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

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**Aims & Motivations**

Tungsten compounds, oxides and nitrides, are widely studied and find application in several technology fields.
- WN\textsubscript{x} → high thermal stability, hardness and low electrical resistivity → barrier layer and gate electrodes in integrated circuits.
- WN\textsubscript{x} → wear resistant and hard coatings → in nano-mechanical systems.
- WOX = electronic and optical properties → electrochromic devices, water splitting.
- Oxygen deficient W-oxide phases (e.g. W\textsubscript{18}O\textsubscript{49}) → catalysts.
- In nuclear fusion, both WN\textsubscript{x} and WOX 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:**

Same experimental equipment of PLD

**W(0,N) films - WN\textsubscript{x} nanowire growth**

**PLD of W(O,N) vs WN\textsubscript{x} - role of laser wavelength**

- \( N_2, \lambda = 532\text{ nm}, 15\text{ J/cm}^2 \)
- \( N_2, \lambda = 1064\text{ nm}, 22\text{ J/cm}^2 \)

**WO\textsubscript{x} production + thermal and laser annealing**

**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\textsubscript{x}) and W nitride (WN\textsubscript{x}) compounds.

Annealing of these metastable systems leads to the formation of interesting nanostructures.
A proper thermal annealing of W(O) and WOX induces respectively the growth of:
- tungsten oxide nanowires protruding out from the surface.
- bundles of W\textsubscript{18}O\textsubscript{49} nanosheets.

Laser annealing of WOX results in the crystallization of different phases of WO\textsubscript{3} that are usually obtained at high T and P.

References:

**www.ensure.polimi.it**