

# Universität Siegen ARIES update

## Small Samples Update

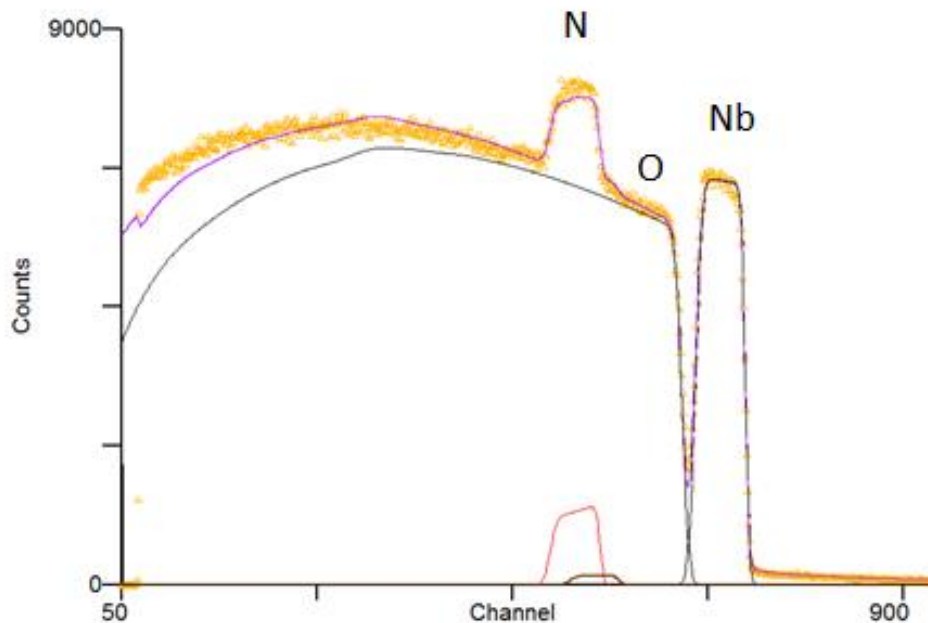
**Stewart Leith, Michael Vogel**



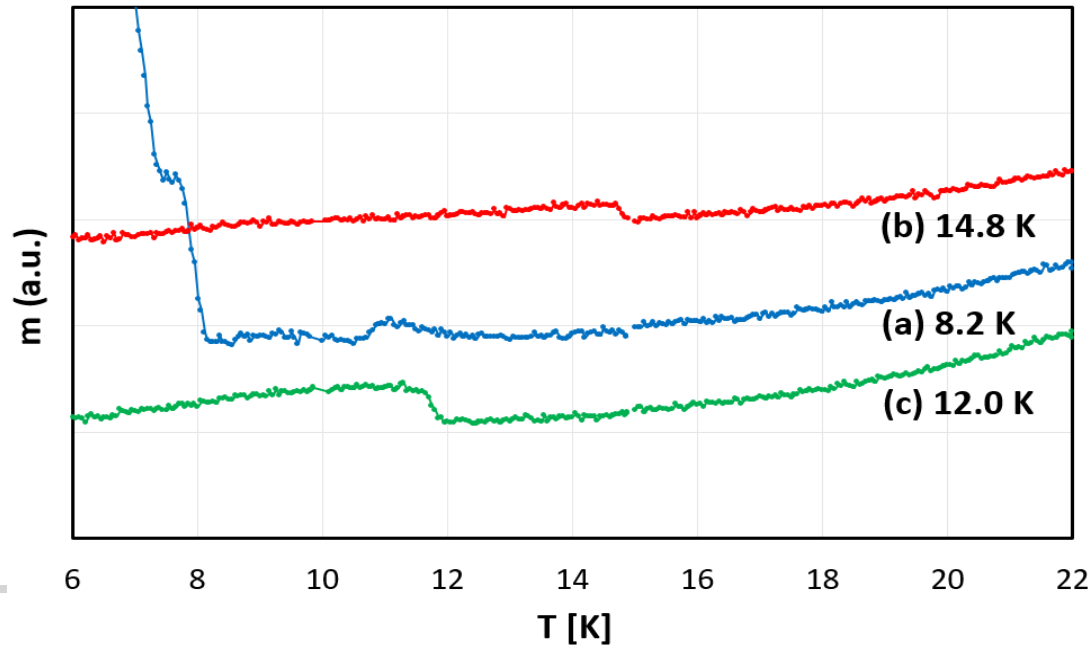
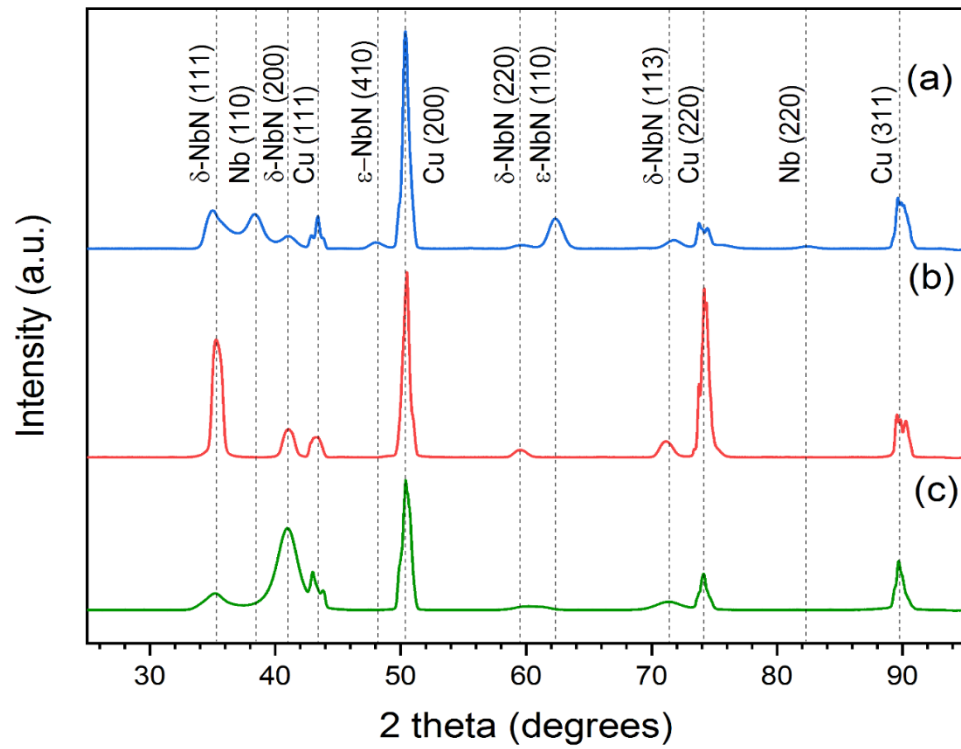
*Authors would like to acknowledge the support provided by European Union's ARIES collaboration H2020 Research and Innovation Programme under Grant Agreement no. 730871.*



- **RBS Analysis:**  $\leq 20$  % N flow rate are found to be under stoichiometric and within the range for  $\delta$ -NbN
- The high percentage of N within the films indicates a lack of the  $\beta$ -NbN and  $\gamma$ -NbN phases,  $x = 0.4$  to  $0.8$
- The decrease in oxygen content in the films with increasing nitrogen flow will affect the absolute stoichiometry of the NbN films



N <sub>2</sub> flow %	Nb (at.%)	N (at.%)	O (at.%)	x
10	48.8	46.2	5	0.95
15	48.75	45.17	6.07	0.93
20	48.30	45.75	6	0.95
25	45.71	51.37	2.90	1.12
30	48.70	50.86	0.43	1.04



## For your later reference

- **$T_c$  Results:** All the investigated samples were found to be superconducting, with  $T_c$  ranging from 8.2 K to 14.8 K.
- Larger Ar/N<sub>2</sub> ratio films proved to be superior.
- Sample (a) presents two distinct transition points at 8.2 K and 10.8 K, which indicates the presence of two separate superconducting phases, as confirmed by the XRD analysis.
- Sample (b) shows the highest  $T_c$  which is in compliance with XRD and SEM results.
- Crystal size and/or orientation seems to lead to a decrease in the  $T_c$ , as revealed by sample (c).
  
- **XRD Results:** Indicative samples shown
- Sample (a): phase mixture of  $\delta$  and  $\epsilon$ -NbN. Nb interlayer detected.
- Sample (b) and (c): cubic  $\delta$ -NbN films.
- (b) shows relatively sharp NbN peaks which are oriented along the [111] growth direction
- (c) has broadened peaks and exhibits a different growth orientation in [200] direction.
- Sample (b) features a columnar growth. Diameter of more than 100nm, explaining the found orientation and sharp peaks
- (c) the columns are a few nm in diameter which, in turn, leads to broadened XRD peaks.

- NbN film deposited onto EP polished copper sample
  - $S_q = 63 \text{ nm} \pm 7 \text{ nm}$  vs 844 nm original (CFM scan size 257 x 257  $\mu\text{m}$ )

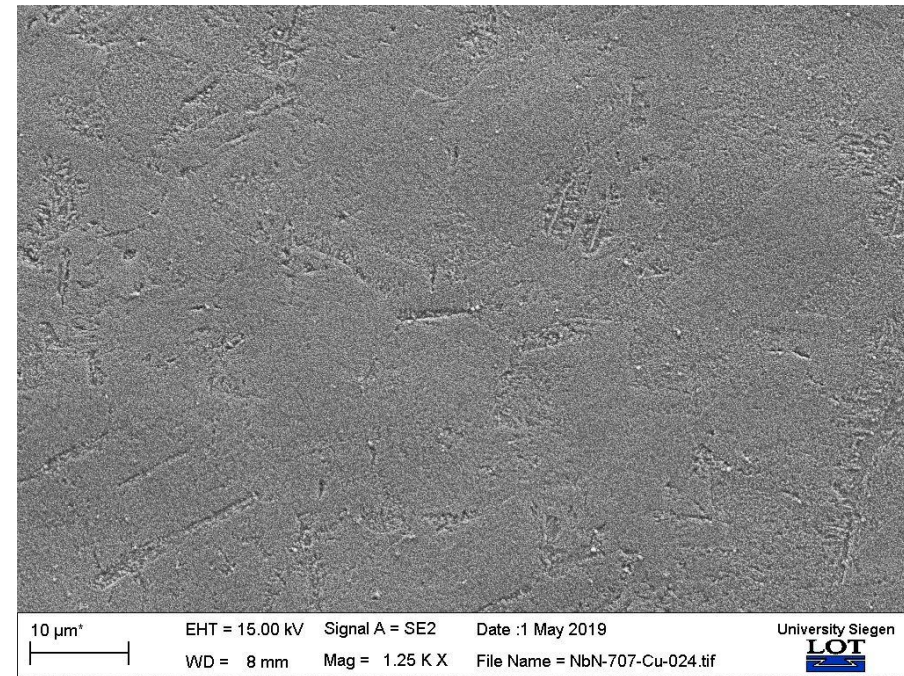
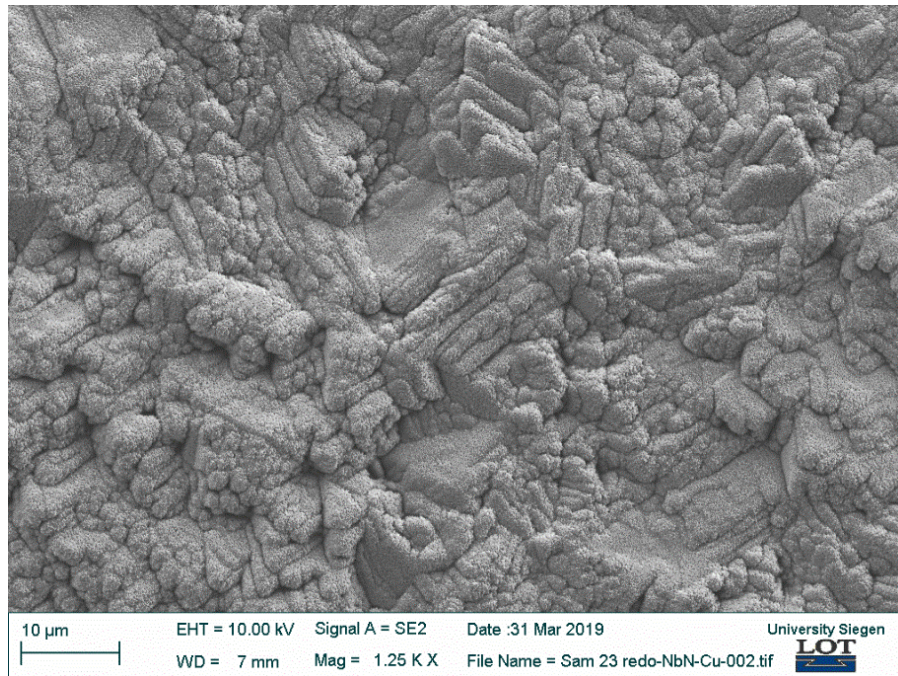


Figure: (Left) Nitric Acid NbN/Cu. (Right) EP NbN/Cu



# Future Work

- Investigate the use of interlayers and deposit optimised NbN films onto different surface treated copper surfaces
- Deposit HiPIMS Nb and NbN films
- Deposit multilayer samples onto copper (e.g. Nb – AlN – NbN or Nb – NbN)
- Investigate N-doped Nb thin films on copper