Investigation of NbN thin films on small, flat samples

Stewart Leith, Jian Fan, Michael Vogel

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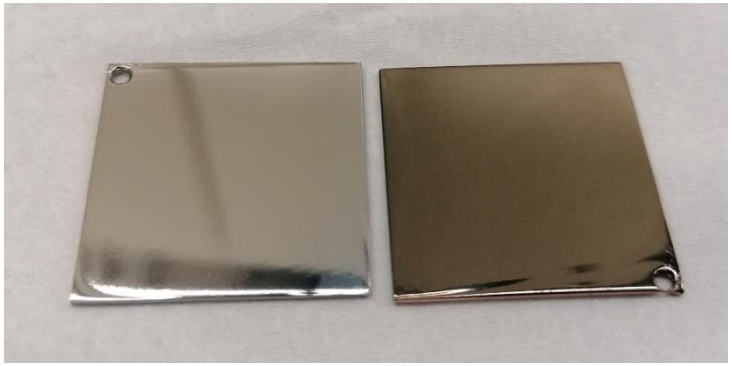
NbN Optimisation Samples

- NbN thin films optimised based on screening study
- Requirements:
  - Dense film
  - Gold film
  - Columnar, cubic structure
  - Higher T_c and B_{en}
  - Smoother Surface

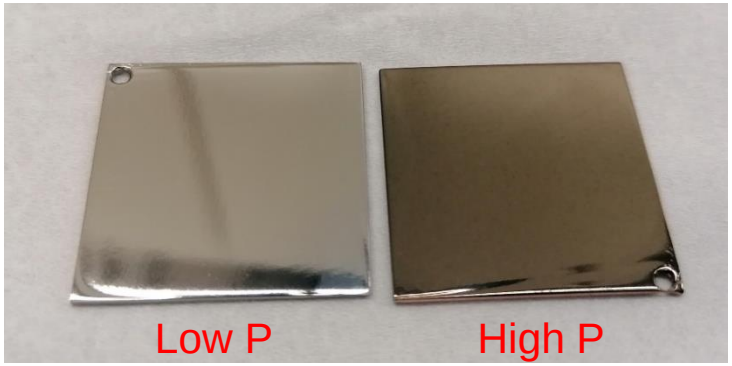
- Optimisation Study:
  - Nitrogen percentage variation
  - Bias effects
  - Pressure variation
  - Optimisation
  - Multilayer samples



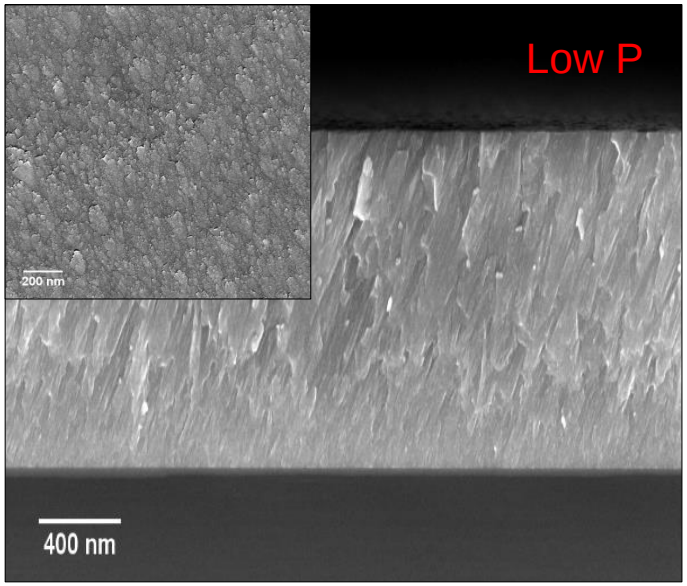
Pressure Variation Results

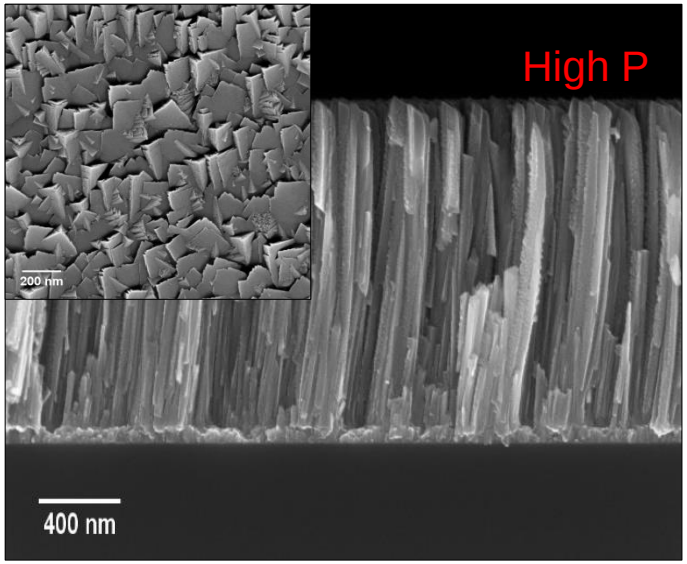
- Lower Pressure leads to denser films (no specific structure) and rounded grains
- Higher deposition pressure (> 1200 mPa) leads to columnar grain structure with faceted surface features
  - Larger crystallite sizes and rougher surface
- Film colour changes from silver (Hex) to gold (Cubic)
- Increased Oxygen at higher pressure

Pressure	Sq (nm)	Crystallite Size (nm)
600 mPa	4.39 ± 0.41	74
1000 mPa	12.14 ± 1.54	295
1400 mPa	16.70 ± 1.72	306
1800 mPa	21.86 ± 2.22	385



Silver: Hexagonal NbN sample. **Gold:** Cubic NbN sample



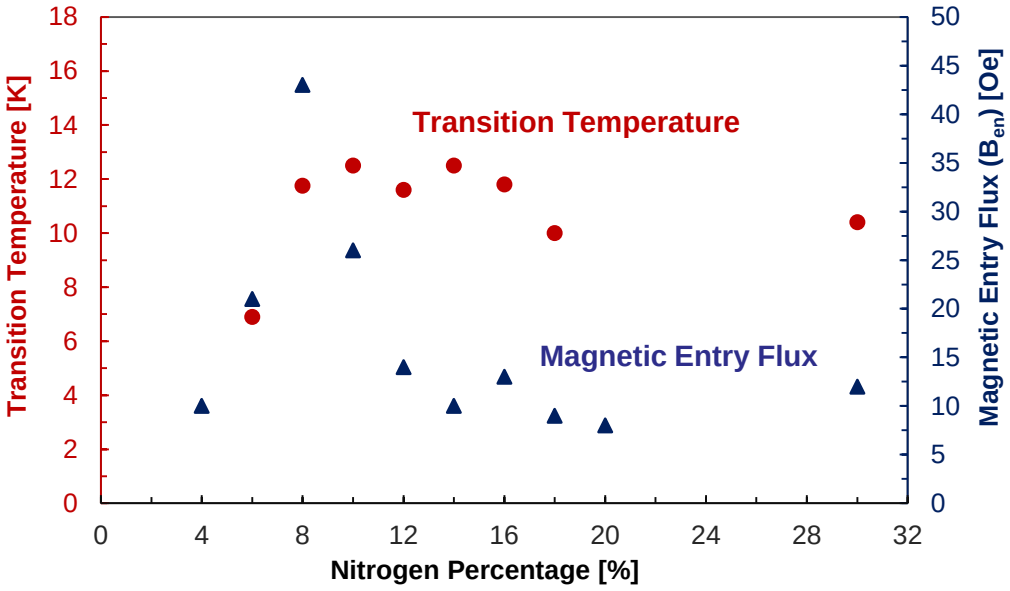


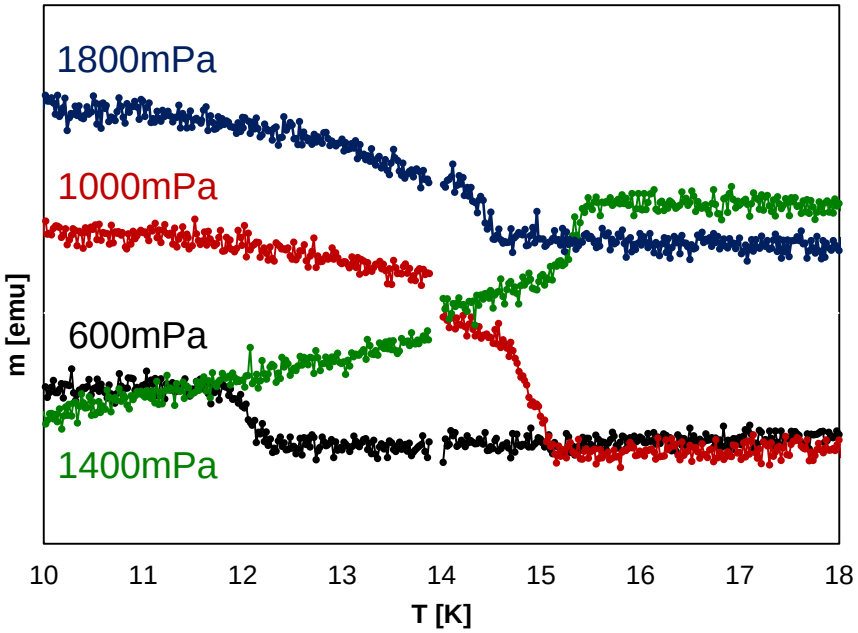
Top: Low pressure film. **Bottom:** High pressure film

NbN Superconducting Results

- VSM used for measurements
- Nitrogen variation:
  - T_c stable from 8% N_2 = ± 12K
  - B_{en} max found at 8% N_2
- Pressure variation:
  - Increase in T_c with increasing pressure.
  - Decrease in T_c for 1800mPa = Oxynitrides?

Pressure	Transition Temp [K]	Flux of first entry (2%) @4.2K [Oe]
600 mPa	12.1	35
1000 mPa	14.9	40
1400 mPa	15.3	23
1800 mPa	14.5	20

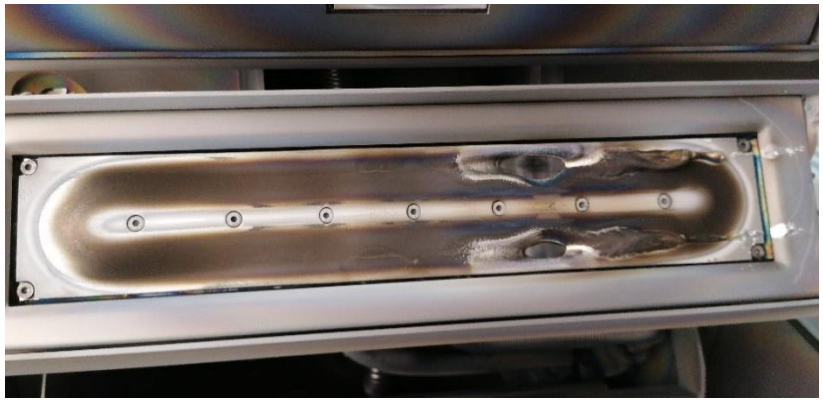




Measurements completed by E. Seiler – IEE SAS

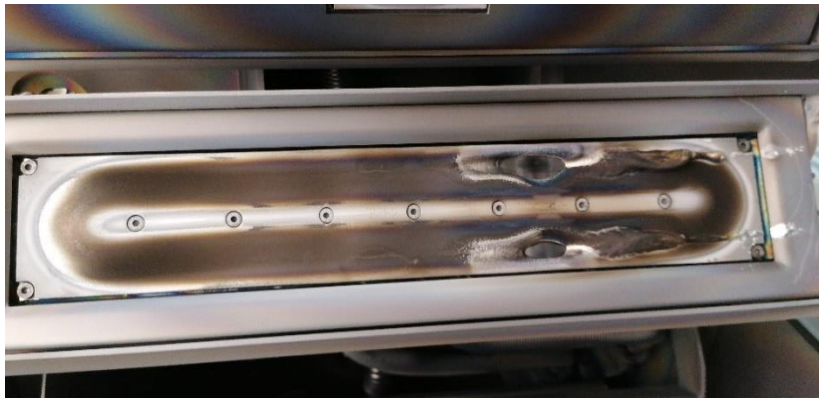
AlN Deposition Trials

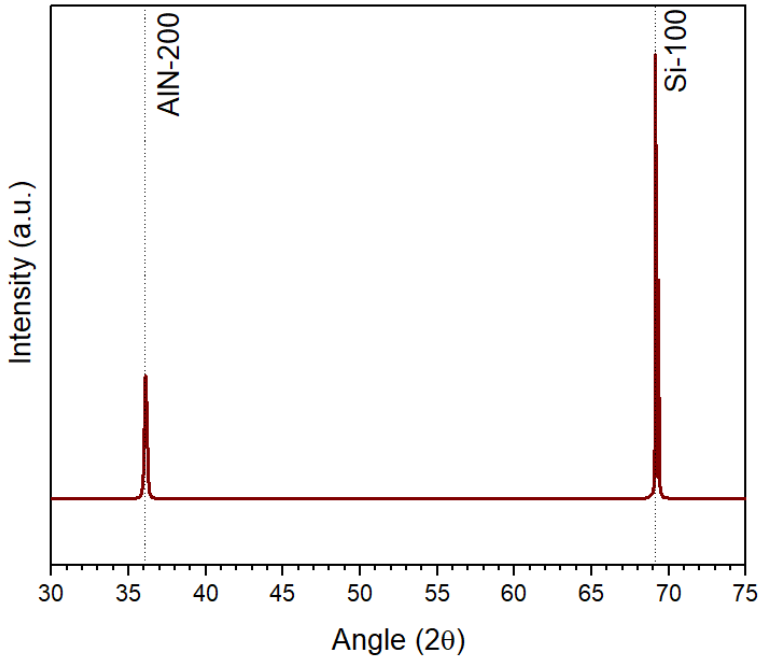
- AlN thin film trials with DCMS completed
  - Target melted due to high power



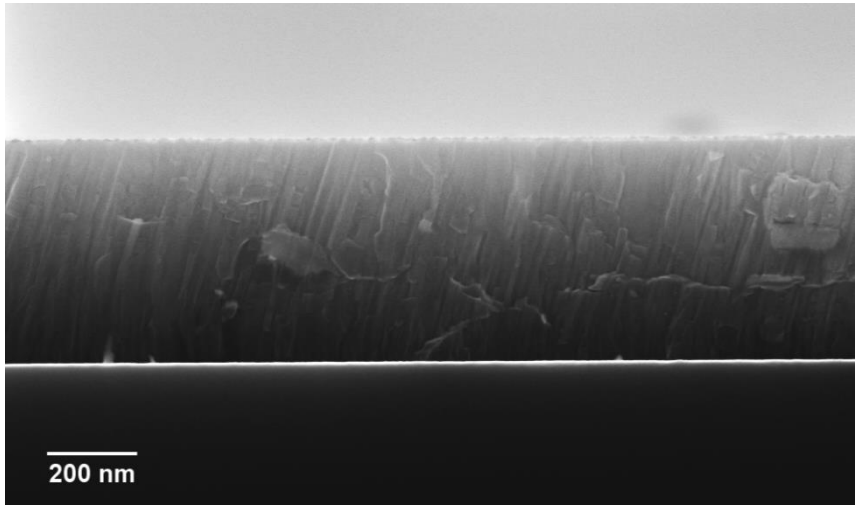
AlN Deposition Trials

- AlN thin film trials with DCMS completed
  - Target melted due to high power
  - AlN(200) matches δ-NbN(111)
  - Fundamental to success of SIS films
  - Table rotation used for homogeneity





- Recipe:
  - Temperature: 600°C
  - Pressure: 600mPa
  - Power: 3500 W (8 W/cm^2)
  - 100% Nitrogen
  - 4 mins = ± 25 nm



Future Work

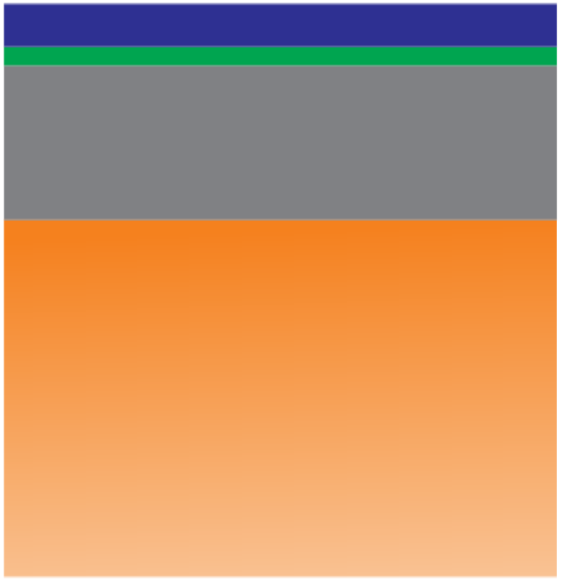
- Initiation of HiPIMS coatings
  - HiPIMS Nb coating
  - HiPIMS NbN coating
- Multilayer Coatings as final goal – NbN/AlN/Nb/Cu
- Nb/Cu QPR sample coatings
  - 2nd on EP treated Cu upcoming
  - Multilayer final coating
- PEP investigation

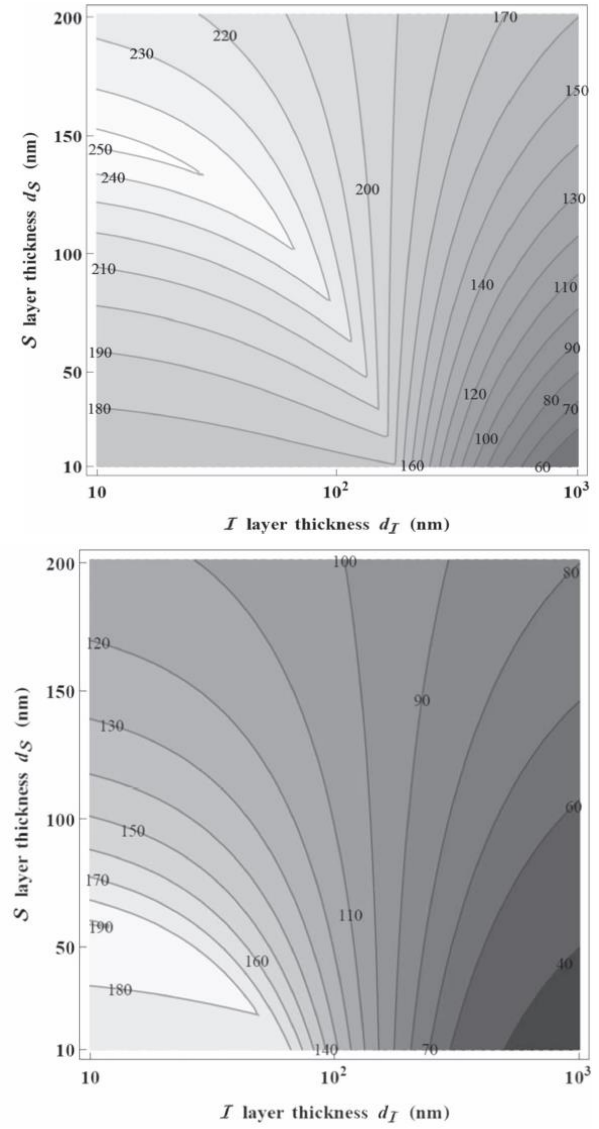
NbN ± 100 nm

AlN ± 25 nm

Nb ± 3 µm

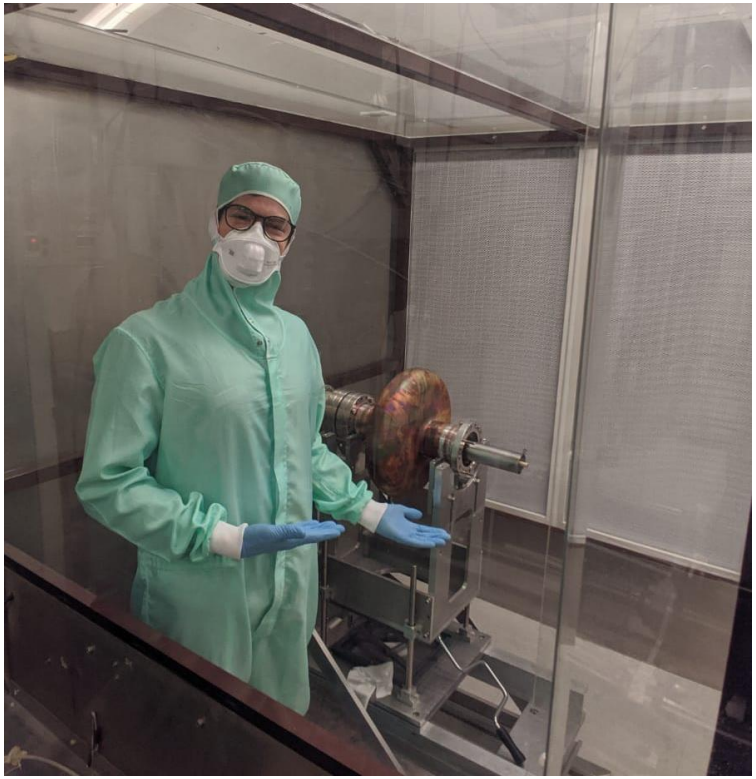
Cu Substrate





Predictions of SIS thickness for NbN-I (Kubo, 2017)
Top: Clean NbN. **Bot:** Dirty NbN

Thanks for your attention!



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