

# ARIES Update – Small samples

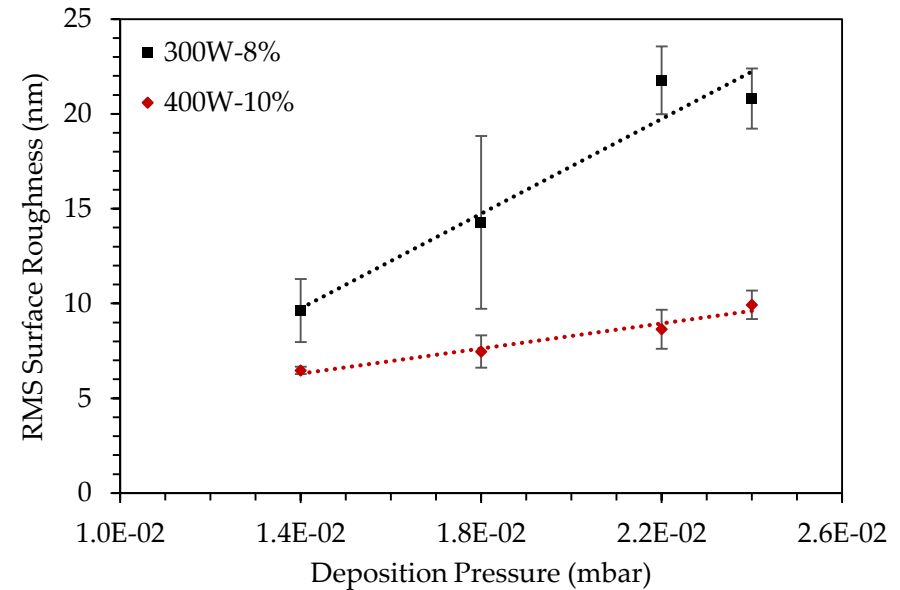
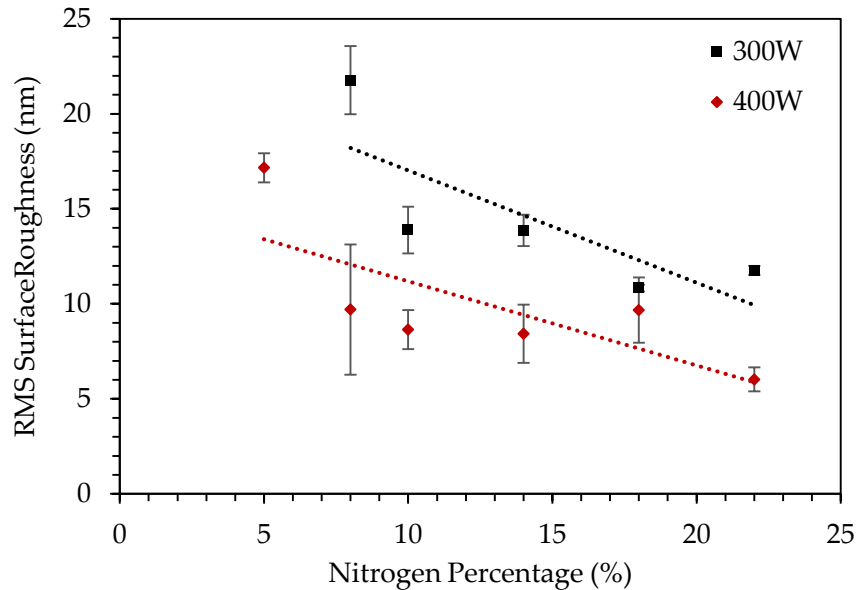
**Stewart Leith, Bing Bai, Michael Vogel**

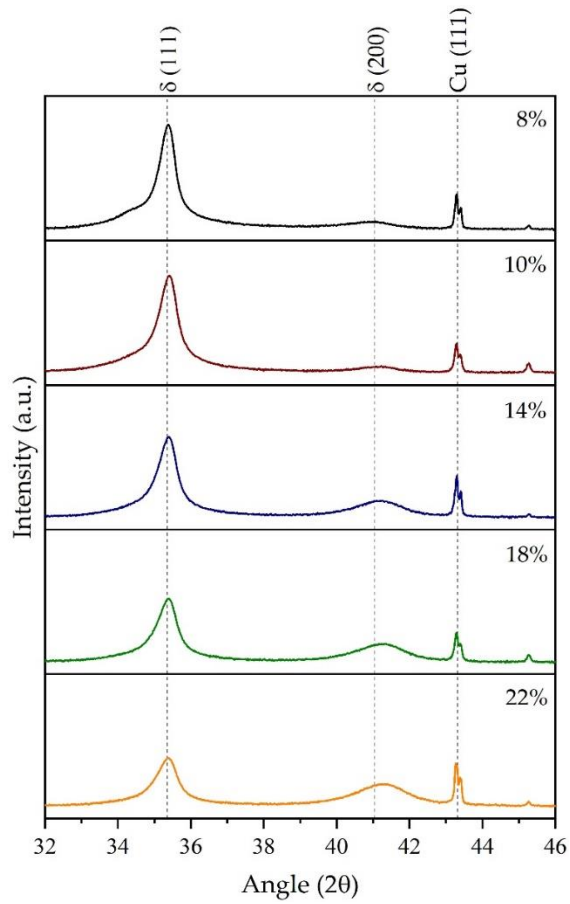


*Authors would like to acknowledge the support provided by European Union's ARIES collaboration H2020 Research and Innovation Programme under Grant Agreement no. 730871.*

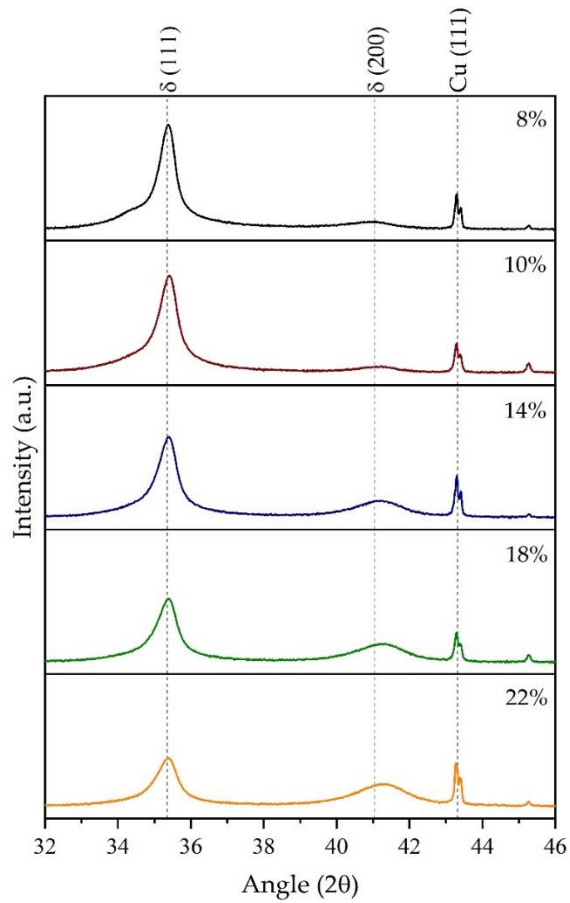


- Specific trends observable in surface roughness. **Decrease** seen with:
  - Increased Cathode Power
  - Increased N<sub>2</sub>%
  - Decreased deposition pressure
- Related to NbN phase formation and subsequent grain morphology

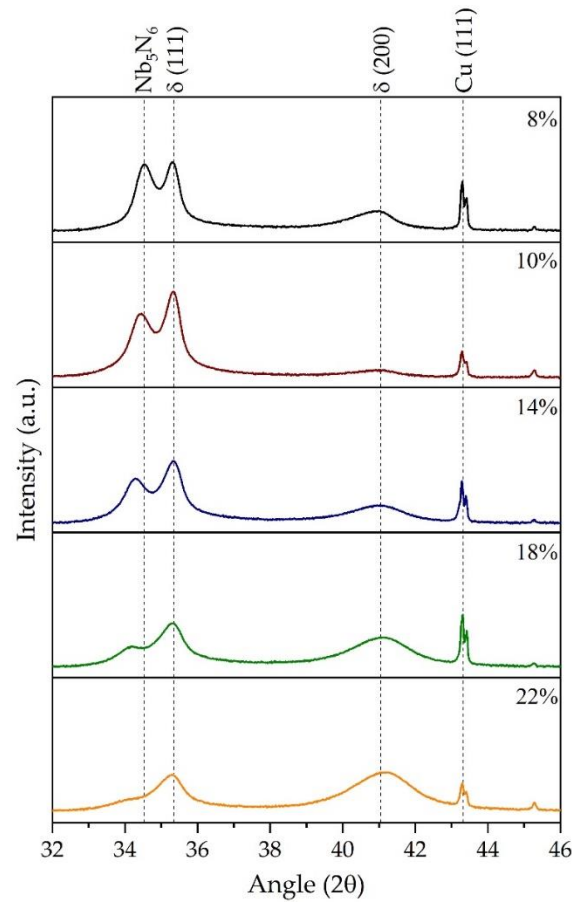




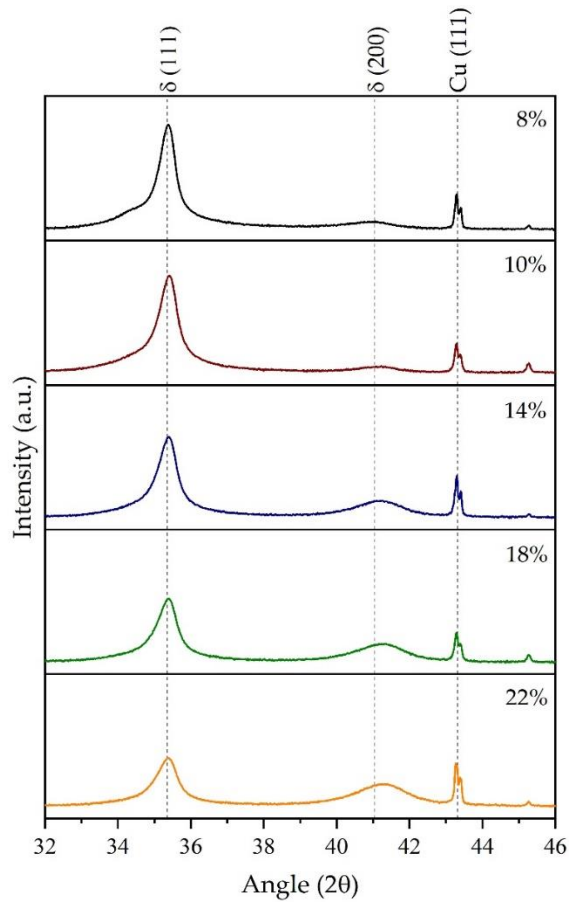
300W



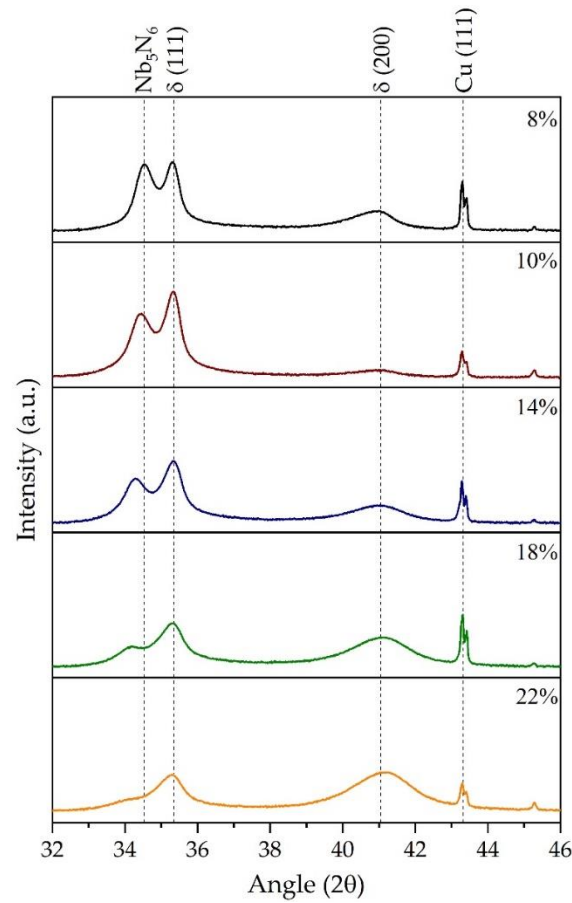
300W



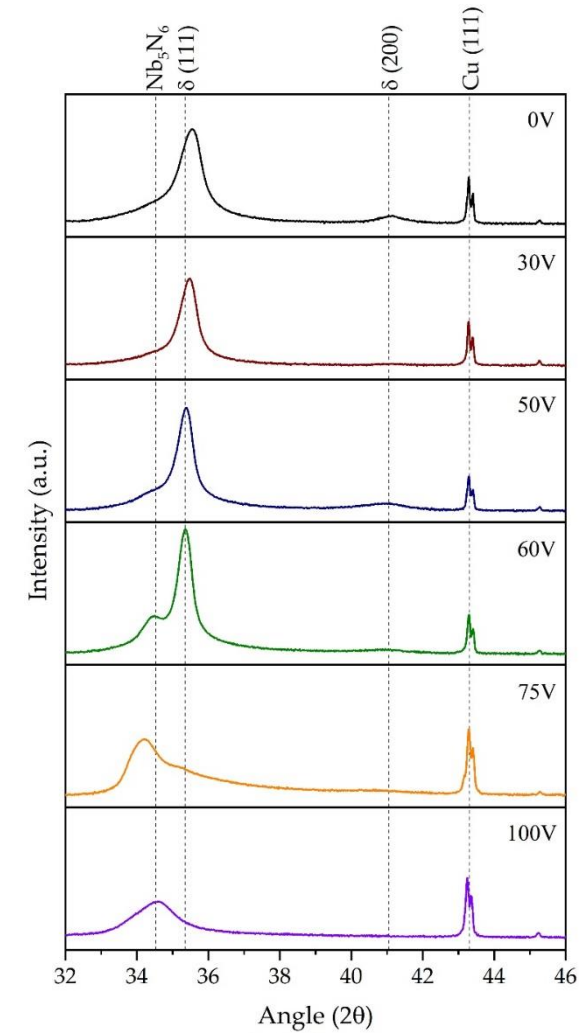
400W



300W

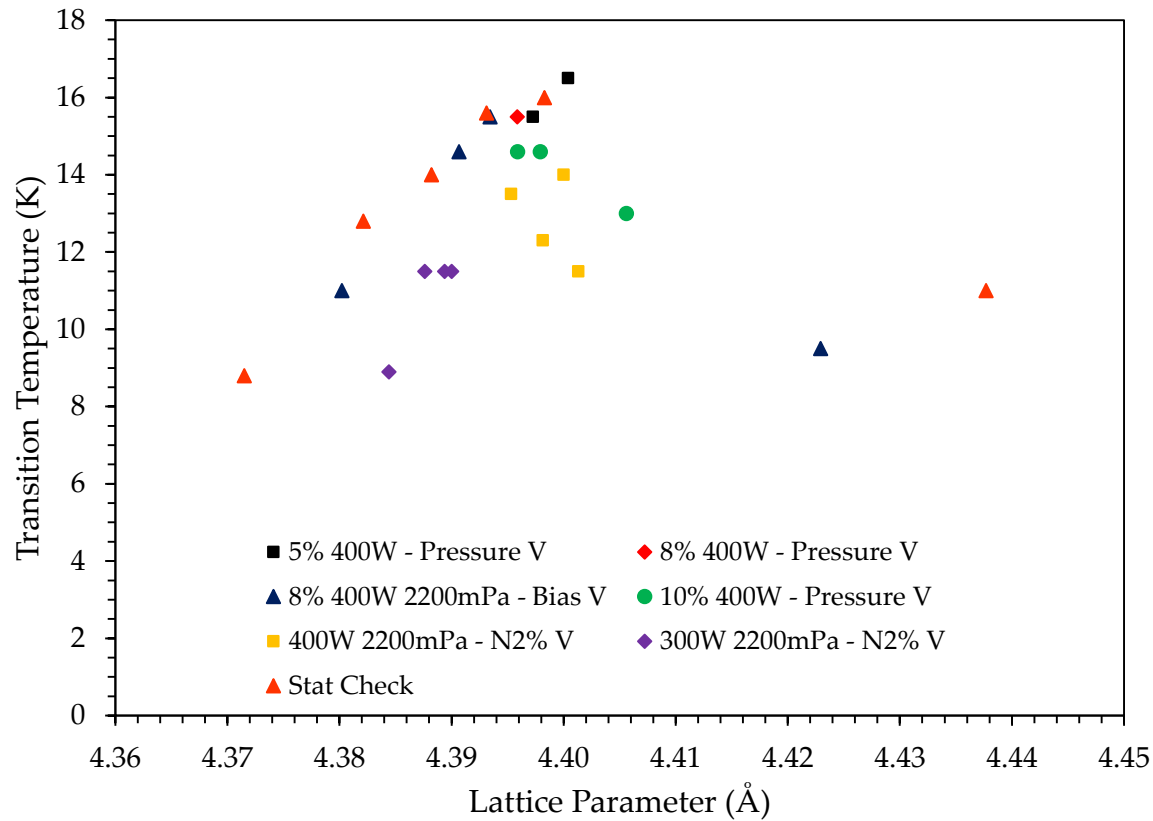


400W

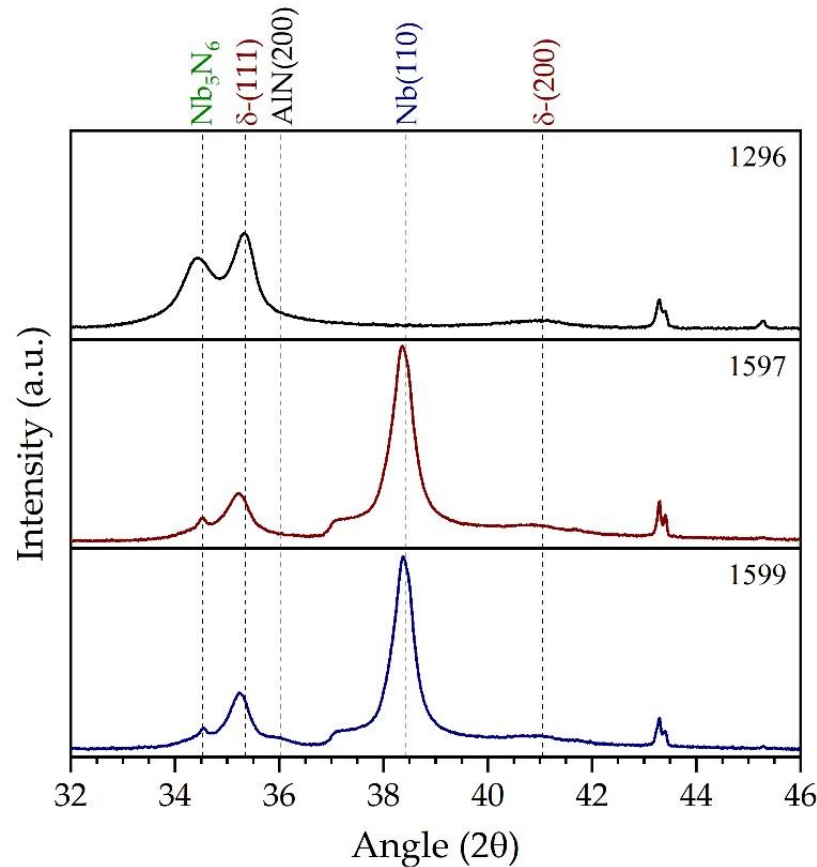


Substrate Bias

- Reliance of Transition temperature on Lattice Parameter. Shown by many authors.
  - Large variability
  - Maximum apparent at ca, 4.4Å



- Final series of HiPIMS SIS films deposited
  - AlN thickness of 8nm (4off) and 30nm (3off)
  - NbN thickness varied as before (100 to 200nm)

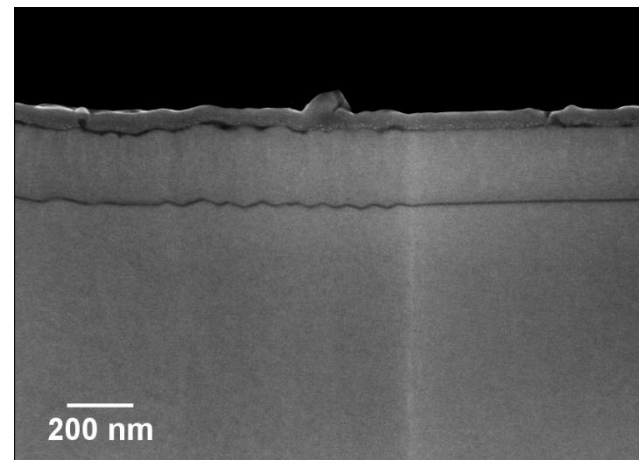
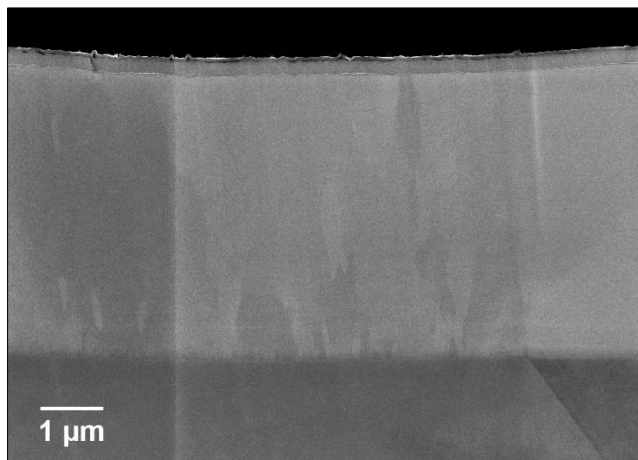
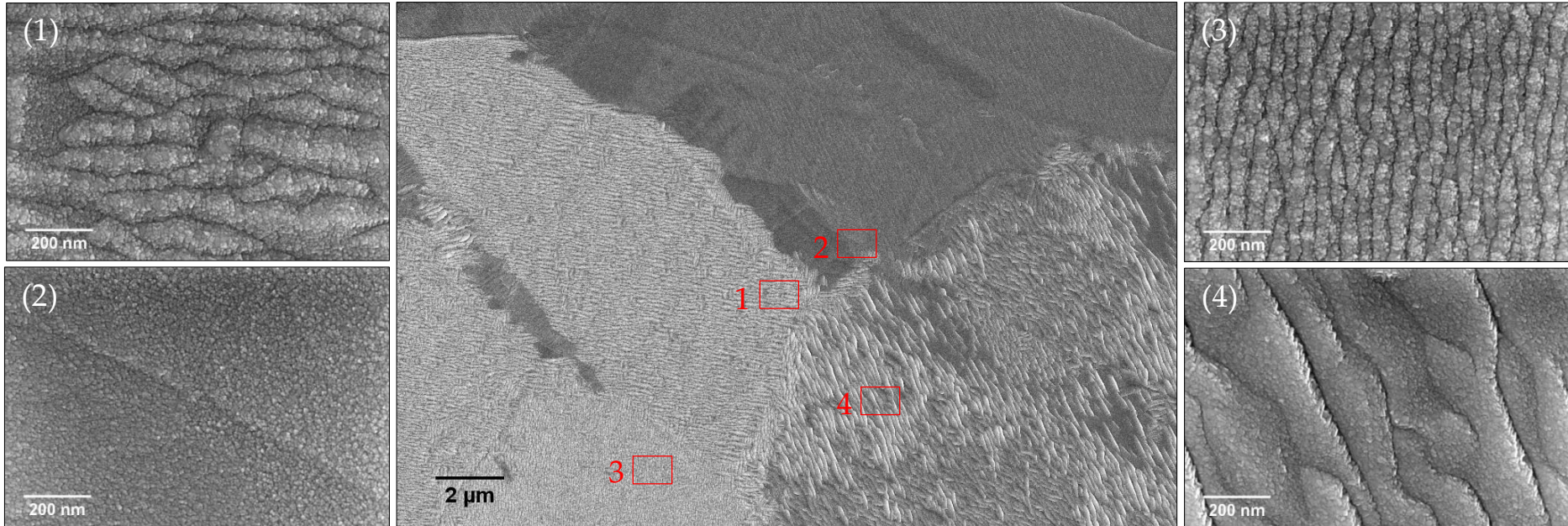


Original

SIS – 8nm AlN

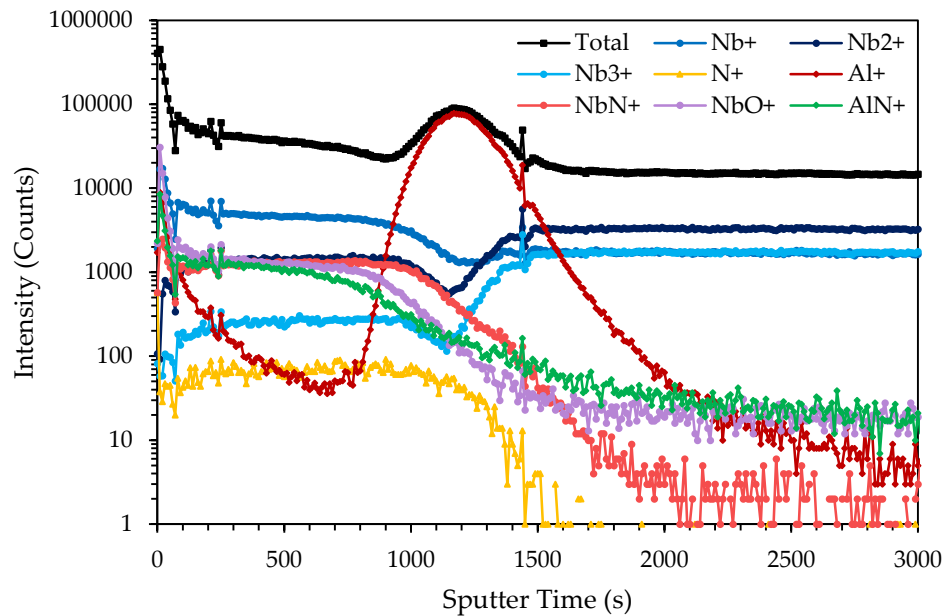
SIS – 30nm AlN

- SIS film morphology dominated by underlying HiPIMS Structure
  - NbN “superimposed” on top of Nb + AlN

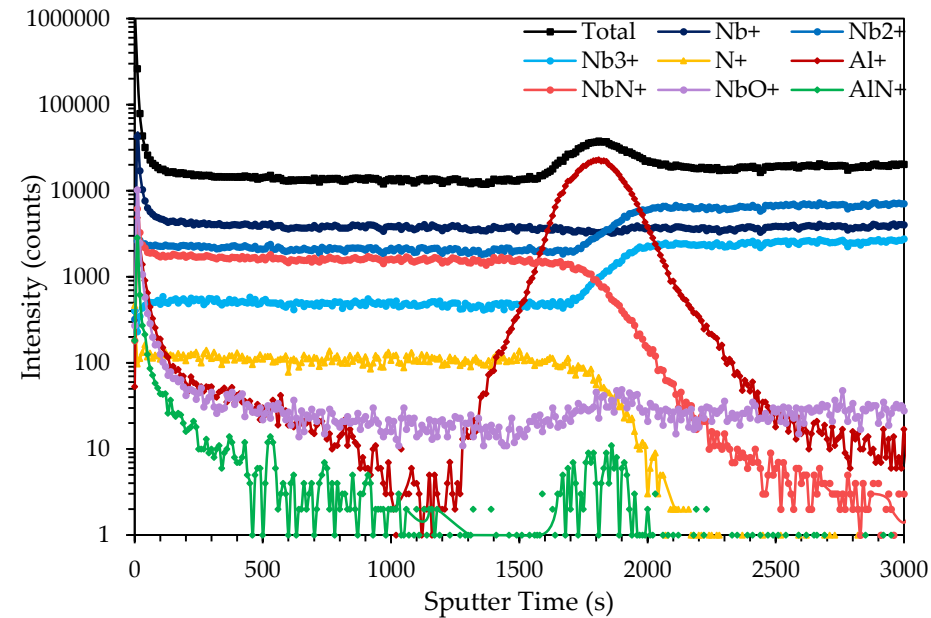




- SIMS analysis completed in positive mode for a selection of ML samples
- Presence of O identified with NbO, in NbN layer. Not in Nb
  - Significant **decrease in O content for HiPIMS NbN** vs DC MS NbN film

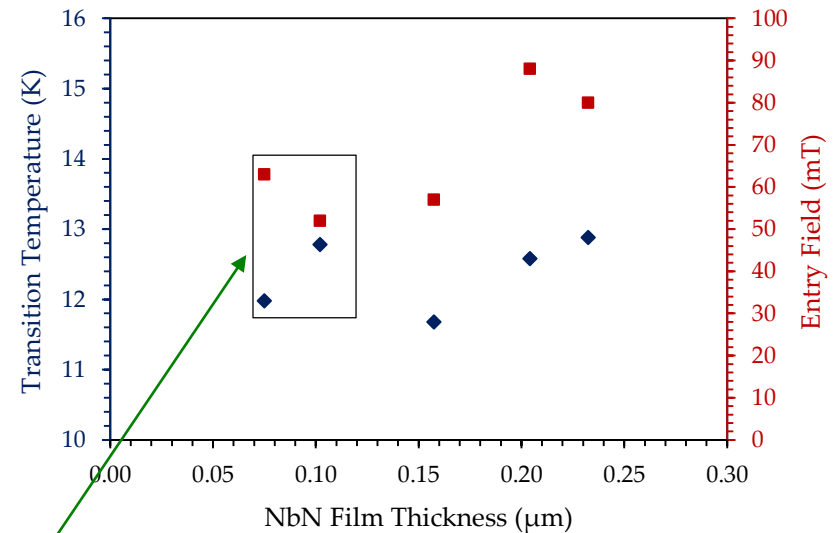
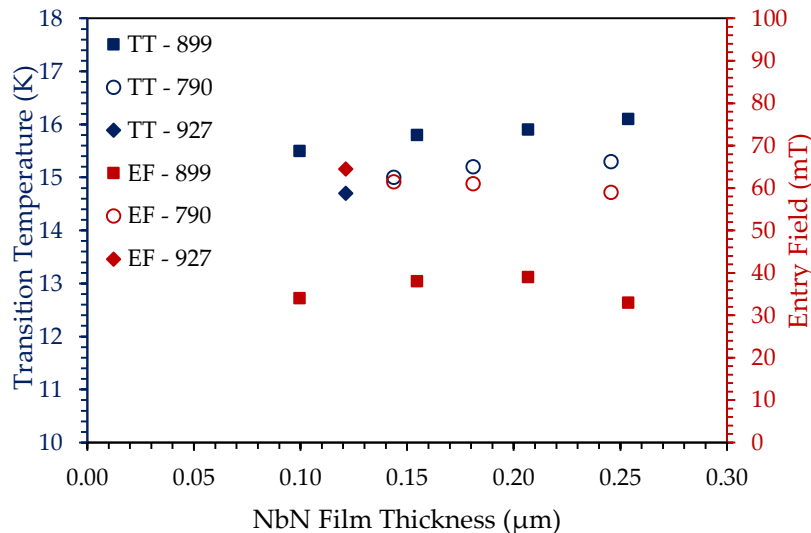


DC MS NbN



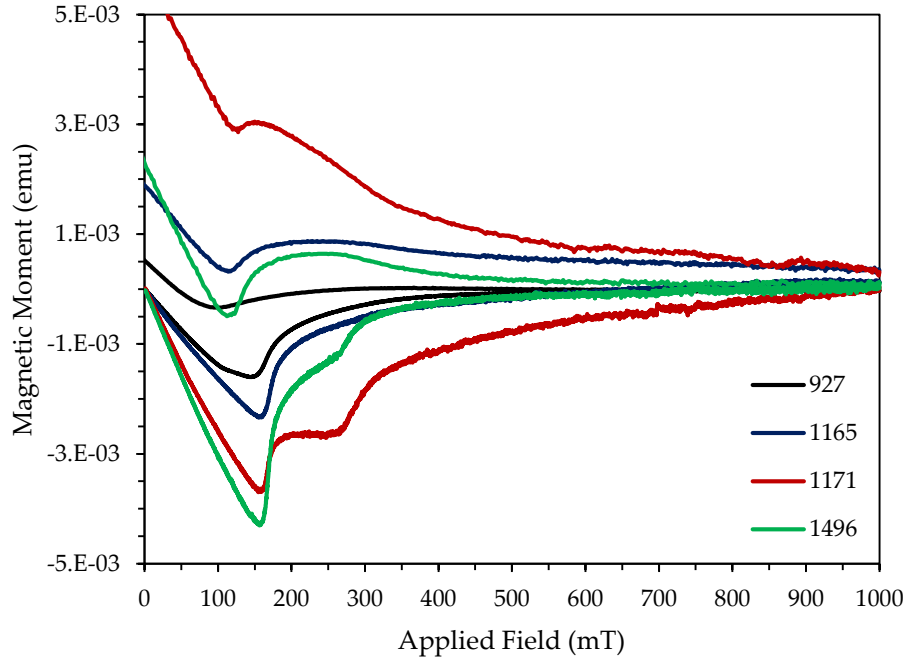
HiPIMS NbN

- NbN Transition temp increases with increasing film thickness
  - Decreased  $T_c$  with HiPIMS NbN SIS films vs original
  - DC MS NbN SIS films display equal  $T_c$  to originals.
- Entry field reaches specific maximums due to film thickness depending on recipe
  - Matches Kubo's theory – Cleaner films = Thicker layer
- Increased entry field for HiPIMS SIS films vs DC MS SIS films.

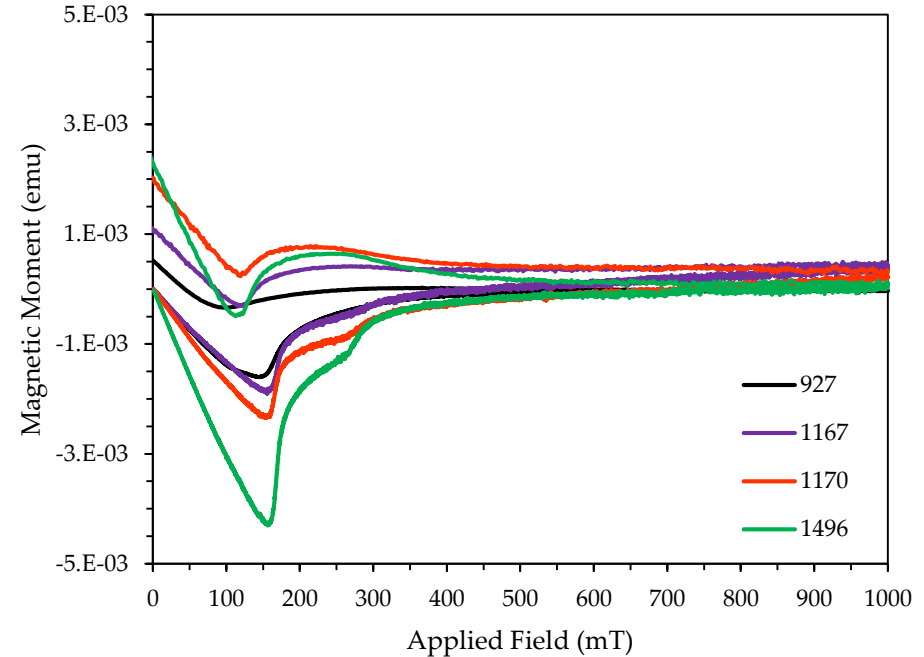


Coated Separately

- DC MS SIS films display smallest magnetisation loop
- Highest  $H_{en}$  samples not necessarily smallest loop
- HiPIMS NbN shows more pronounced “dip” but earlier separation. Decreased BL barrier?



Best performing  $H_{en}$



Best performing  $H_{tr}$

## Next Steps

- Superconducting analysis of final HiPIMS NbN and HiPIMS SIS samples

# Thanks for your Attention!

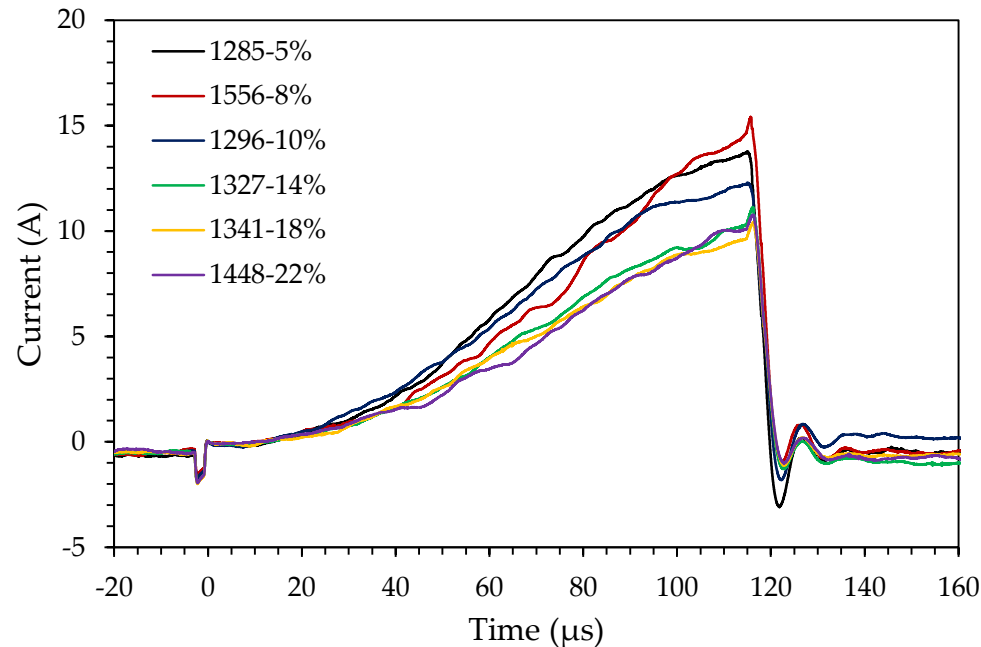


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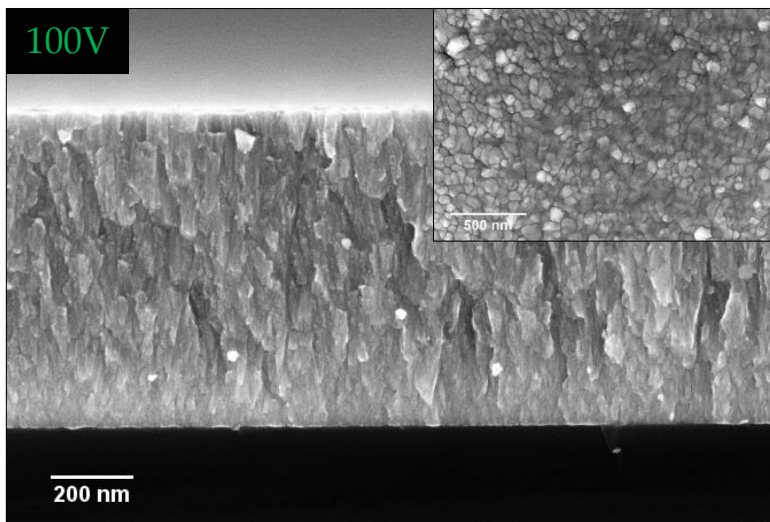
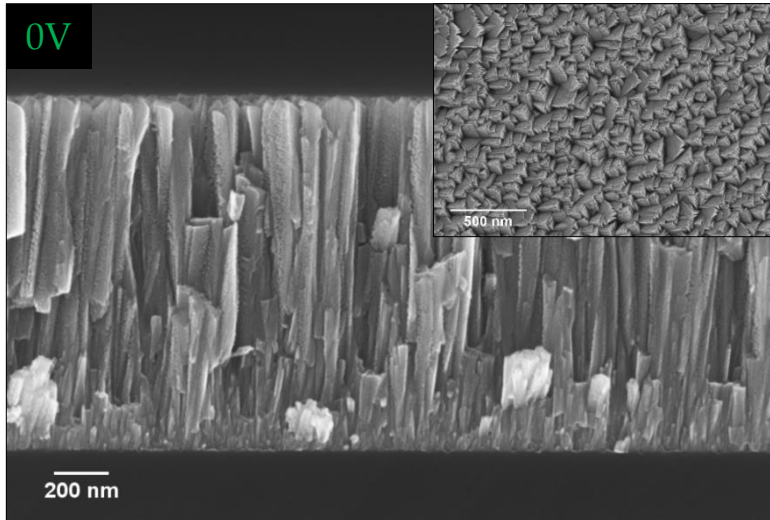


# Extra Slides

- Waveform general trend indicates decreasing peak current with increasing  $N_2\%$
- Aging target leads to increased peak current
  - Aging target similar effect to increased pressure (Iosad *et al*, 2011)

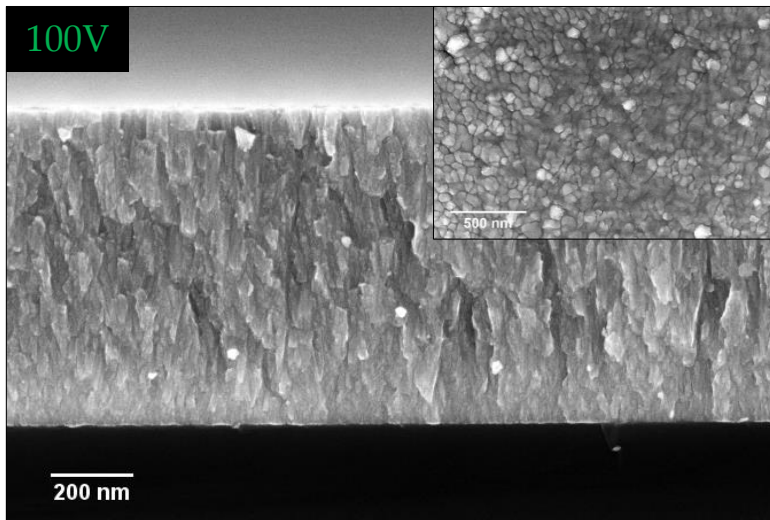
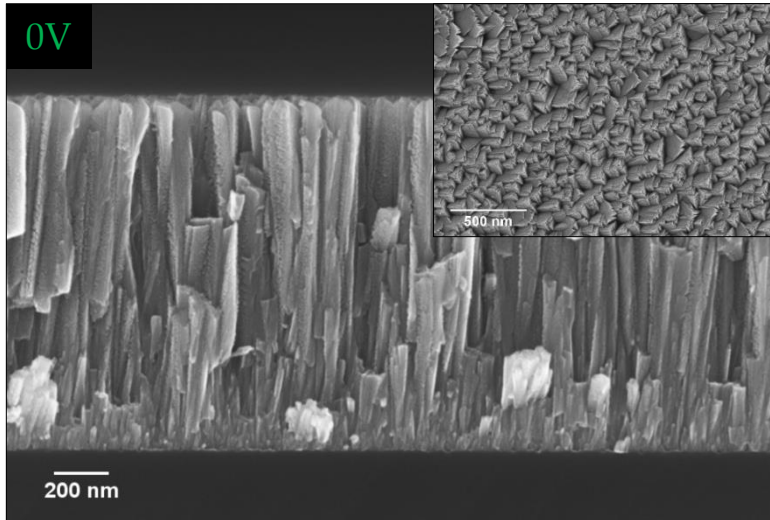


## Substrate Bias

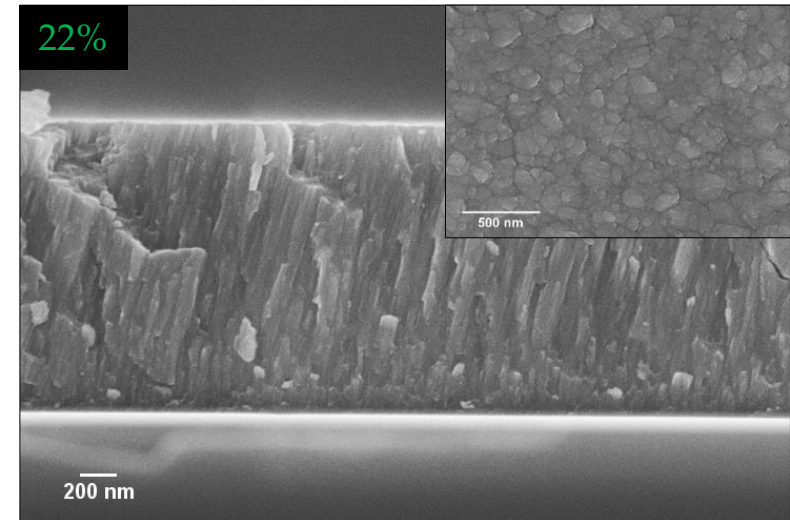
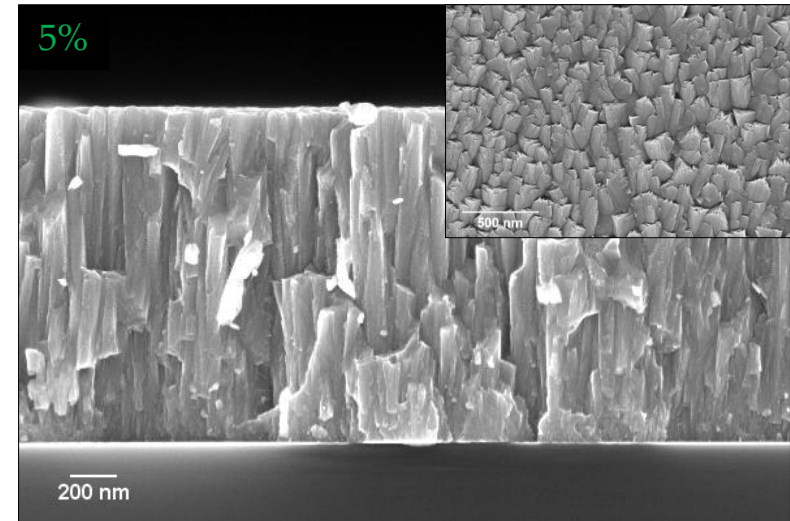




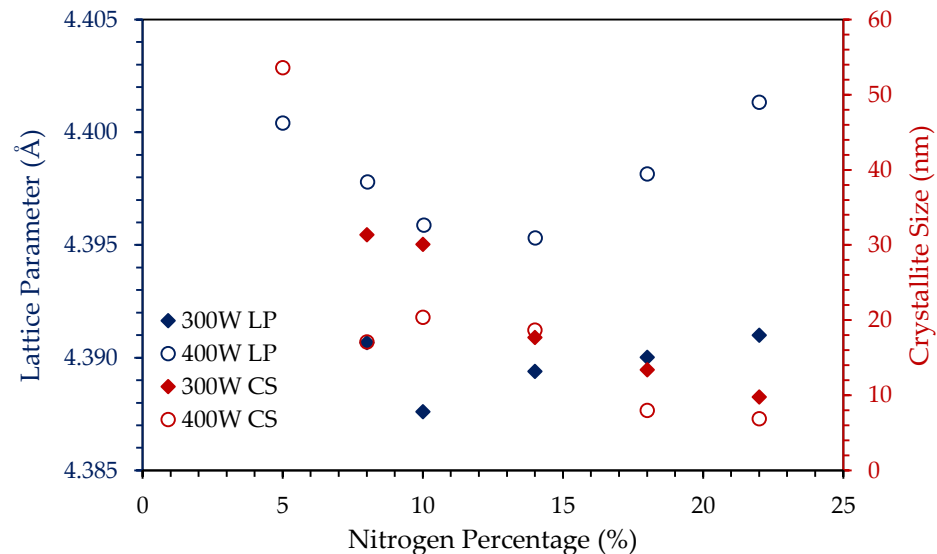
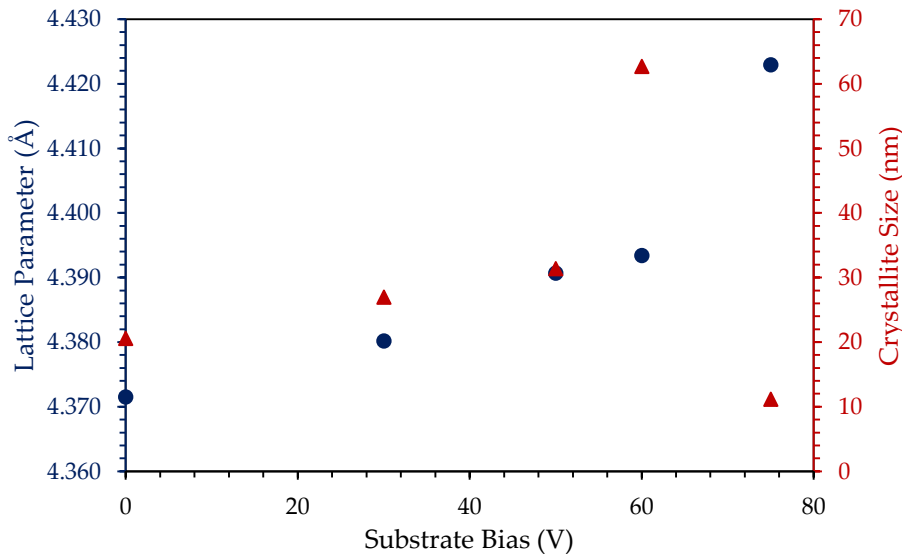
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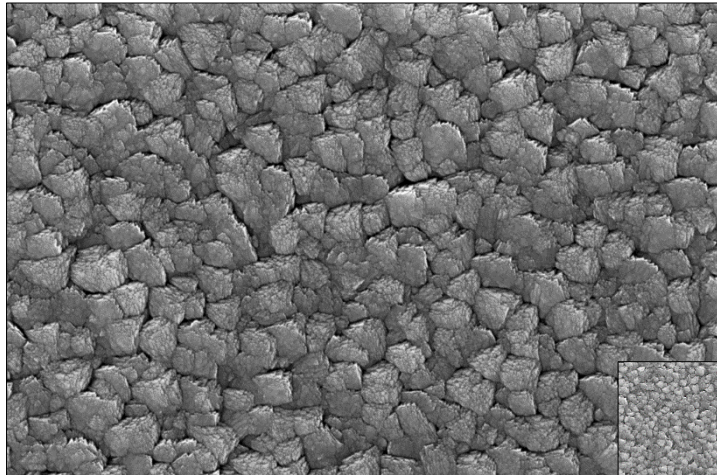


## Nitrogen Percentage

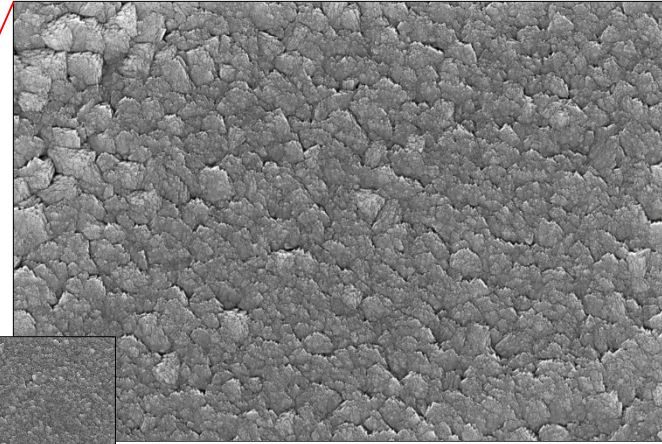


- Lattice Parameter dependent on specific deposition parameters. **Increases with:**
  - Increasing substrate bias
  - Decreasing Pressure
  - Increasing Cathode Power
- Reaches a specific minimum for N<sub>2</sub>% - related to phase formation
- Crystallite size **increases with:**
  - Decreasing cathode power
  - Decreasing N<sub>2</sub>%
  - Increasing substrate bias. Except at high values due to phase change.
  - Increasing deposition pressure

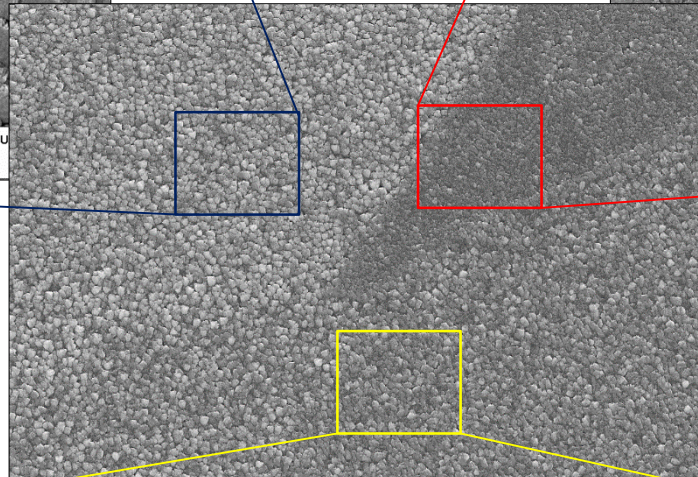




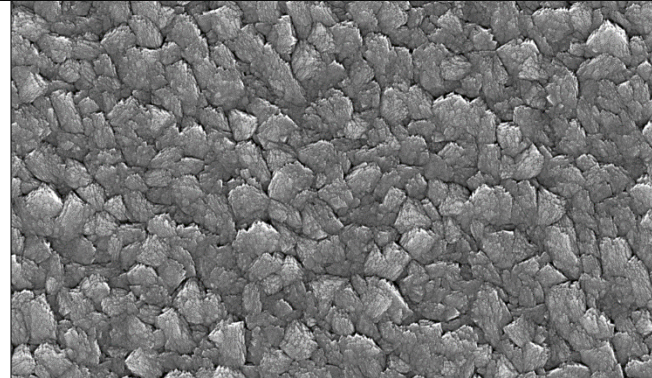
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WD = 7 mm Mag = 50.00 K X File Name = NbN-Cu-025.tif



EHT = 10.00 kV Signal A = InLens Date :24 Nov 2020  
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1 μm<sup>+</sup> EHT = 10.00 kV Signal A = InLens Date :24 Nov 2020  
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100 nm<sup>+</sup> EHT = 10.00 kV Signal A = InLens Date :24 Nov 2020  
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