



Science and
Technology
Facilities Council



IFAST – 3rd Annual Meeting

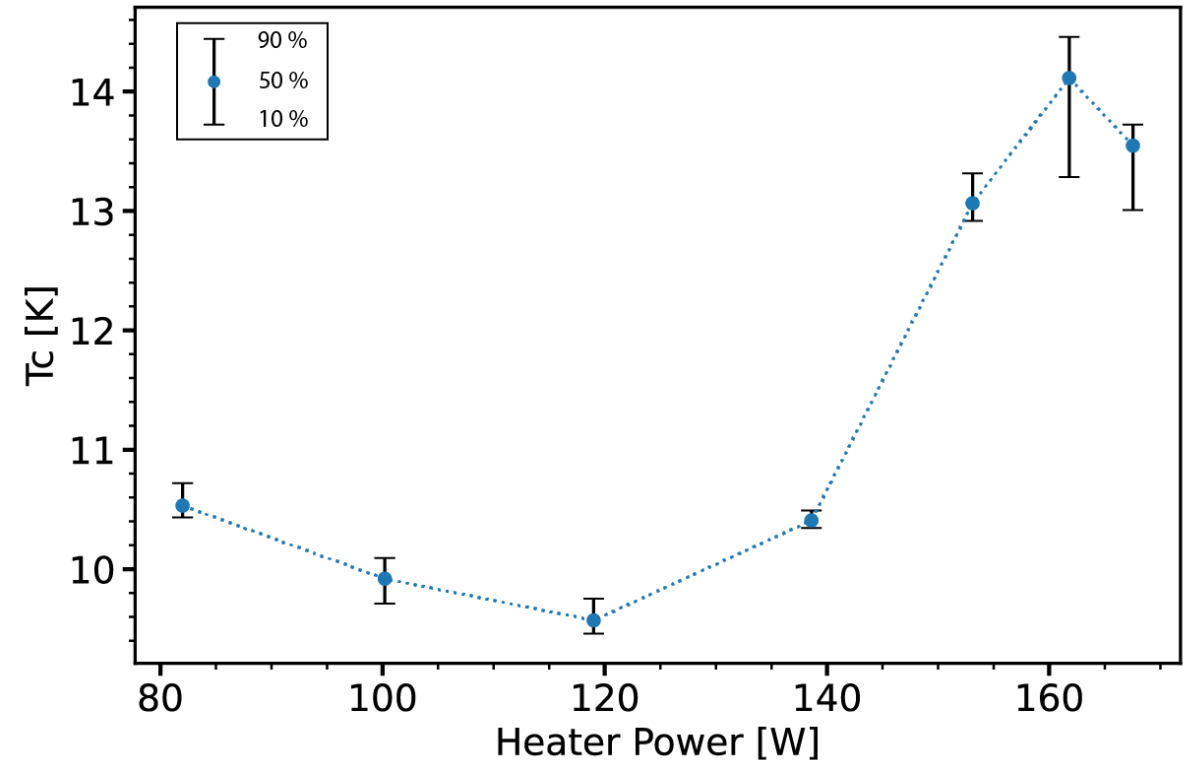
WP9 Meeting - V_3Si Thin Film Update

Overview from previous meeting

A series of thin V_3Si films were deposited using pulsed DC sputtering of a single target, at varying temperatures.

Highest T_c (14.1 K) achieved was at the limit of the heater setup.

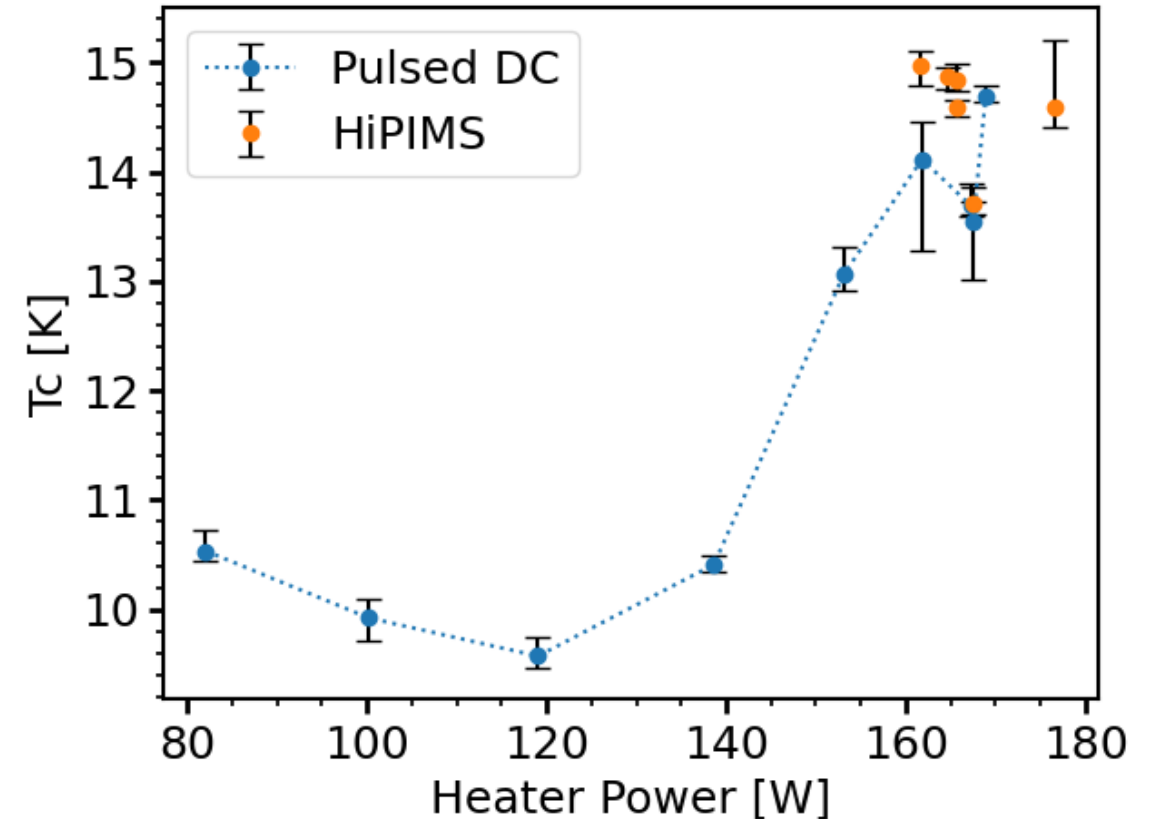
Plan was to investigate HiPIMS, Post-Annealing and niobium substrate.



Thin Film deposition – HiPIMS - Sapphire

HiPIMS at high temperatures resulted in a slight increase in maximum T_c measured (14.85 K).

Overall, higher consistency and sharper superconducting transition.



HiPIMS – Sapphire

Using HiPIMS Deposition parameters:

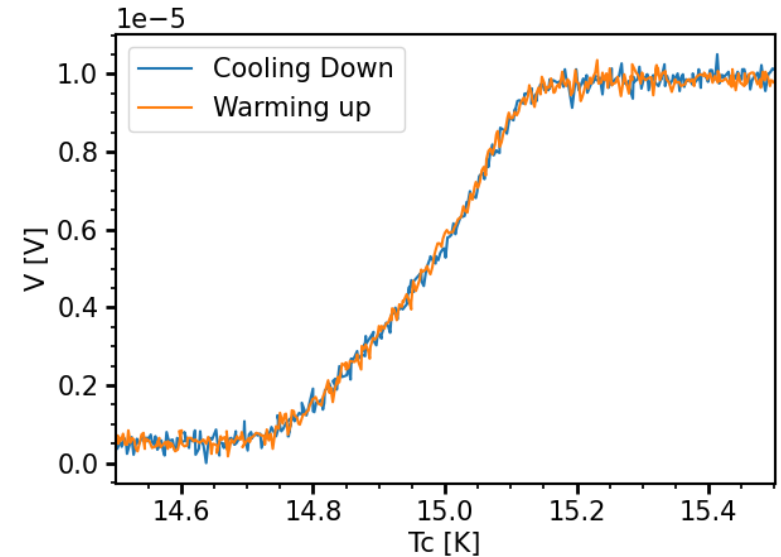
Power - 300W

Duty Cycle – 10 %

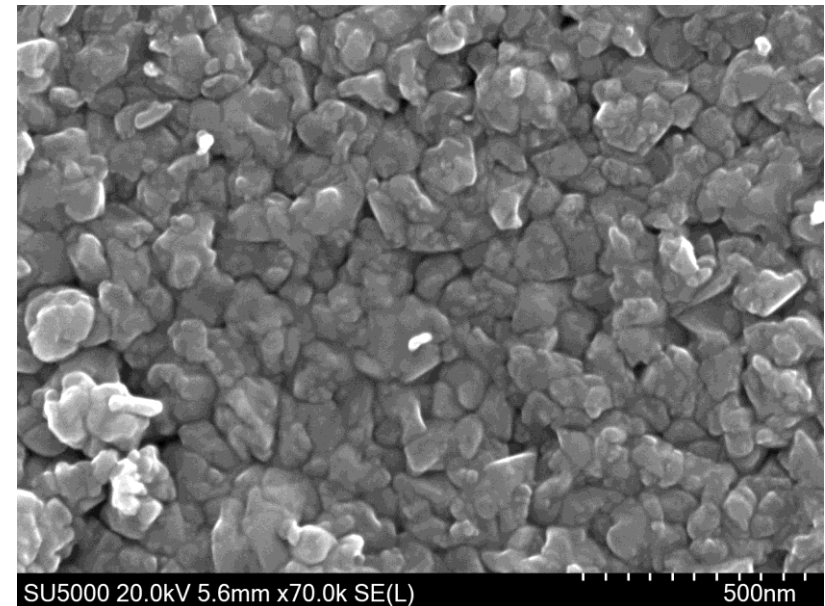
Pressure – 5×10^{-3} mbar

T_c – 14.8 K

SEM - Granular structure observed.
- Grain size still small.



Four Point Probe [0.3 mA]



SEM

Post Annealing – Sapphire



Alongside film deposition. A tube furnace was recommissioned for post annealing.

Allowing annealing up to 1200 C at 3×10^{-3} mbar.

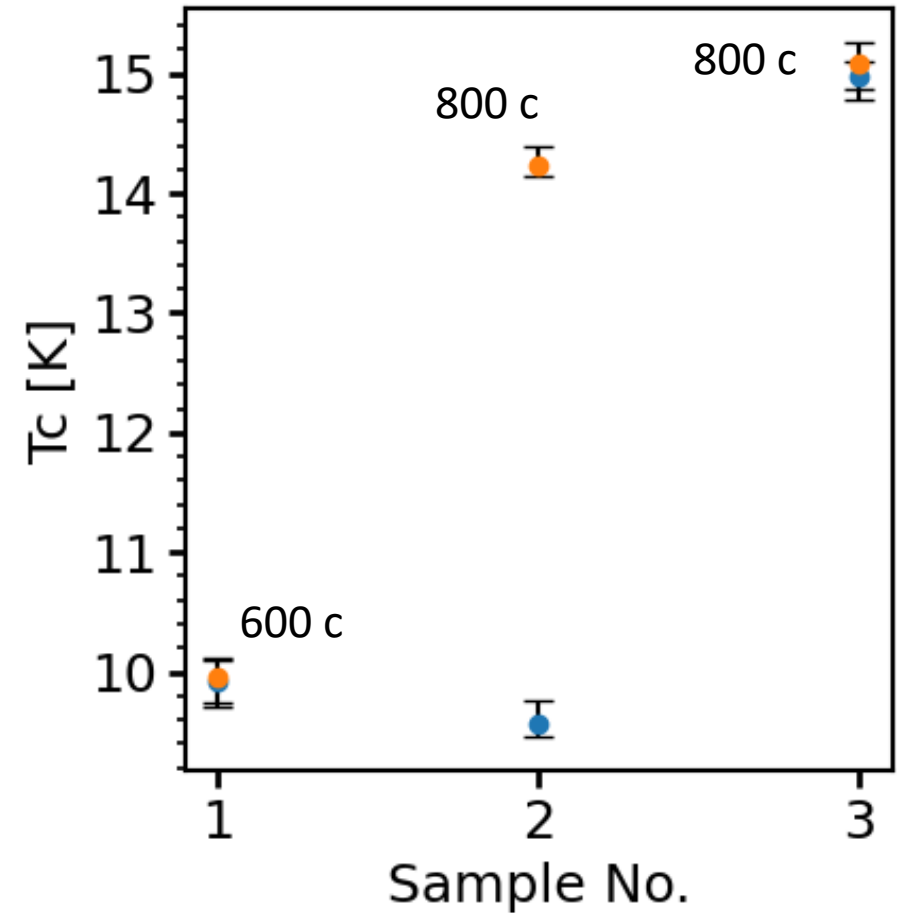
Post Annealing - Sapphire

So far three V_3Si on sapphire sample have been annealed.

Sample 1: 600 C for 3 hours, No change observed in T_c .

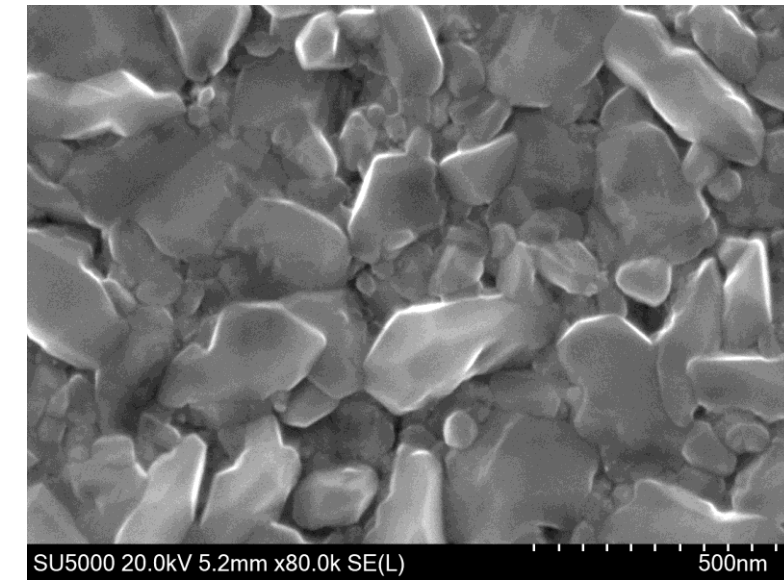
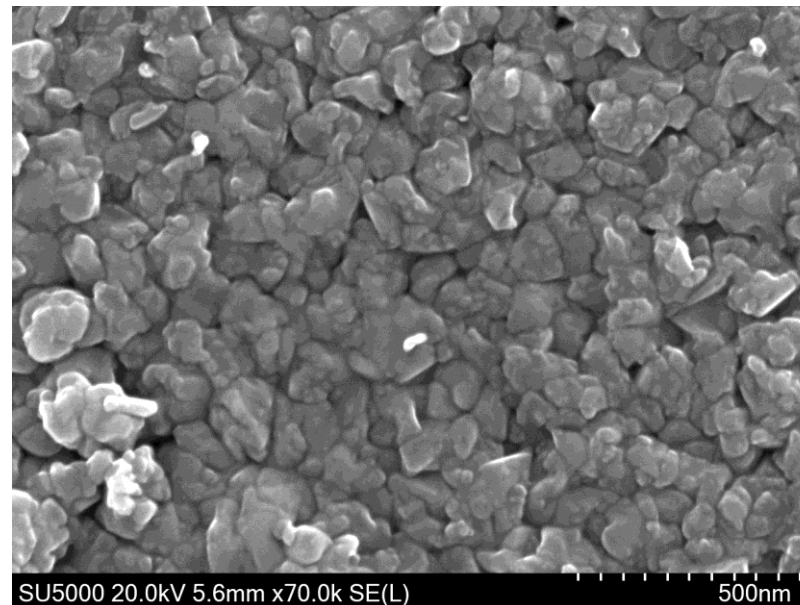
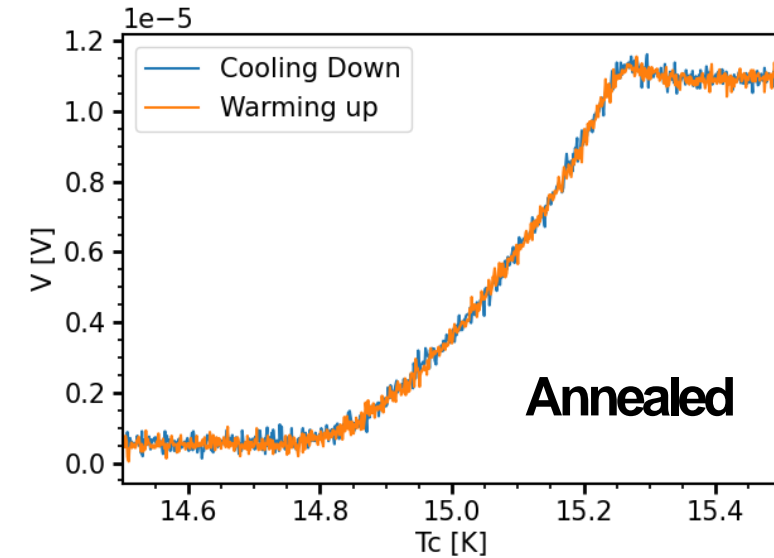
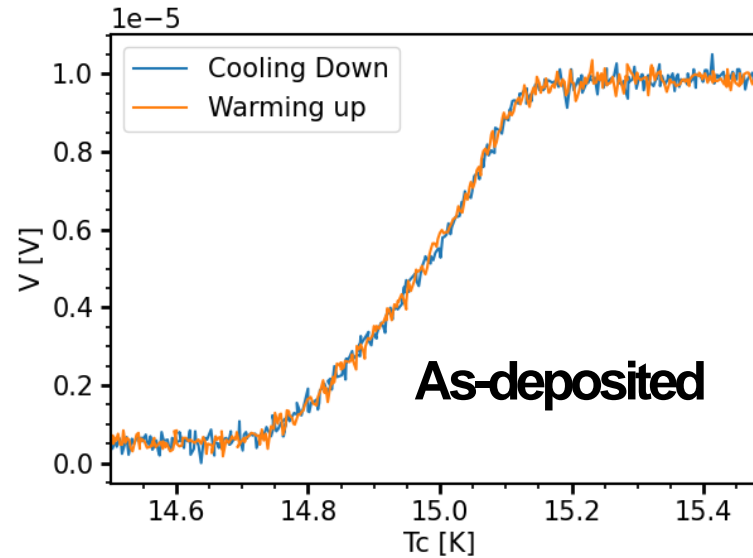
Sample 2: 800 C for 3 hours, Significant increase in T_c from <10 K to >14 K.

Sample 3: 800 C for 3 hours, slight increase in T_c from 14.8 K to 15 K.



Post Annealing – Sapphire (Sample 3)

- Looking at the ‘best’ sample.
- Sample annealed using tube furnace at 800 C at 3×10^{-3} mbar.
- Much larger grain structure observed.
- An increase in T_c by 0.2 K.



Deposition - V_3Si on Niobium foils

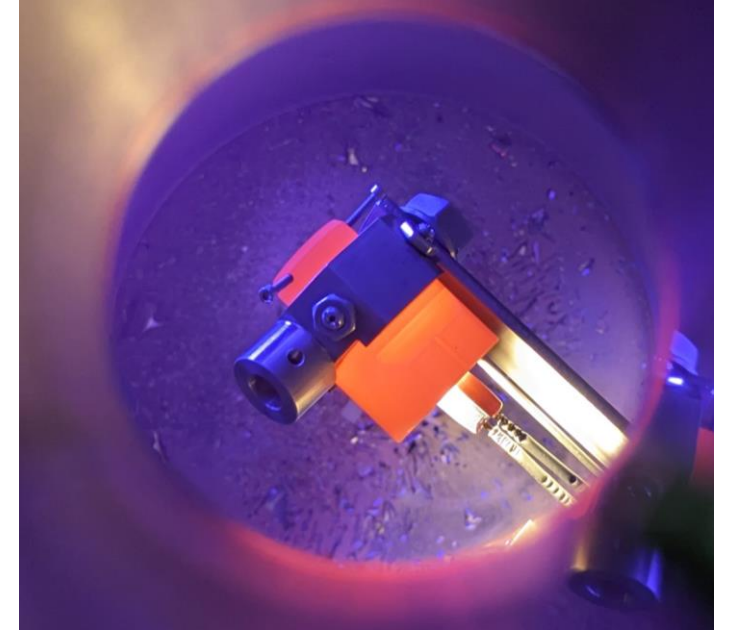
- Following the deposition parameters on Sapphire substrates. We have started looking at Nb foil substrates.

Typical deposition parameters:

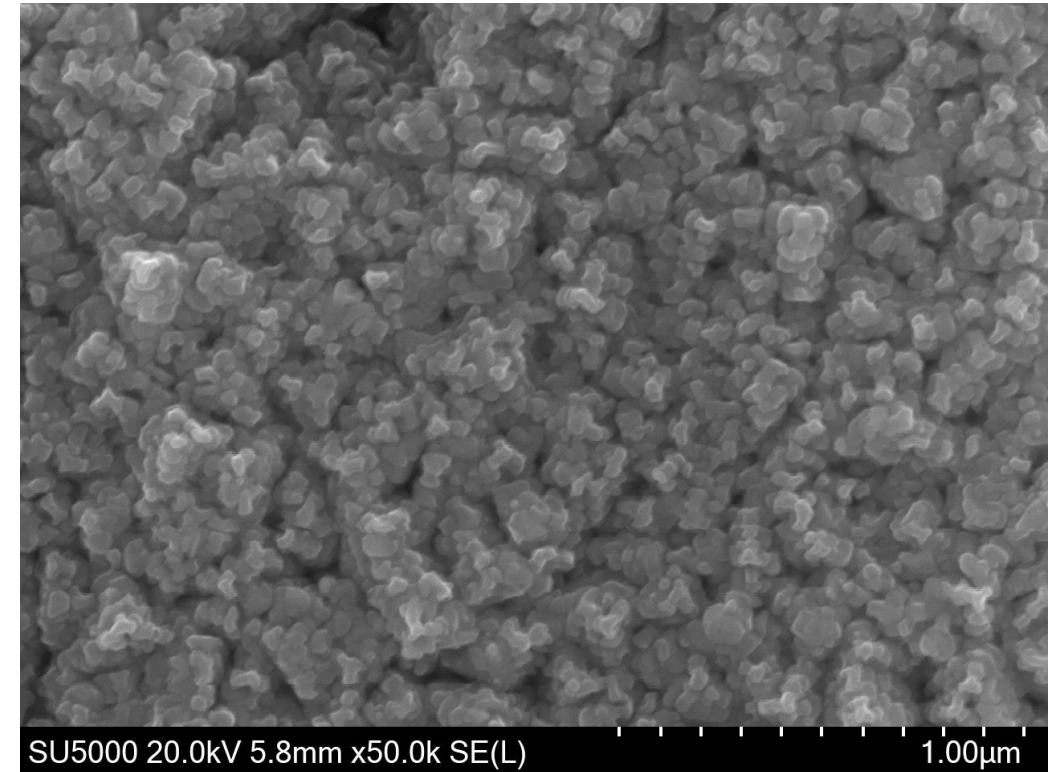
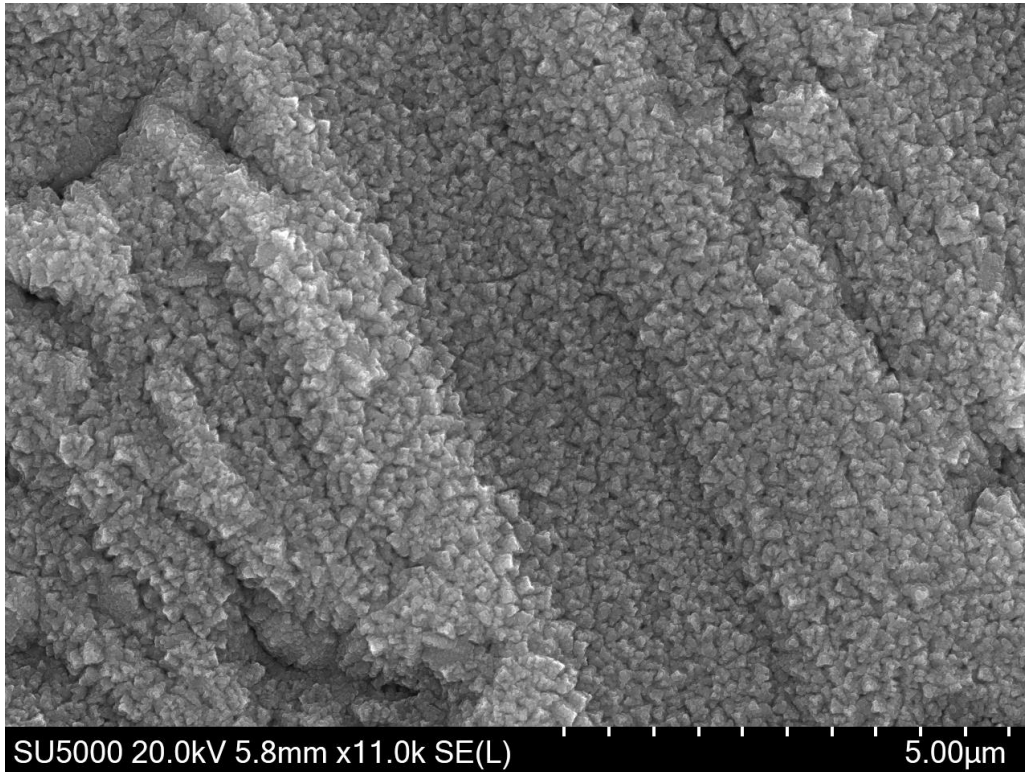
Power - 300W

Duty Cycle – 10 %

Pressure – 5×10^{-3} mbar



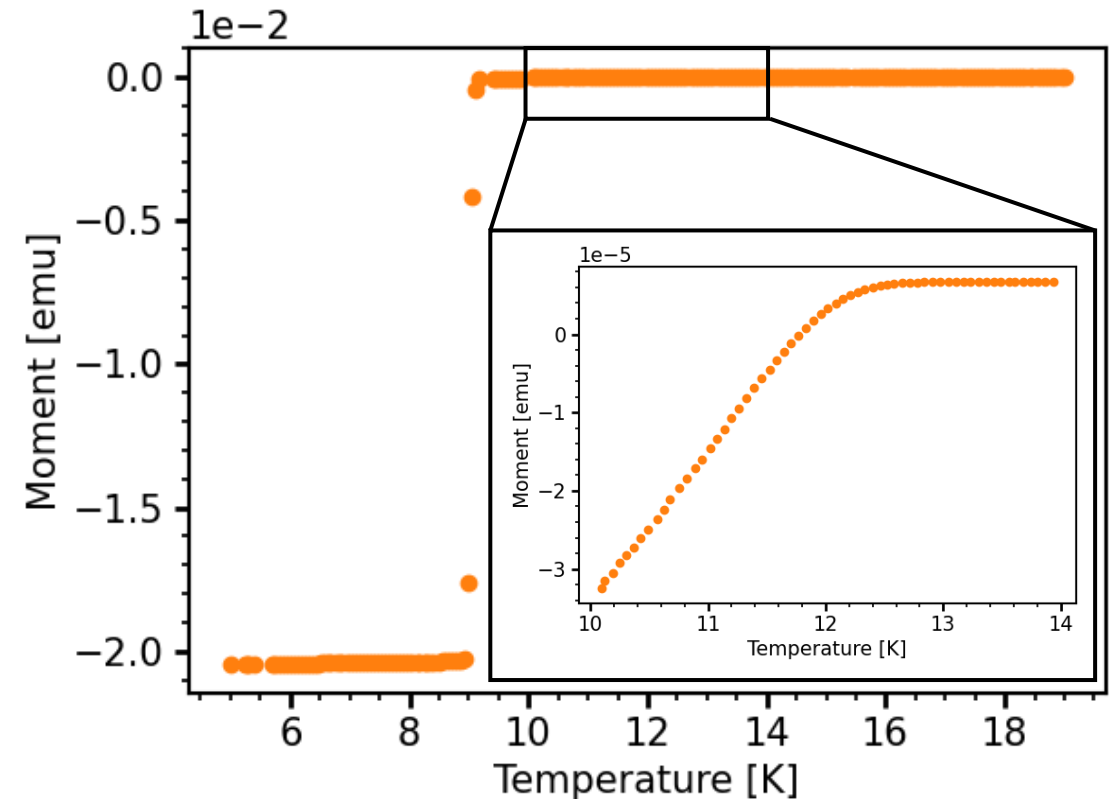
SEM – V₃Si on Niobium



Typical SEM image: Granular structure observed. Overall roughness and density is high. Caused by the roughness of the underlying Nb foil substrate?

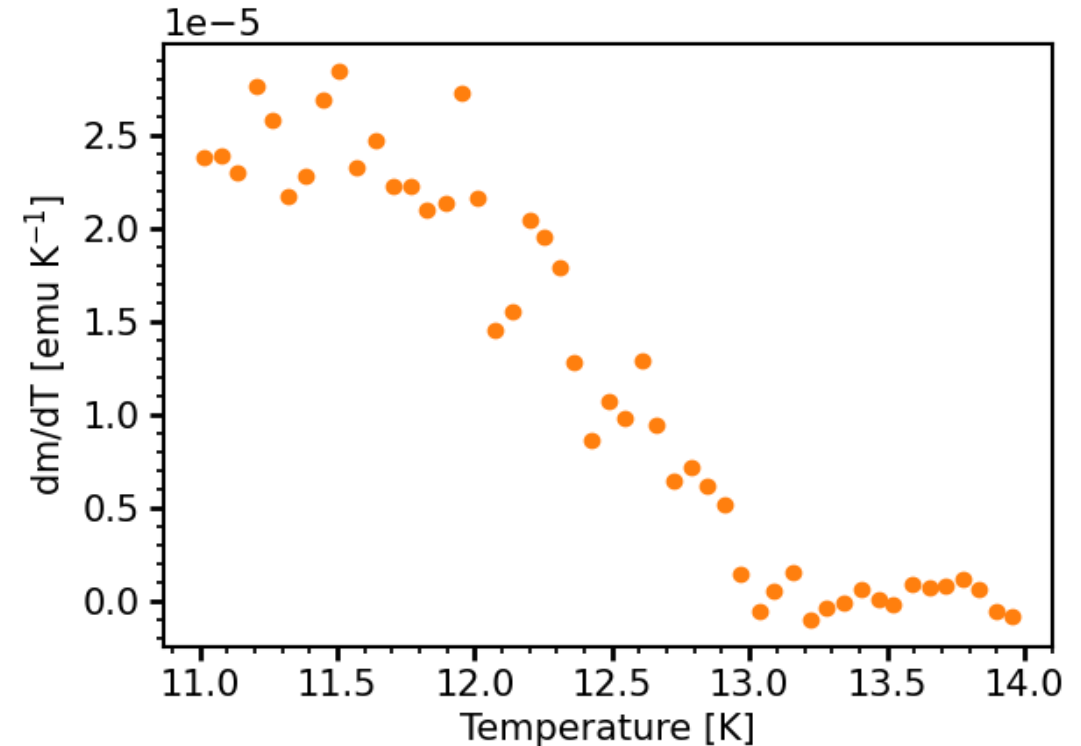
Thin Film deposition – V_3Si on Niobium

- Samples were sent to RAL for GIXRD and VSM measurements.
- Niobium substrate T_c : 9.1 K
- V_3Si film: A transition is observed starting at 13 K.
- The transition observed is very wide and overshadowed by the Nb transition.



Thin Film deposition – V_3Si on Niobium

- Samples were sent to RAL for GIXRD and VSM measurements.
- Niobium substrate T_c : 9.1 K
- V_3Si film: A transition is observed starting at 13 K measured from the first derivative.
- The transition observed is very wide and overshadowed by the Nb transition.

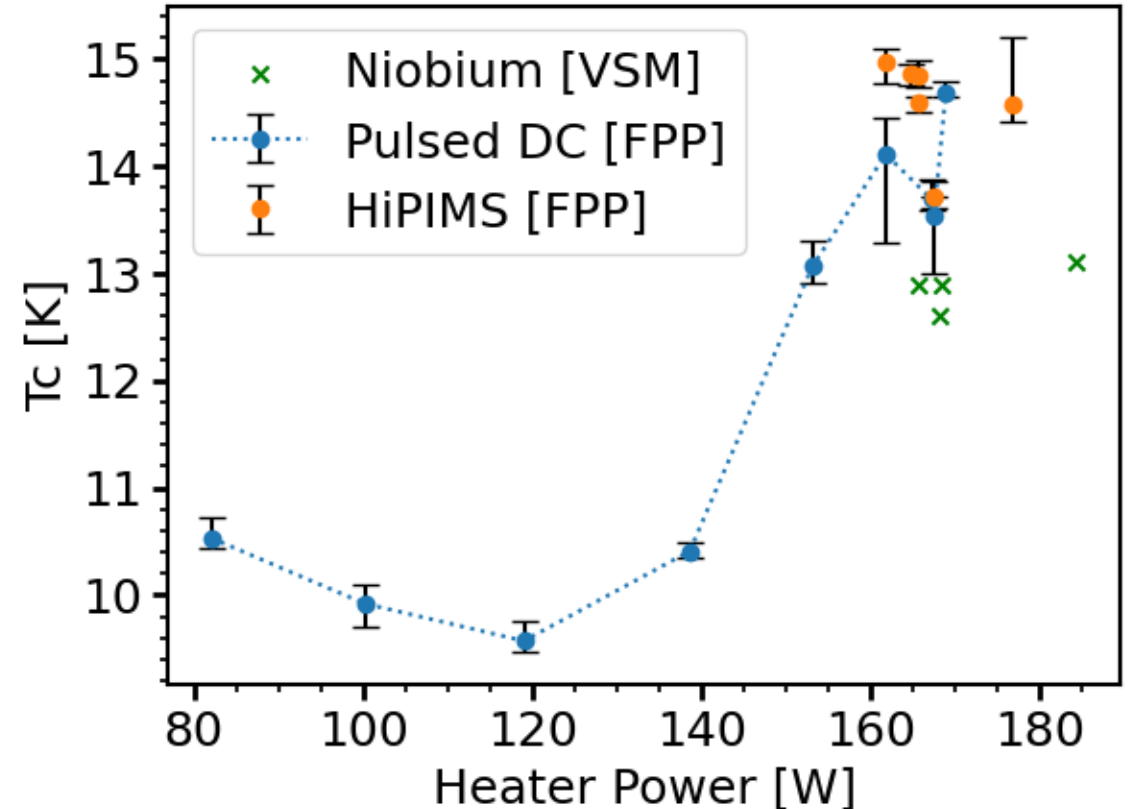


Thin Film deposition – V_3Si on Niobium

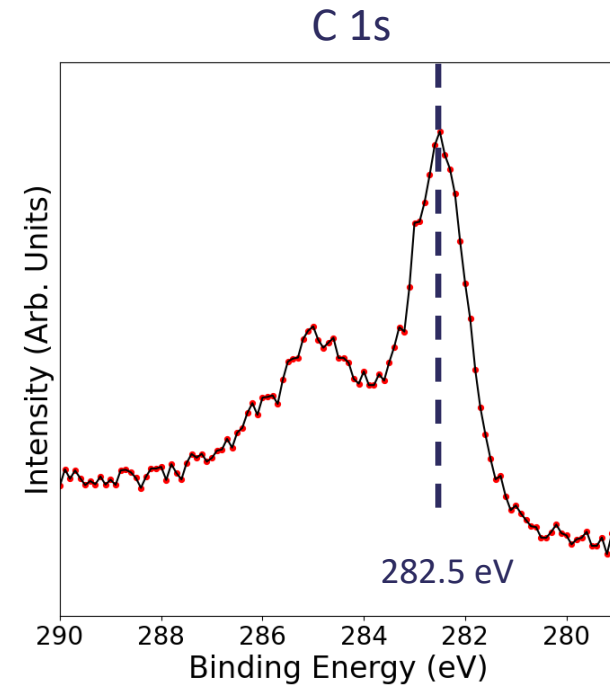
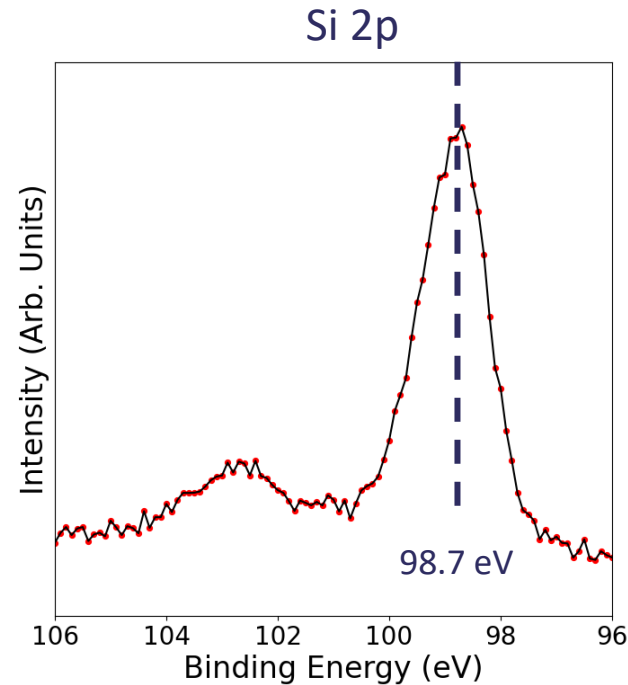
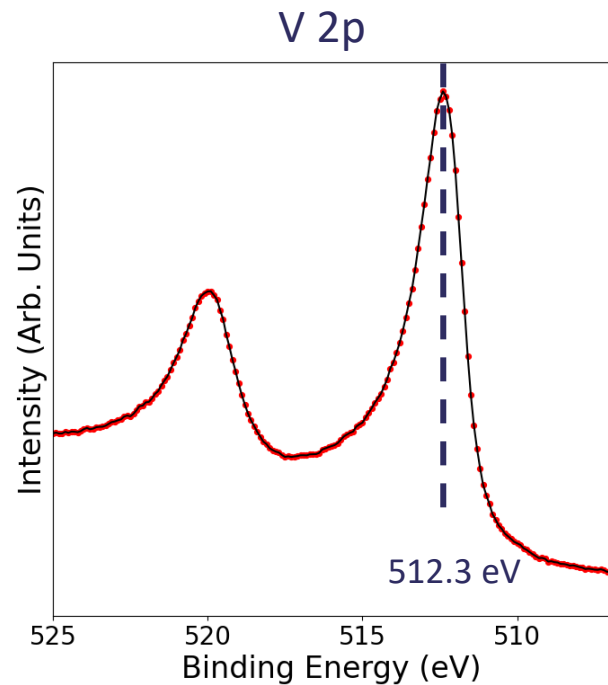
- A total of four samples have currently been produced (Marked in green).

- At the limits of the deposition system a T_c of 13 K on a Nb foil is measured using VSM.

- This is ~ 2 K lower than best measured T_c measured on sapphire (Using FPP).



XPS – V₃Si on Niobium



XPS notes:
Vanadium aligning with metallic V.

Silicon shifted 0.7 eV from ref.

Carbon present in the film aligning with typical carbide BE.

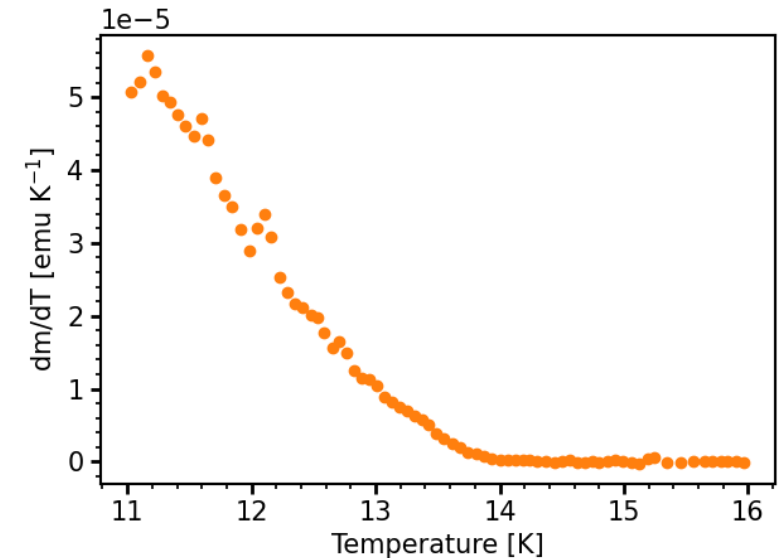
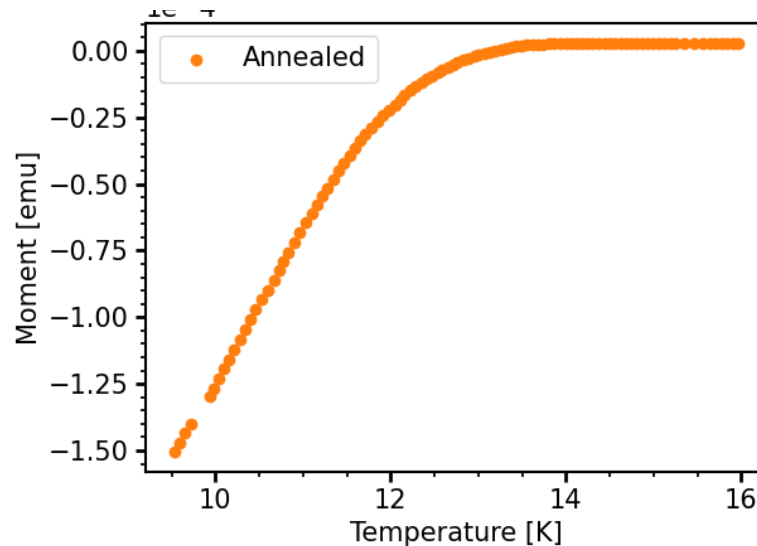
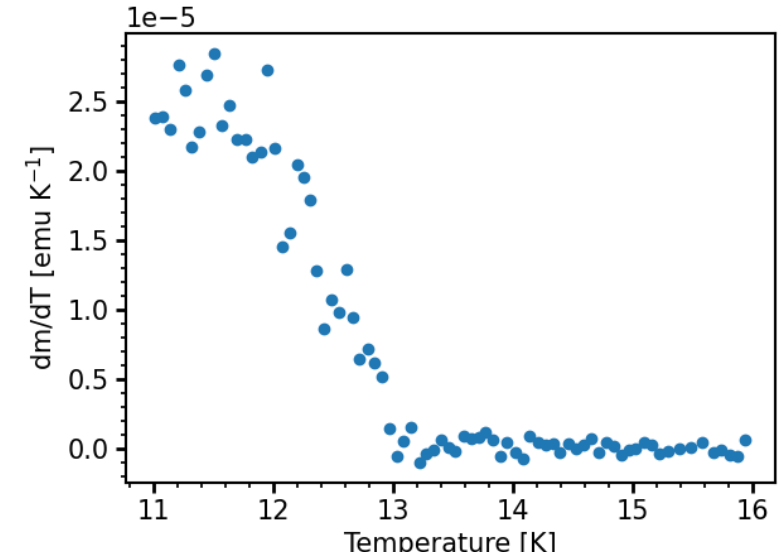
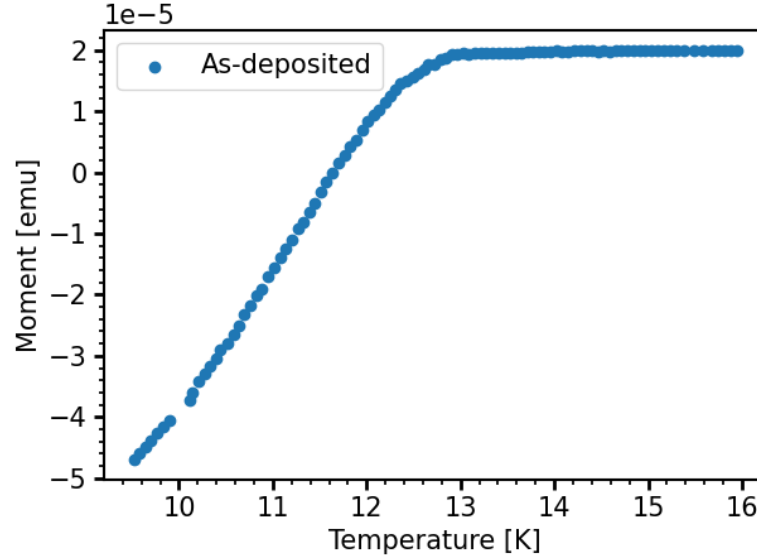
- Sample was sputtered for 4 hours to probe the bulk of the film and not just the adventitious species on the surface.
- Oxygen present on the surface but not present after sputtering. Carbon present after sputtering.

Post Annealing – V₃Si on Niobium

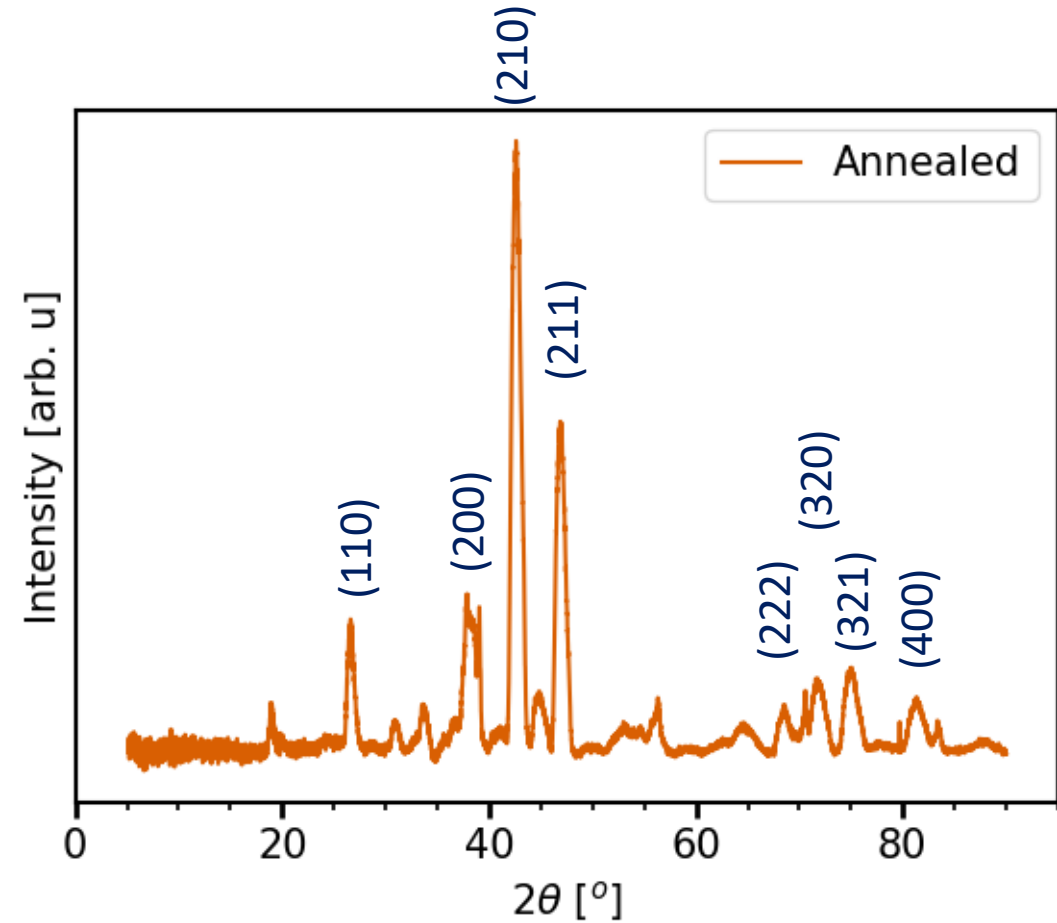
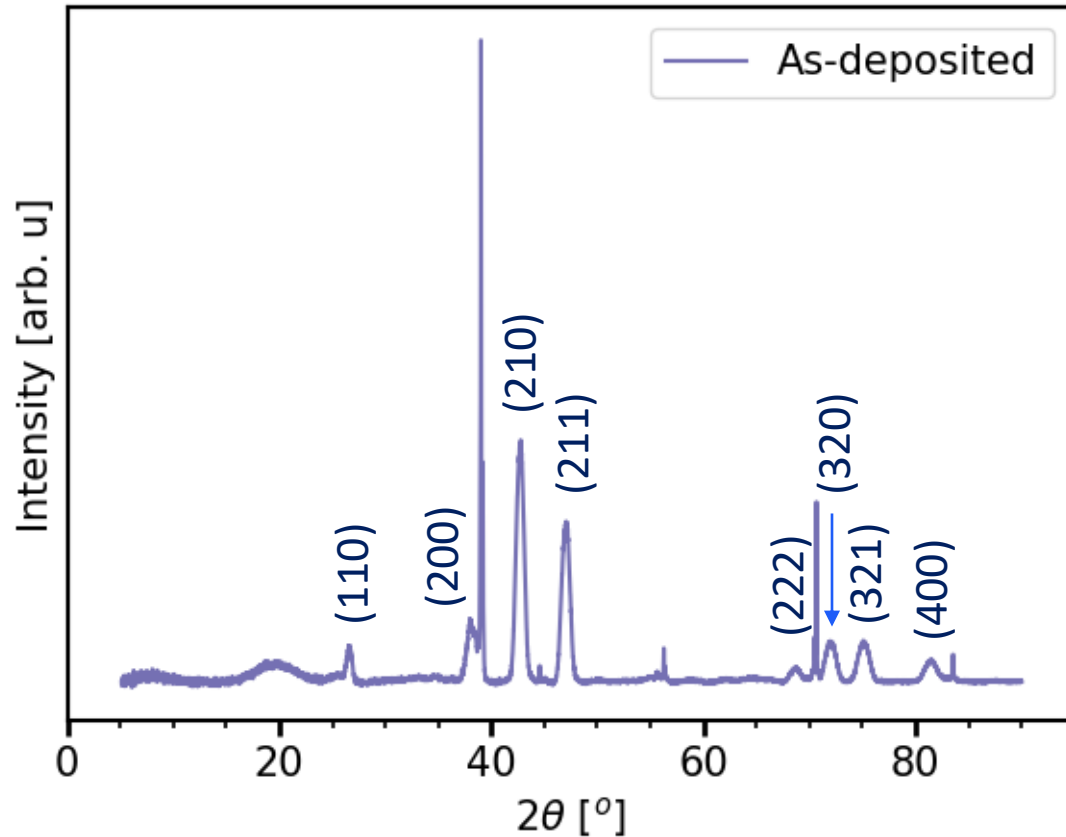
- Lastly, one Nb sample was annealed at 800 C for three hours following the same recipe as the sapphire samples.

- The T_c increased by 0.7 K to ~ 13.8 K, however the transition looks broader.

- This is likely from the introduction of contaminates from the furnace.



GIXRD - V₃Si on Niobium



- Using GI-XRD, annealing has introduced more unidentified peaks. Insinuating the poor pressure in the tube furnace is introducing other elemental species.

Summary

- A series of V_3Si on Sapphire and Nb substrates have been deposited.
- The maximum heater power in the deposition chamber a T_c of ~ 14.9 K and ~ 13.1 K has been on achieve on sapphire and niobium respectively.
- Post annealing at 800 C at 3×10^{-3} mbar has shown an improvement in T_c but currently introduces contamination into the film.

