**Introduction/Motivations**

Particles are accelerated in Radio Frequency (RF) structures with large field gradients and the RF cavities made of superconducting materials provide the best solution. However, they are relatively expensive, so a good and reliable alternative is RF cavities made of copper and coated with a thin layer of superconducting material. The quality and properties of these coated layers are very sensitive to deposition conditions and parameters. Thus, to develop the UK capability in a field of coated superconducting RF the ASTeC began a research programme based on Physical Vapour Deposition (PVD) coatings. Samples of niobium coatings of silicon substrates have been deposited with different parameters and their superconducting properties were characterised on a new testing facility at low temperatures using a pulse tube cryocooler.

**SRF Thin Films**

The films were all niobium on silicon substrates produced by Physical Vapour Deposition (PVD) with different deposition parameters such as temperature T and power P with pulsed 350 Hz DC mode. The substrate was biased to ground.

- **Figure 1:** T = 400°C, P = 200 W
- **Figure 2:** T = 20°C, P = 200 W

The film thickness is about 1.8 microns. Also EDX study showed that there is 1% Al impurity. This is from the Al ring holding the target in place. SEM study showed a columnar structure.

**Evaluation at Low Temperatures - Setup**

The properties of the thin films, particularly the Residual Resistivity Ratios (RRRs) and the critical temperature $T_c$, were measured using the following set up:

- **Figure 6:** A schematic showing the experimental setup to investigate the RRRs of the thin film samples
- **Figure 7:** The inner components of the experimental facility
- **Figure 8:** Photograph of 2 samples attached to the copper sample holder

The samples (~1 cm$^2$) are held to the copper sample holder are attached to the surface of the films with conductive epoxy adhesive for the four-point resistance measurements.

The system is pumped to a vacuum in the magnitude of 10$^{-1}$ mbar and then cooled to about 4 K (temperatures monitored with sensors on the sample holder itself and elsewhere in the setup). The heater (attached to the same copper 'stage' as the sample holder) is then heated to maintain temperatures at regular intervals up to around 15K.

The four wire measurement setup is then used to measure the potential difference whilst a 10mA current is supplied so as to calculate the resistance at each temperature interval.

**Conclusions & Further Work**

Further samples are going to be produced by varying the deposition parameters for a systematic study of their correlation with surface structure, morphology to measured RRR and $T_c$ with an aim to identify the optimum parameters necessary to maximize the RRR of the 2D thin film samples. A facility to test larger 3D samples in an RF cavity structure is under development for future use based on the ongoing results of this experiment.

**Evaluation at Low Temperatures - Results**

Overall, the thin films have been showing predictable behaviour such as critical temperatures around 9 ± 1 K (approximately around the general critical temperature of Niobium under atmospheric pressure) and improving RRR measurements with increasing density of the thin film structure from RRR~2 for the samples produced at 200 W to RRR~30 for the samples produced at 200 W.

**Figure 9:** A graph of the results from one of the experiment runs to investigate

**Figure 10:** A graph of the results of different sample temperatures at 400W power showing the relationship with the RRR results

Improving the deposition conditions by increasing the temperatures to increase the densities (see Figures 3 to 5) already improves the RRR by a factor of 2.

**Figure 11:** A graph of the results from one of the experiment runs to investigate