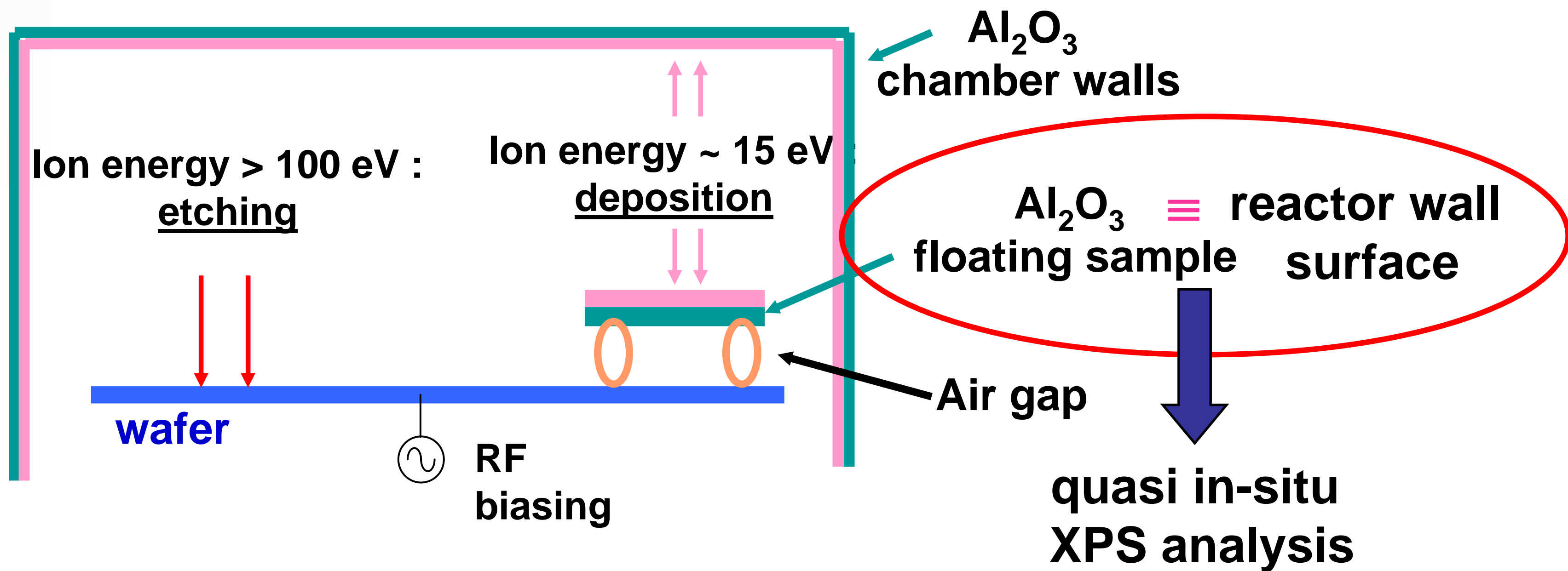


➔ acceptable wafer-to-wafer reproducibility

Introduction (2)

How to characterize chamber walls coating ?

➔ **The air gap technique**: Al_2O_3 floating sample fixed on top of the wafer



Chemical nature (and thickness) of the **coatings on the chamber walls**

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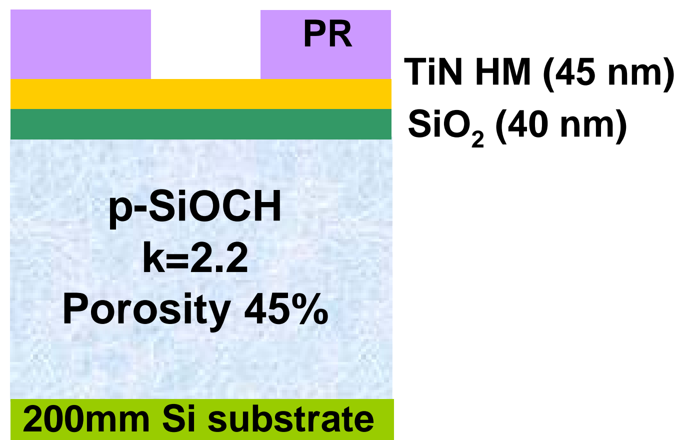
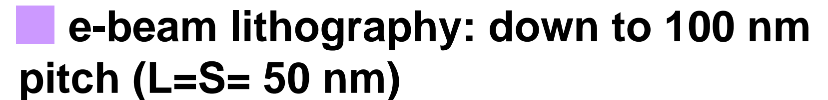
Experimental setup (1)

Patterning of damascene structures with metallic hard mask

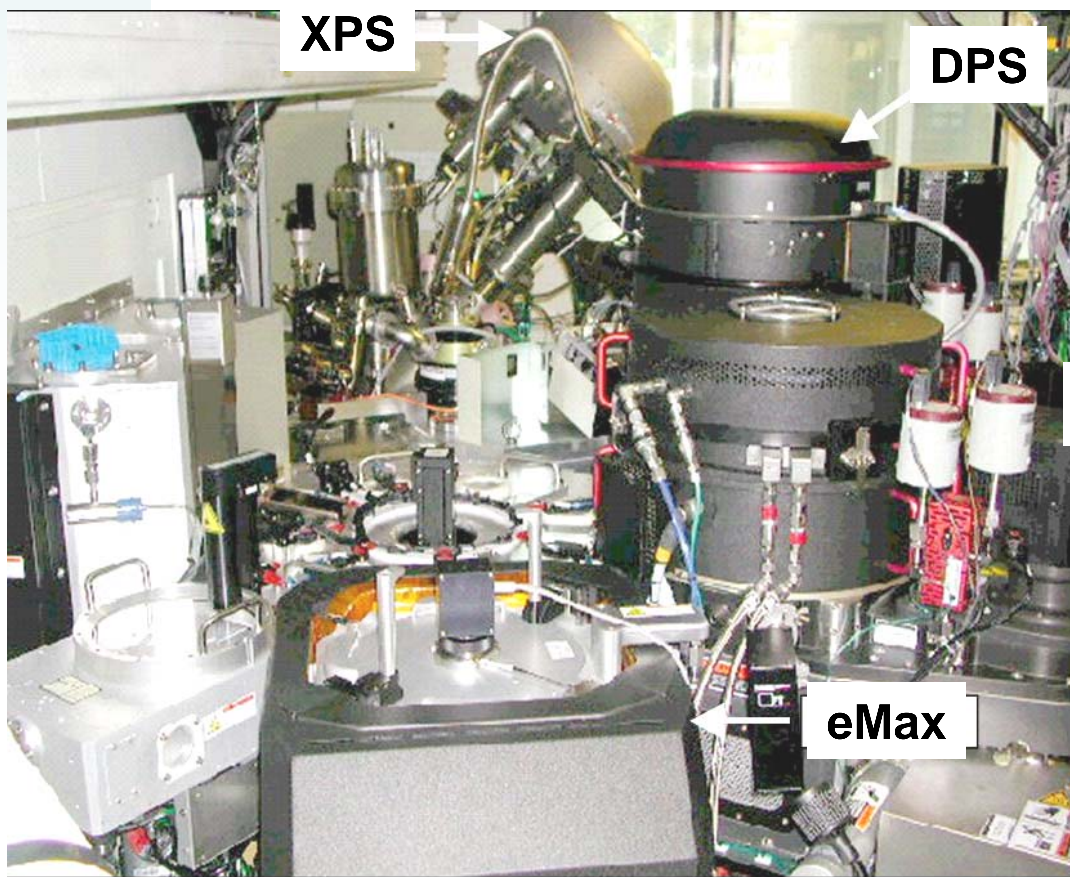


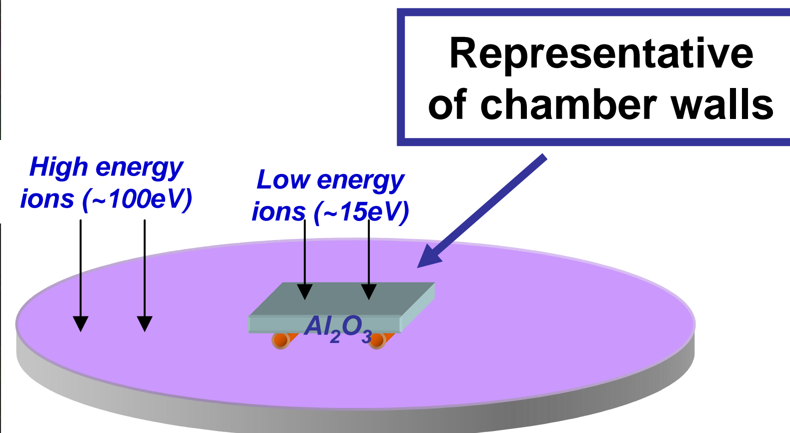


- ❑ TiN hard mask opening step (Cl_2/Ar plasma) in a silicon etcher (ICP)
- ❑ Ash step (O_2 plasma) in a silicon etcher
- ❑ SiO_2 and low-k etching (FC plasma) in an oxide etcher (MERIE)

Experimental setup (2)

200 mm Centura Platform 5200B (AMAT)





- ❑ Air gap thickness is chosen to prevent RF biasing for each etcher
- ❑ Etching time is adjusted to minimize the Al_2O_3 sample temperature that must be close to the chamber walls temperature

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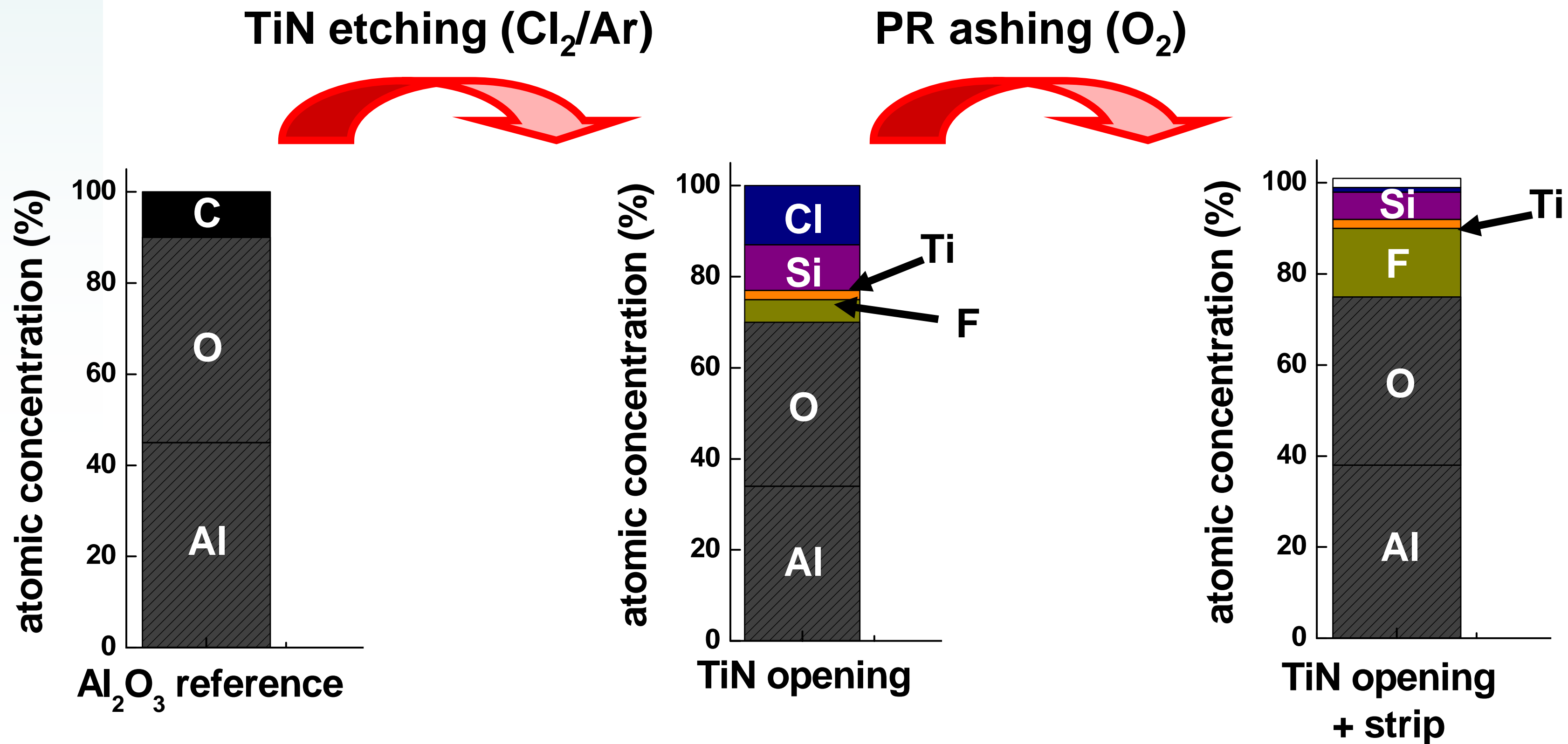
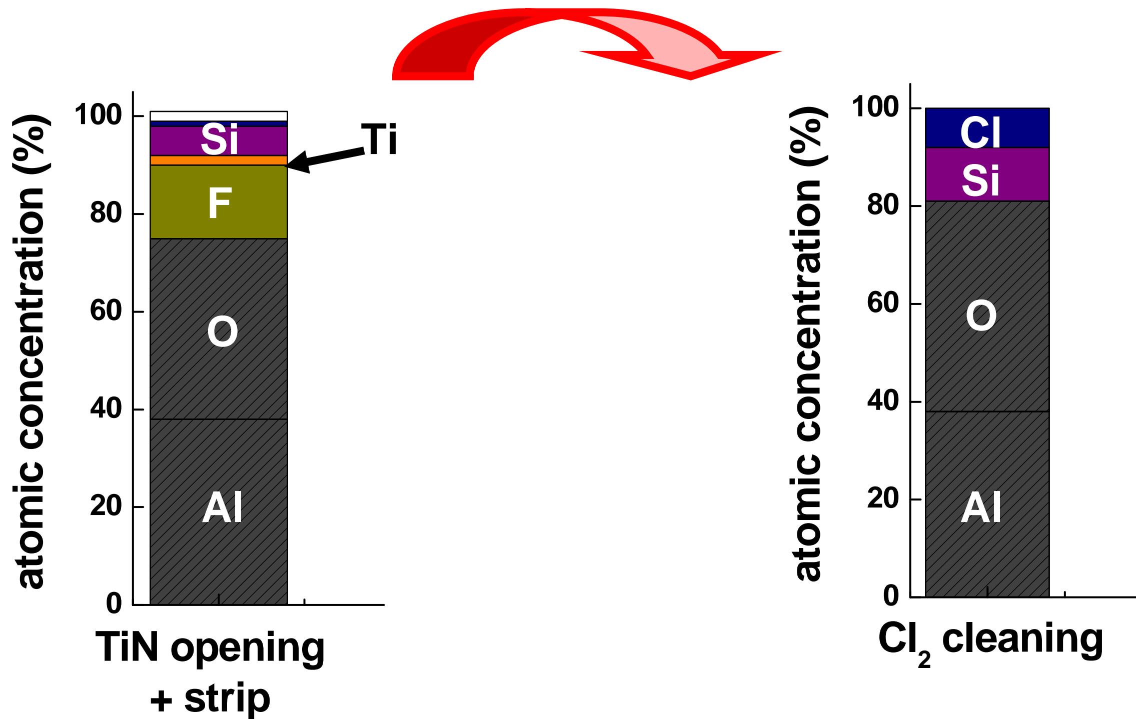
Chamber walls coating after TiN opening



- Thin Ti containing SiOCl layer after TiN etching
- Thin SiO_x/TiO_x mixed layer after TiN etching and PR removal
- F coming from AlF species sputtered from chamber walls

Cleaning procedure after TiN opening

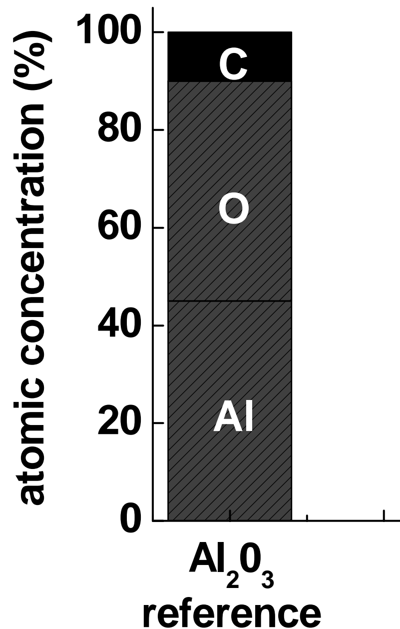
Removal of Ti compounds from chamber walls

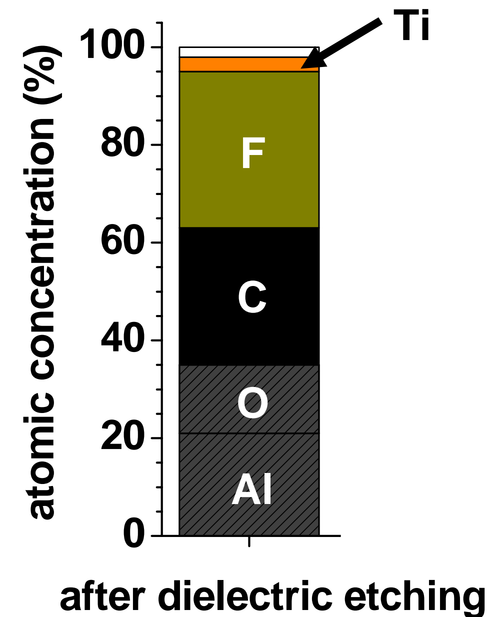


- Cl_2 plasma removes Ti compounds from chamber walls
- Two step cleaning procedure in the silicon etcher
  - Cl_2 plasma
  - SF_6/O_2 plasma

Chamber walls coating after dielectric etching

dielectric etching in the oxide etcher
($CF_4/CH_2F_2/Ar$)

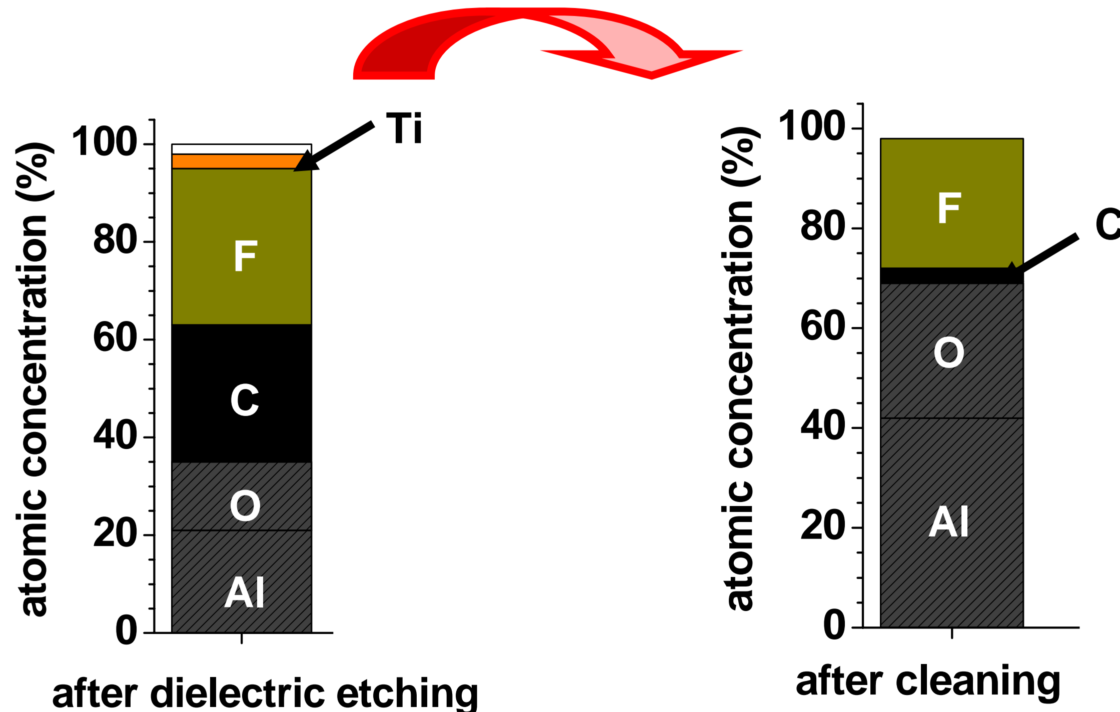




❑ Thick Ti containing FC layer after dielectric etching

Cleaning procedure after dielectric etching

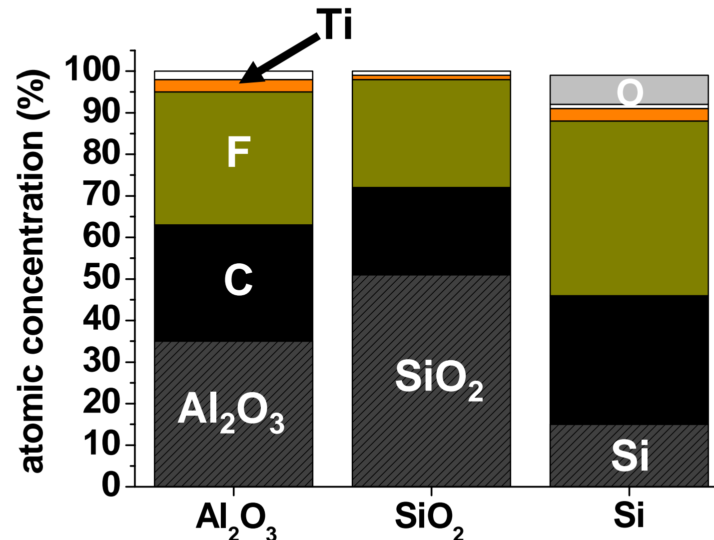
Removal of Ti compounds from chamber walls



- ❑ SF_6 plasma removes Ti compounds from chamber walls
- ❑ Two step cleaning procedure in the oxide etcher
  - SF_6 plasma
  - O_2 plasma

Impact of chamber walls material on coating

After dielectric etching ($CF_4/CH_2F_2/Ar$)



- ❑ Ti containing FC layer whatever chamber walls material
- ❑ Nature of the coating independent of chamber walls material

Conclusion

Patterning of damascene structures with TiN hard mask

❑ **TiN opening step in a silicon etcher (ICP reactor)**

- **Thin SiO/TiO mixed layer after etching in Cl_2 plasma and O_2 strip**
- **two step cleaning procedure (Cl_2 and SF_6/O_2 plasmas)**

❑ **Dielectric etching in an oxide etcher (MERIE reactor)**

- **Ti containing FC layer in a FC plasma**
- **two step cleaning procedure (SF_6 and O_2 plasmas)**

❑ **Nature of the coatings independent of chamber walls material**