



**POLITECNICO**  
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# Growth of nanostructured $\omega$ -phase titanium films deposited by biased HiPIMS

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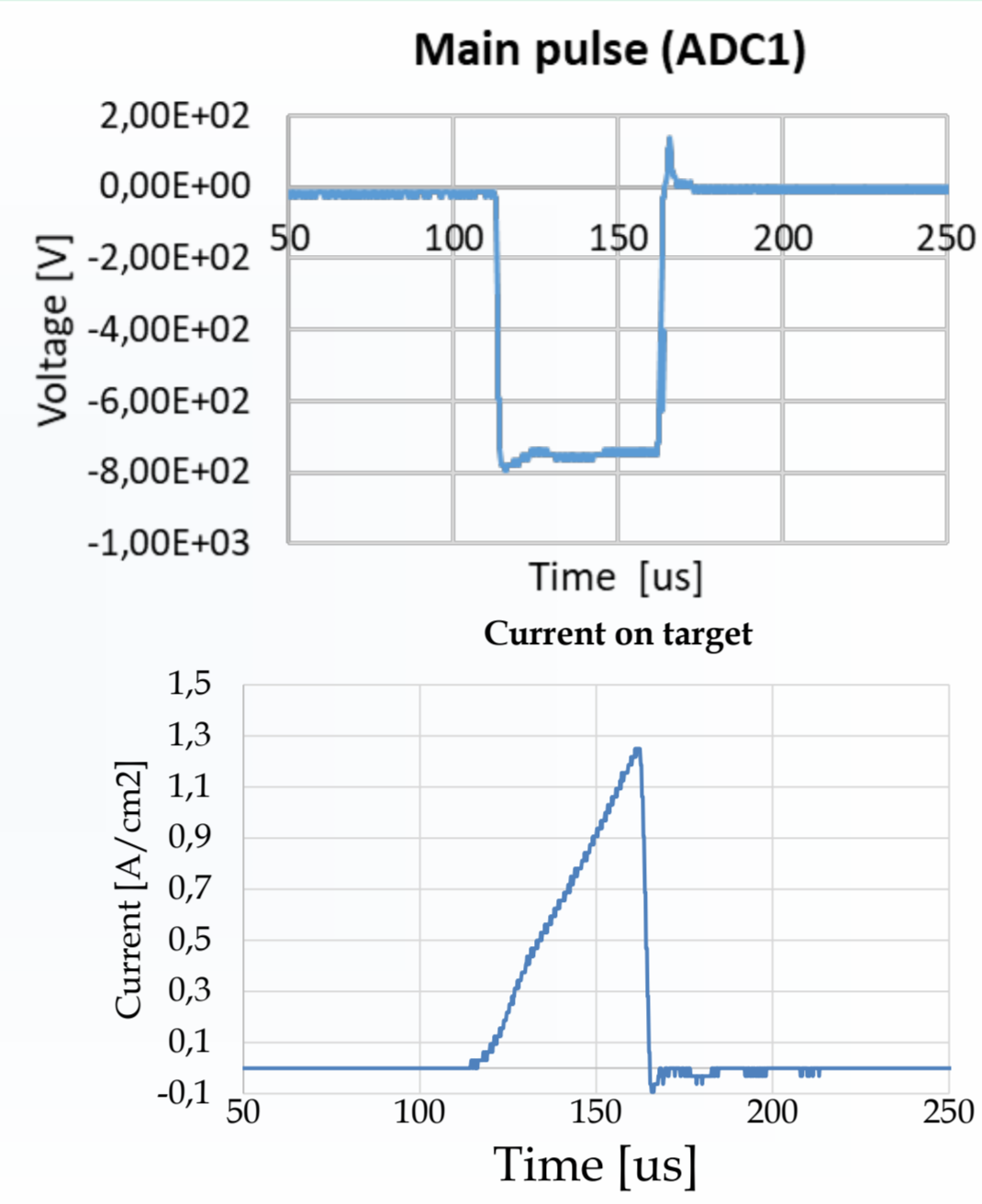
## Aim and Scopus

Ti films have been extensively studied and exploited in various fields such as in aerospace, production of medical implants, microelectronics and as adhesion layer for Ti oxides and nitrides. Despite the huge interest on this topic there are few works related to Ti metallic films deposited by HiPIMS. In the present work we report the deposition of Ti films at various bias voltages.

## Deposition Parameters

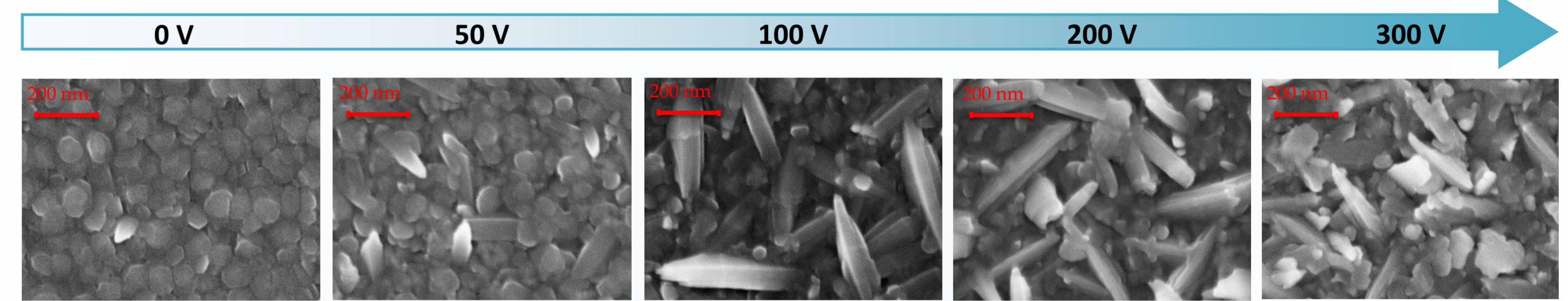
- **Target:** Ti - 2' diameter
- **Substrate:** Si (100)
- **Ambient gas:** Ar
- **Background pressure:** 3 - 6 E-07 mBar
- **Working pressure:** 5 E-03 mBar
- **Gas flux:** 80 sccm
  - $t_{on} = 50 \mu s$
  - $t_{off} = 2800 \mu s$
  - Duty cycle = 1.75 %
  - Frequency = 350.88 Hz
  - $t_{tot} = 30 \text{ min} \rightarrow 240 \text{ min}$

- ADC1:
  - Voltage = 790 V
  - Current = 0.5 A
  - Power = 450 W
- ADC2:
  - Voltage = 0 - 300 V

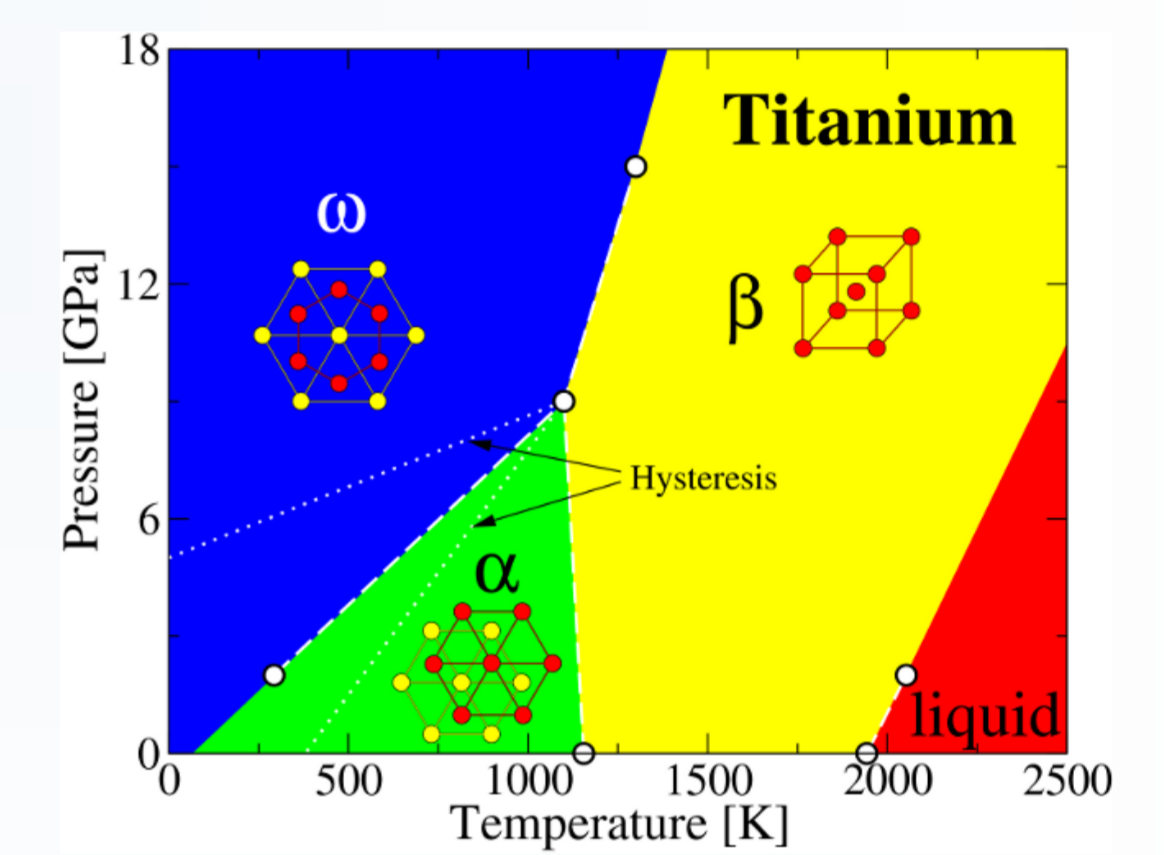
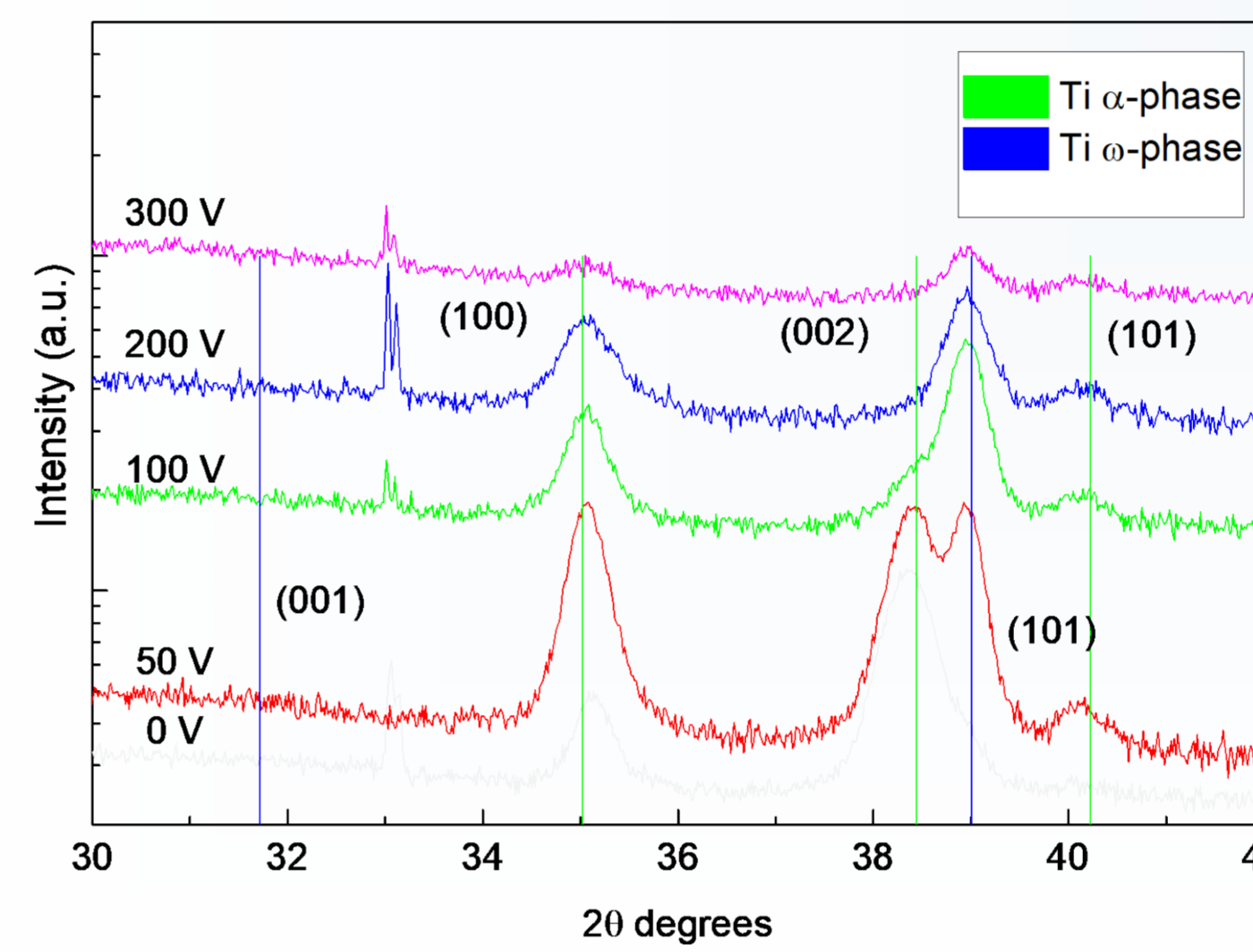


## Effect of Bias Voltage on Ti deposition with HiPIMS

### SEM analysis:

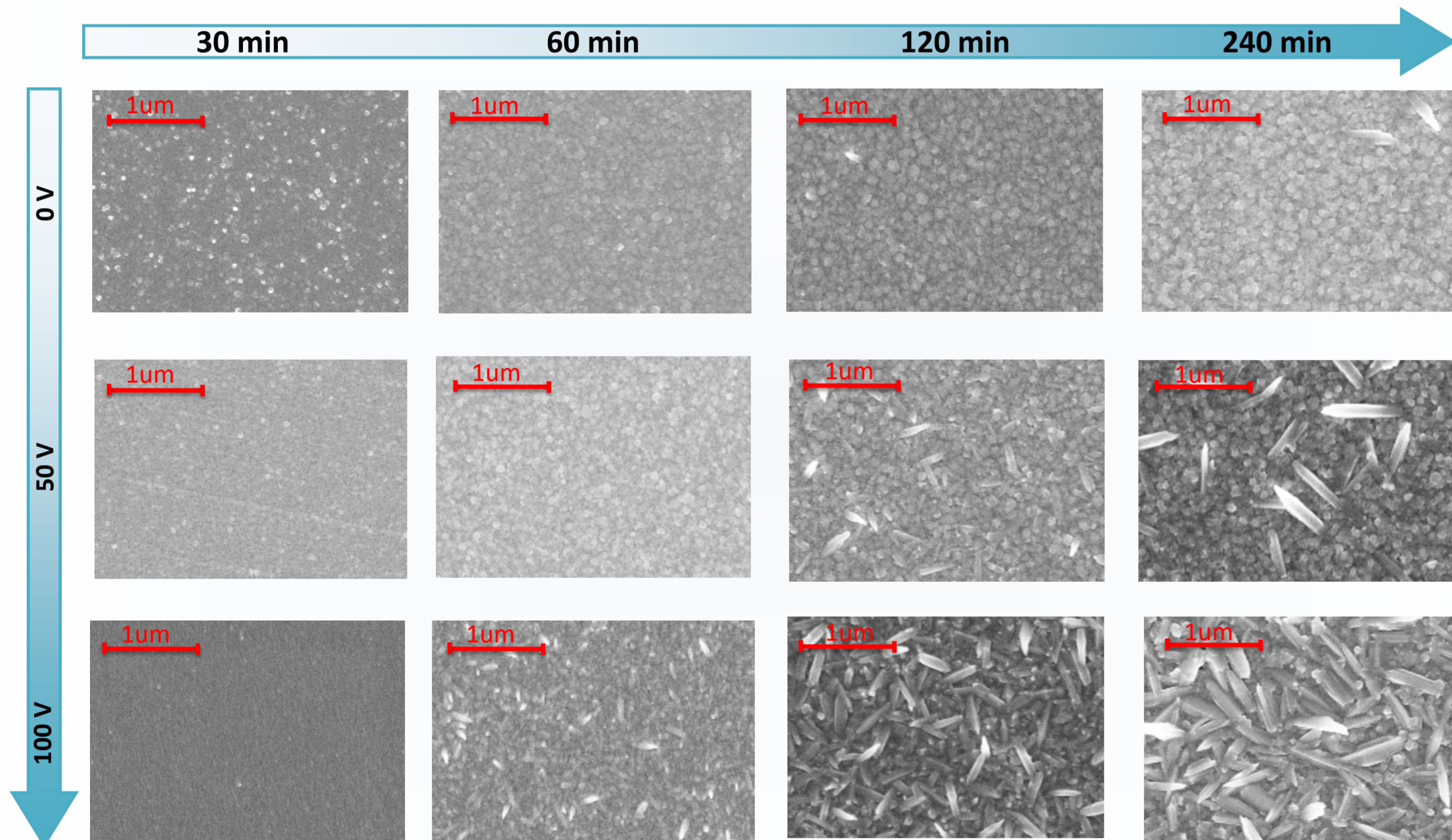


### XRD analysis:



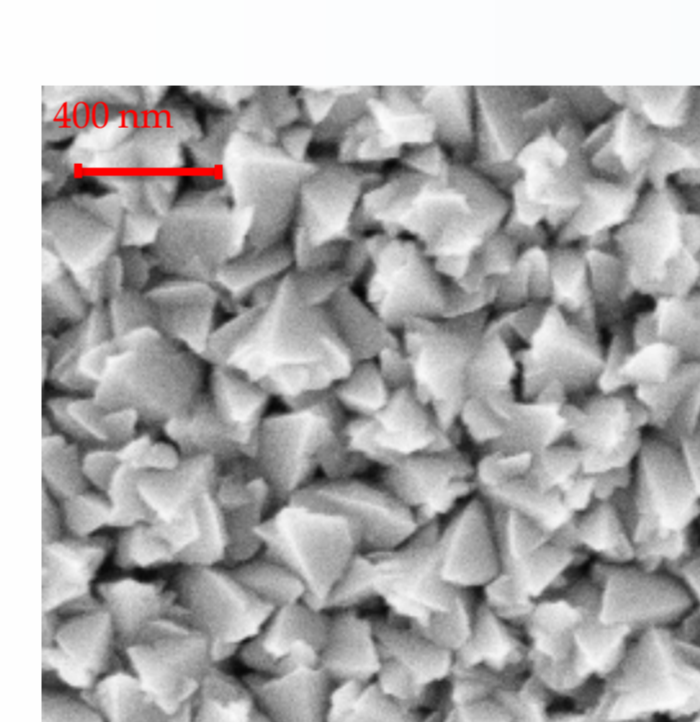
- Nucleation of hexagonal  $\omega$  phase!!
- Max at 100 V
- At 200 - 300 V  $\rightarrow$  low crystallinity

## Effect of Bias Voltage & Deposition time: morphology

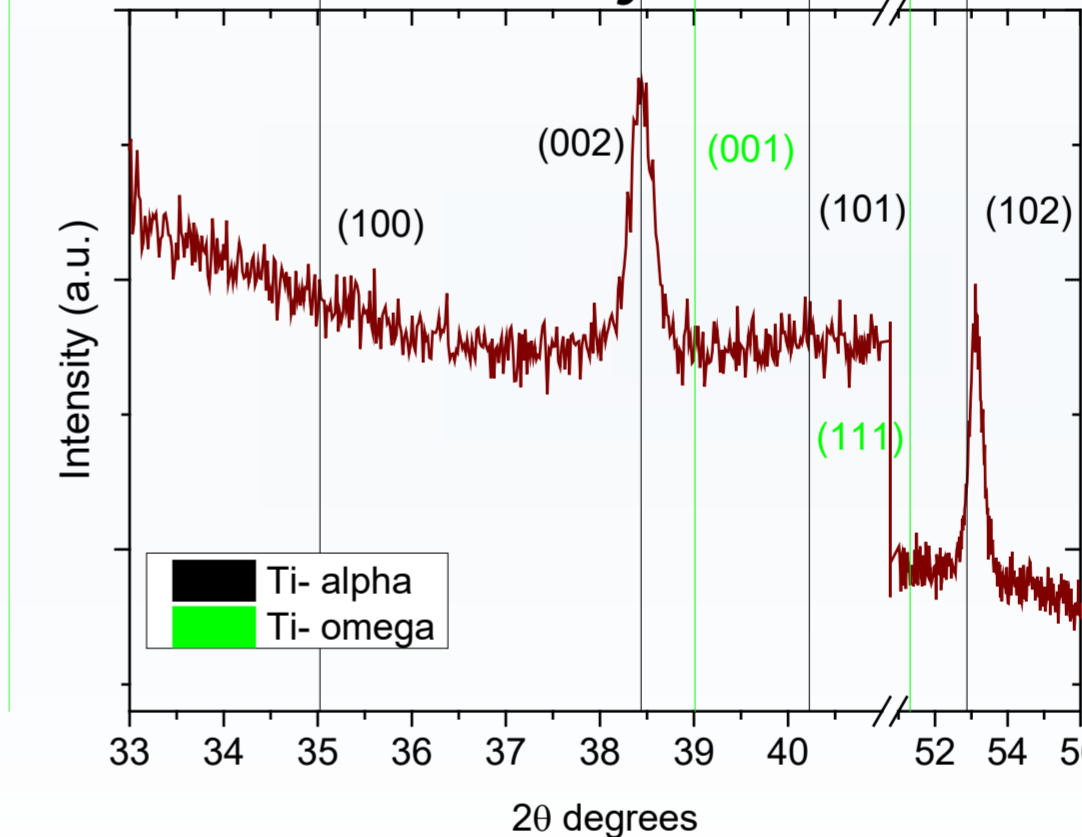


## Ti deposition with DC Magnetron Spattering

### SEM analysis:



### XRD analysis:

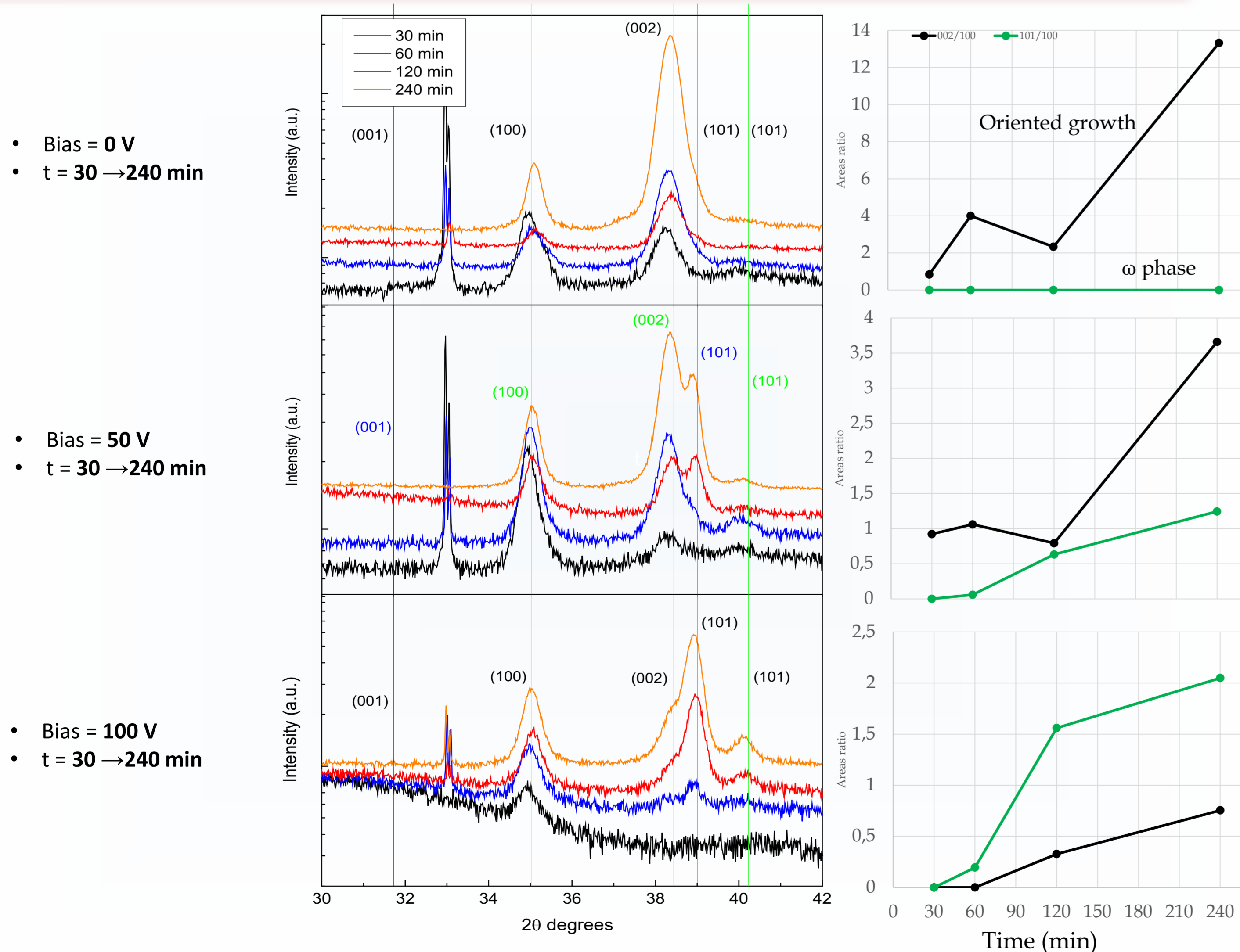


- Cauliflower growth
- Mainly oriented along (002) and (102)

### DC:

- $t_{tot} = 60 \text{ min}$
- Voltage = 440 V
- Current = 1 A
- Power = 450 W

## Effect of Bias Voltage & Deposition time: structure



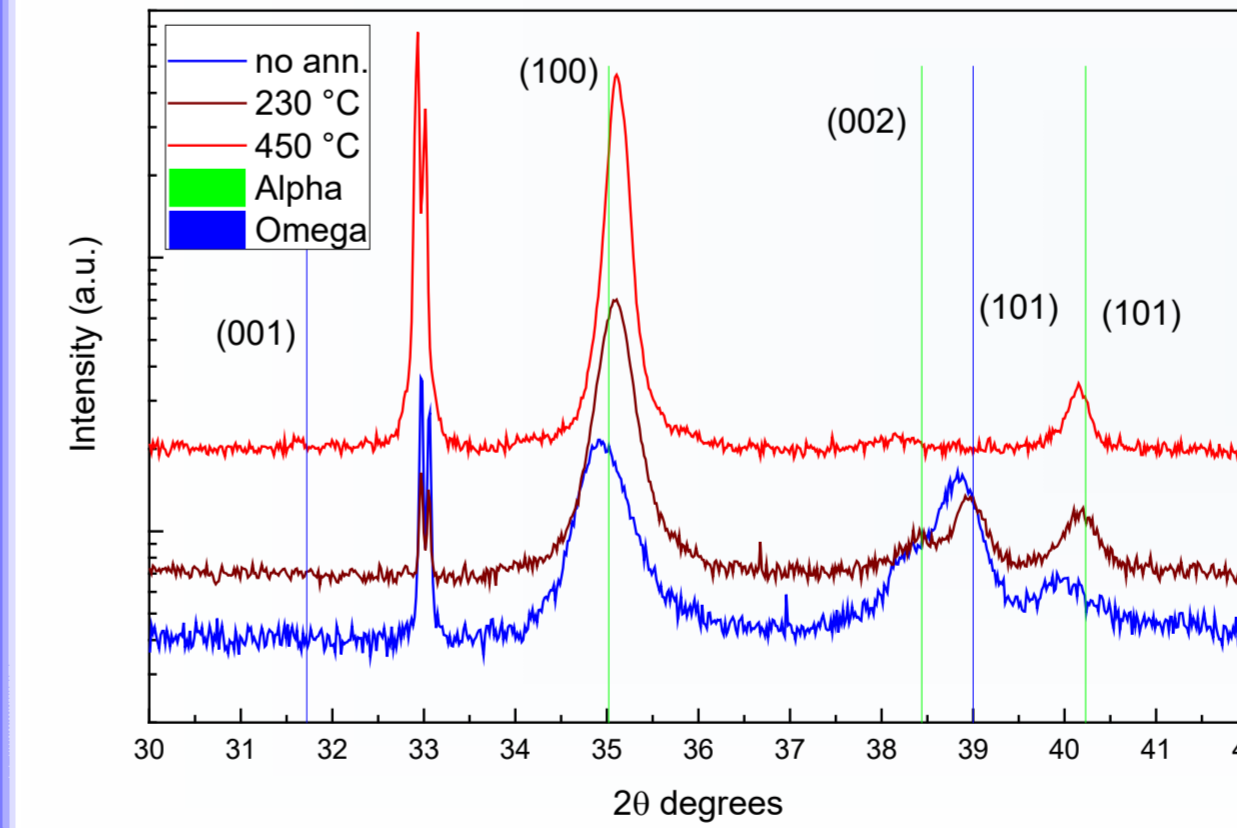
- Bias = 0 V
- $t = 30 \rightarrow 240 \text{ min}$

- Bias = 50 V
- $t = 30 \rightarrow 240 \text{ min}$

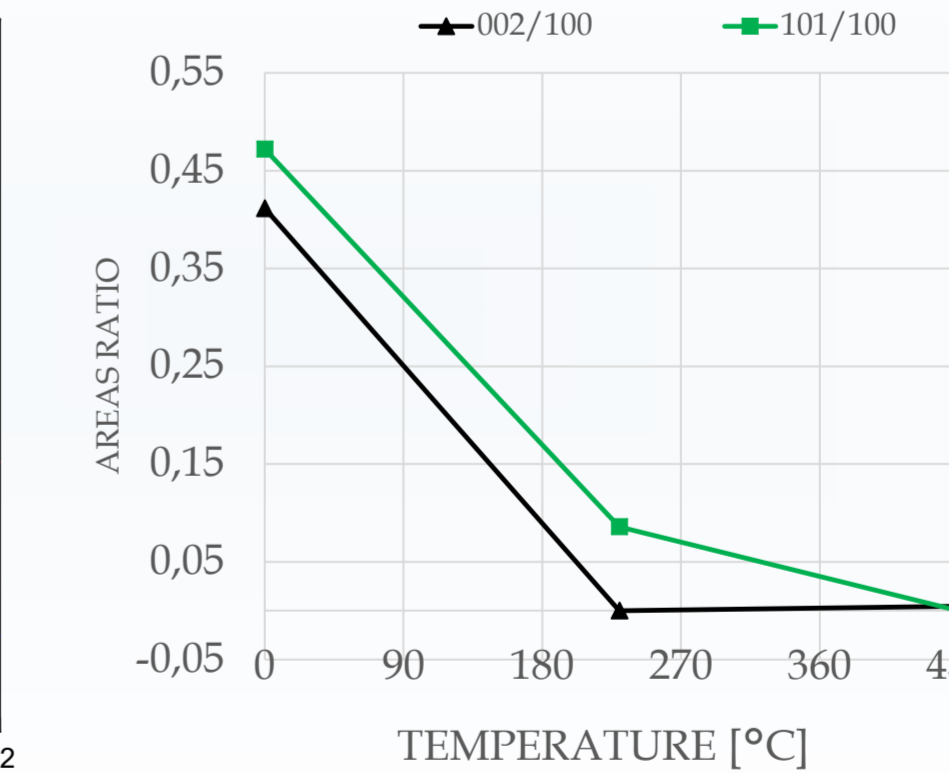
- Bias = 100 V
- $t = 30 \rightarrow 240 \text{ min}$

## Annealing

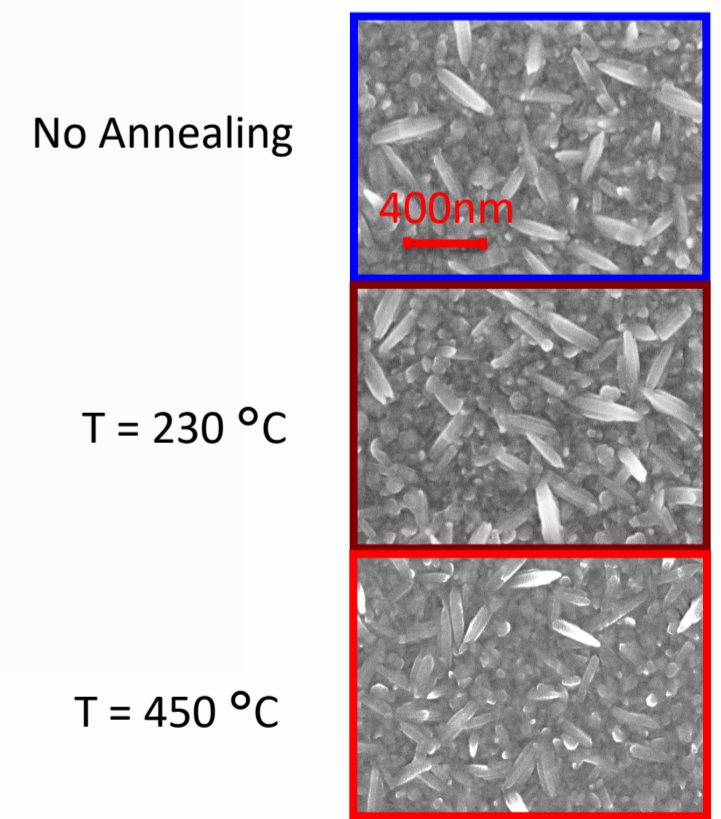
### XRD analysis:



### Disappearing of $\omega$ phase!

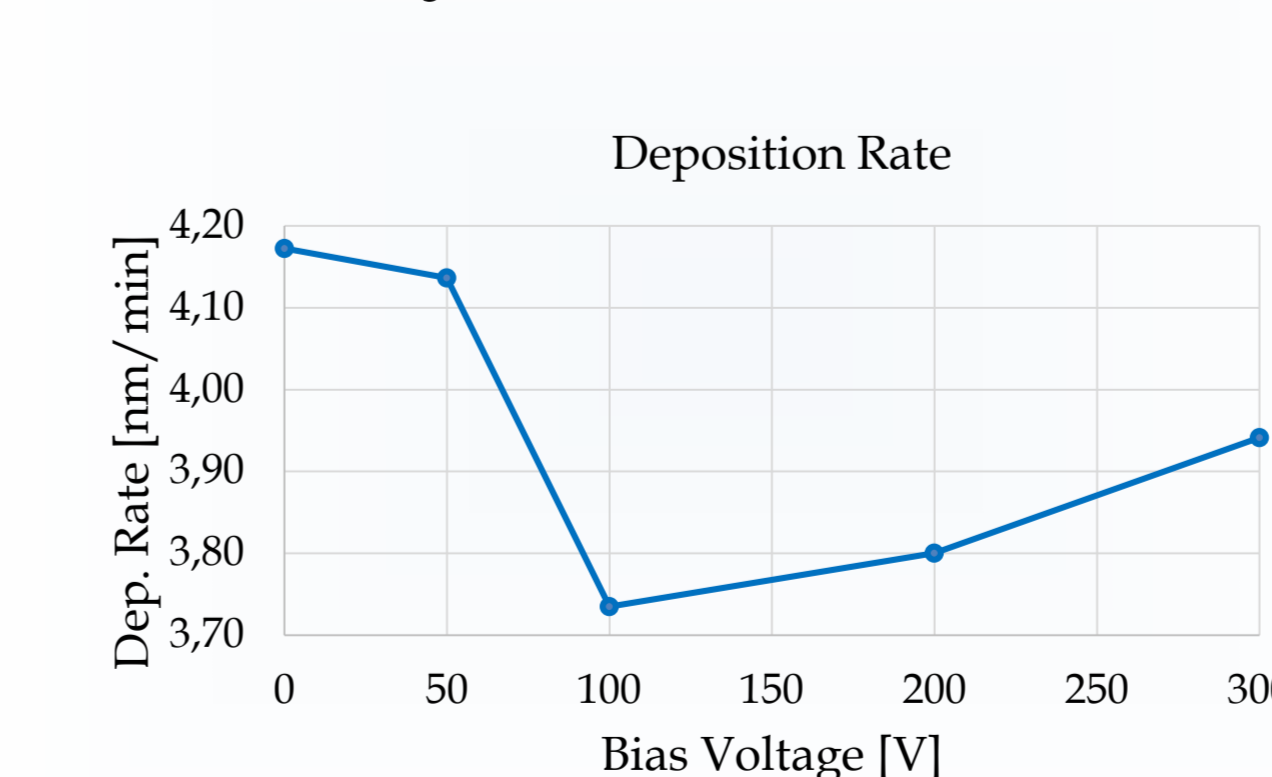


### SEM analysis:



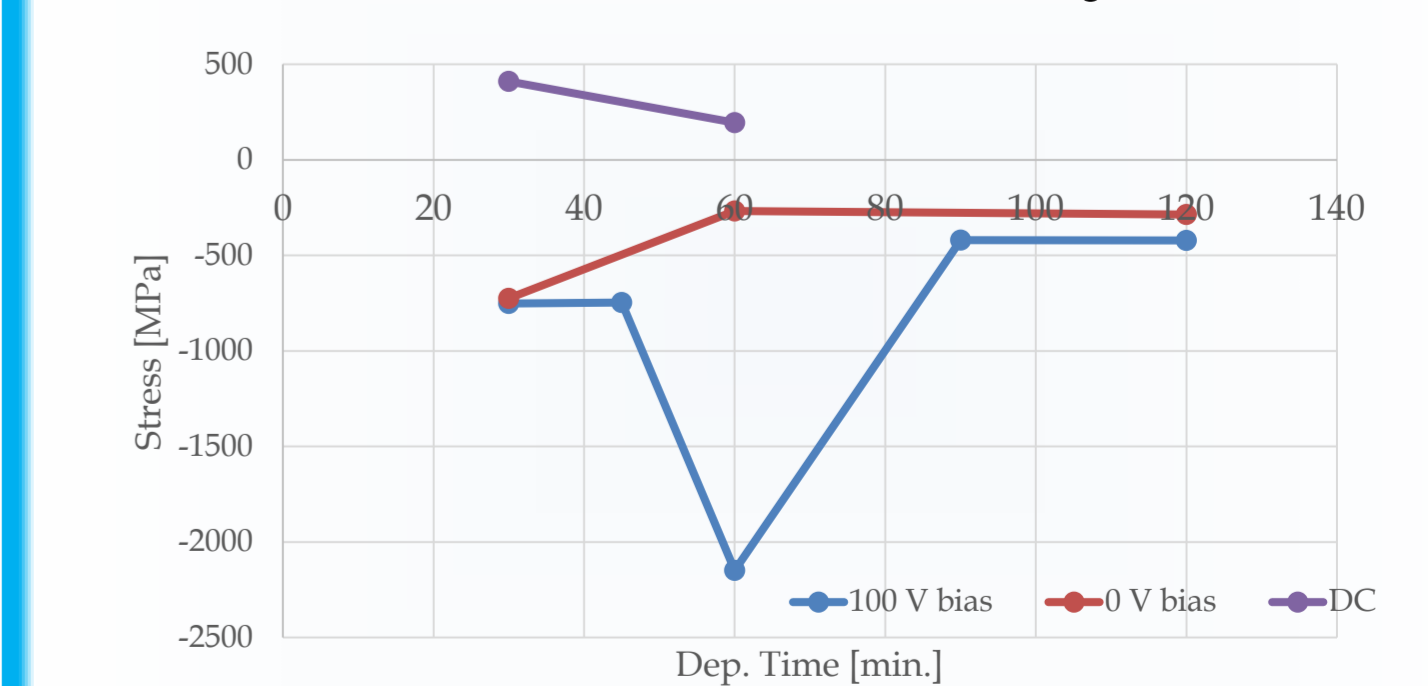
## Deposition rate

### EDX analysis



## Stresses

### Substrate curvature analysis

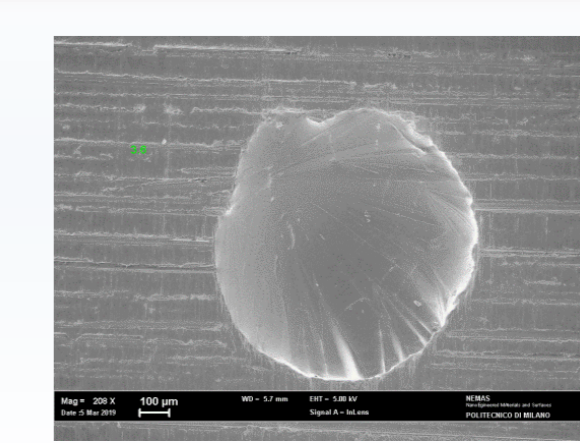
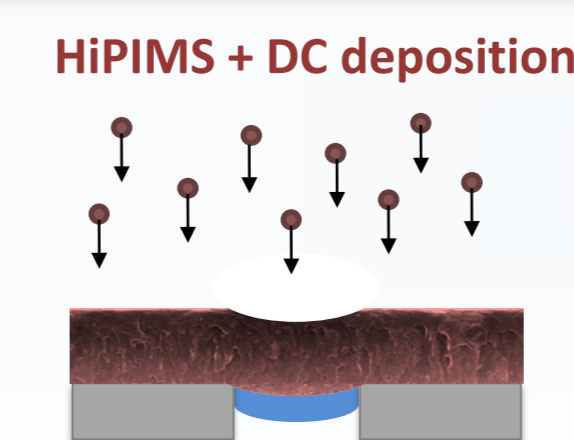
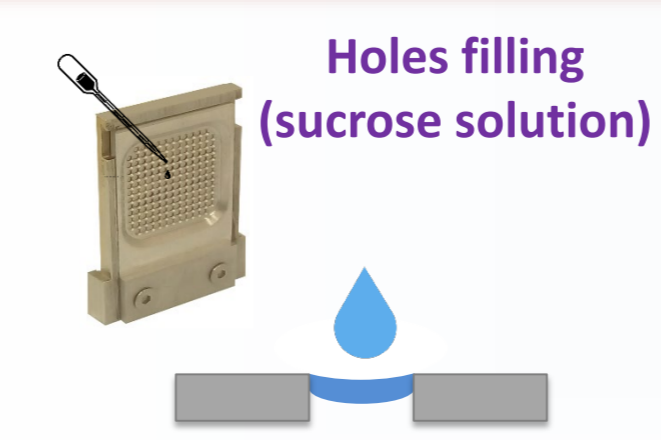


Chason, E., et al. *Journal of Applied Physics* 119.14 (2016): 145307.

## Conclusions

- Investigated the role of energy of depositing Ti species
- crystallographic oriented growth of  $\alpha$ -Ti (hcp phase)
- nucleation of a simple hexagonal phase  $\omega$ -Ti, is promoted.
- $\omega$ -Ti phase  $\longleftrightarrow$  elongated grains

## Production of substrates for laser driven ion acceleration



Free standing Ti film  
300 nm thick!