

Synthesis of metastable W-O and W-N films and nanostructure growth induced by thermal and laser annealing

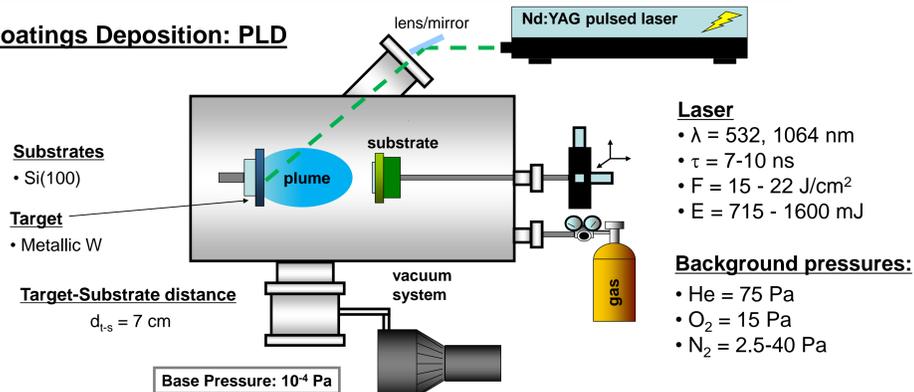
Aims & Motivations

Tungsten compounds, oxides and nitrides, are widely studied and find application in several technology fields.

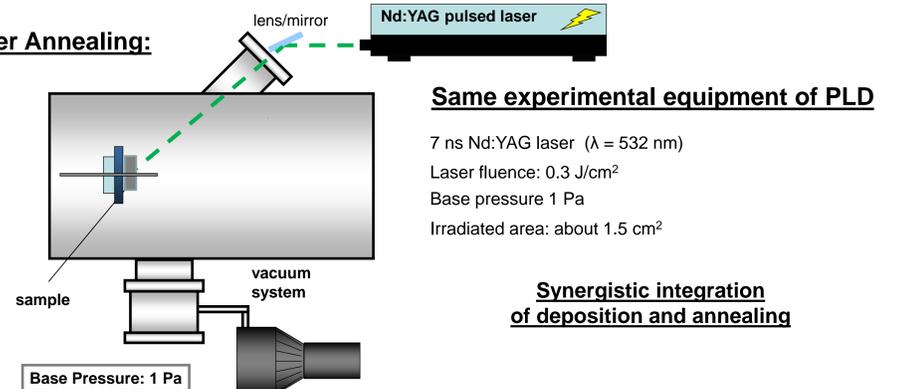
- **WN_x** → high thermal stability, hardness and low electrical resistivity → **barrier layer and gate electrodes** in integrated circuits.
- **WN_x** → wear resistant and hard coatings → in **nano-mechanical systems**.
- **WO_x** → electronic and optical properties → **electrochromic devices, water splitting**.
- Oxygen deficient W-oxide phases (e.g. W₁₈O₄₉) → **catalysts**.
- In nuclear fusion, both WN_x and WO_x coatings may be formed on W in tokamaks → modification the properties of the plasma-facing components.

Pulsed Laser Deposition & Laser Annealing

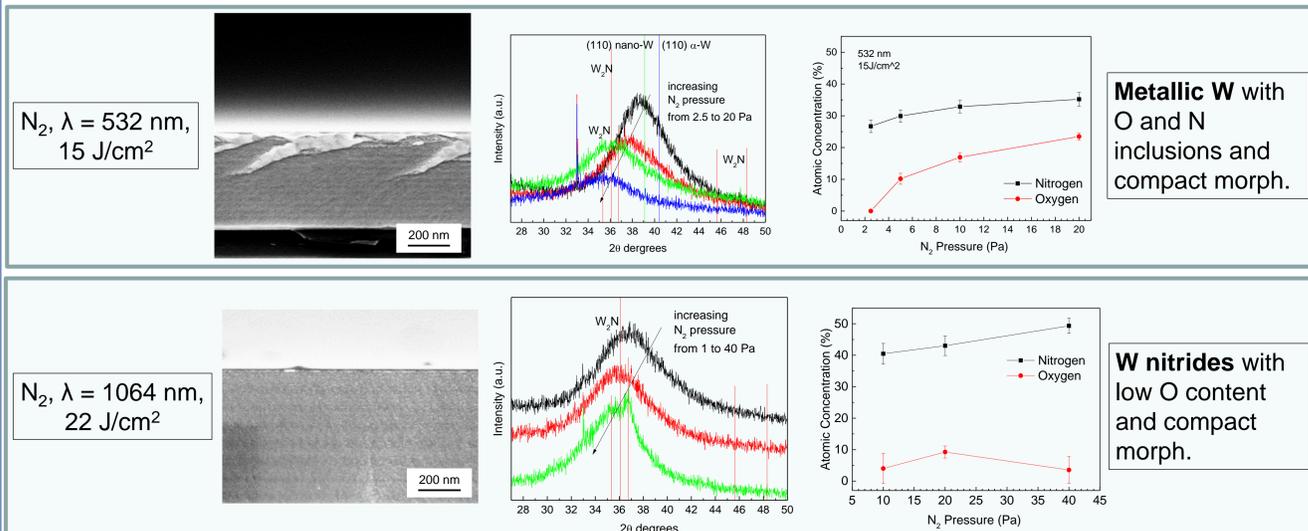
Coatings Deposition: PLD



Laser Annealing:

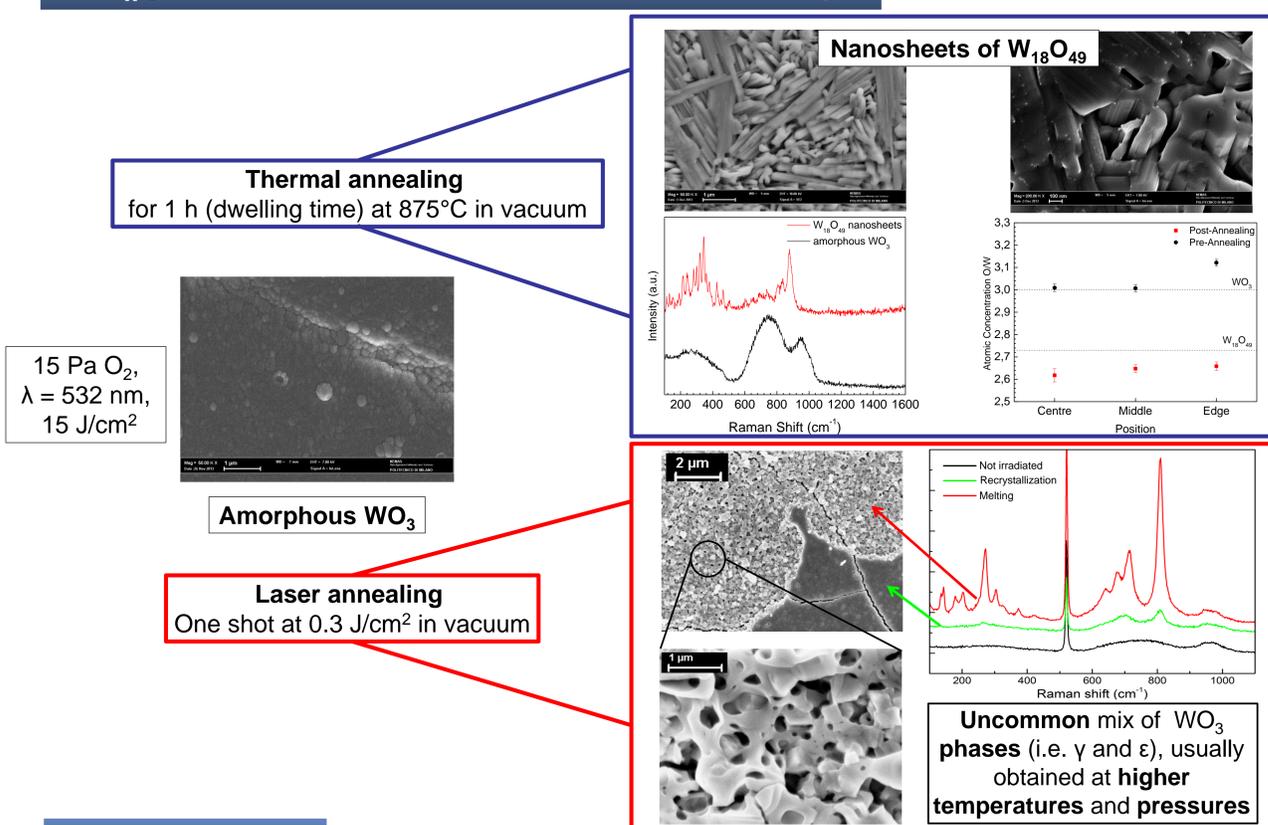


PLD of W(O,N) vs WN_x - role of laser wavelength

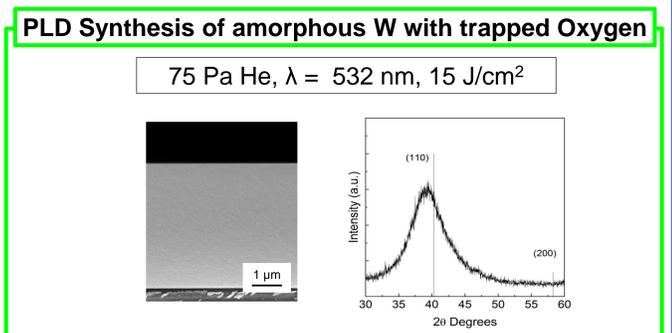


Laser wavelength and fluence enhance reactivity of the background atmosphere leading to the formation of nitrides

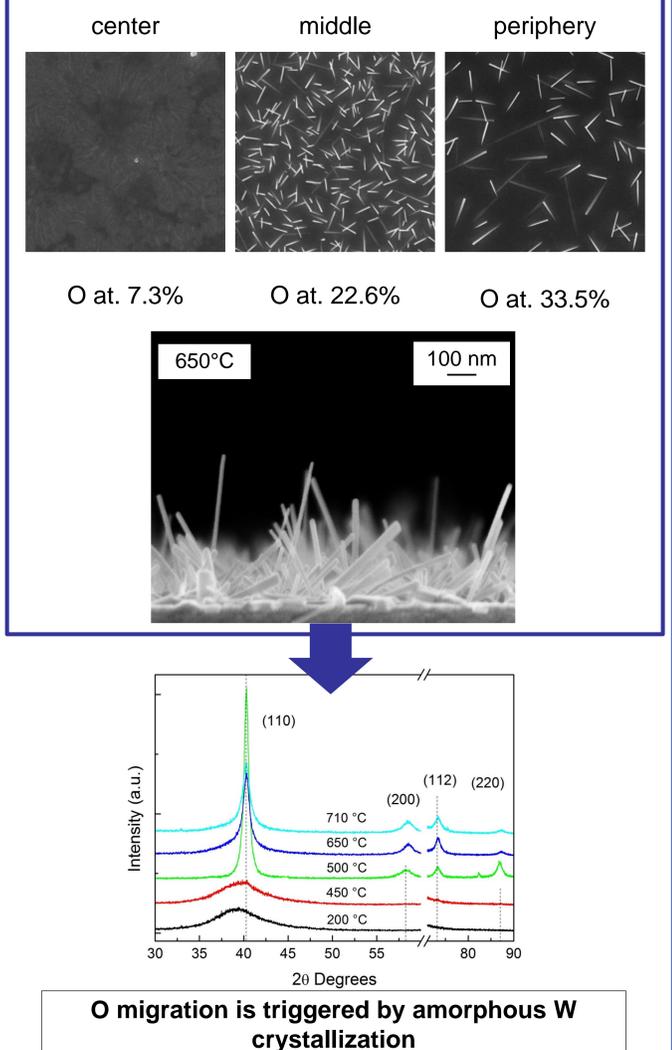
WO_x production + thermal and laser annealing



W(O) films - WO_x nanowire growth



Annealing at 500°C – 650°C leads to O migration and W₁₈O₄₉ nanowire growth



Conclusions

Thanks to the features of nanosecond Pulsed Laser Deposition in presence of a process gas, we deposited:

- metallic tungsten (W) with gas inclusions (O,N).
 - W oxide (WO_x) and W nitride (WN_x) compounds.
- Annealing of these metastable systems leads to the formation of interesting nanostructures.
- A proper thermal annealing of W(O) and WO_x induces respectively the growth of:
- tungsten oxide nanowires protruding out from the surface.
 - bundles of W₁₈O₄₉ nanosheets.
- Laser annealing of WO_x results in the crystallization of different phases of WO₃ that are usually obtained at high T and P.

References:

- [1] A. Pezzoli et al., J. Nucl. Mater. 463 pp. 1041 (2015)
- [2] D. Dellasega et al., Nanotechnology 26 (2015)
- [3] Hayashi et al., J. Phys. Soc. Jpn. 61, 916 (1992)
- [4] Souza Filho et al., Phys Rev B, 62 (2000) pp. 3699

