IET International Travel Award Report

Dr Xinyun Liu

Thanks to the support from the Institution of Engineering and Technology (IET), I had the privilege to visit Professor Rainer Hillenbrand's group. As a world-leading research group in scattering-type scanning near-field optical microscopy (s-SNOM), Professor Hillenbrand's group at CIC nanoGUNE has been at the forefront of instrumental and methodological developments in this field. This trip has played a key role in advancing my research by enabling access to world-class facilities and expertise. It provided the opportunity to carry out hands-on experimental work, deepen my technical skills, and gain valuable insights that directly contribute to the progress of my projects.

Ion implantation is a key technique for fabricating nanostructures in quantum devices, such as qubits and single-photon emitters. Accurate characterisation of ion-implanted regions is therefore essential for optimising implantation parameters and improving device performance. Conventional characterisation methods, such as secondary ion mass spectrometry (SIMS), transmission electron microscopy (TEM) and Raman spectroscopy, often face trade-offs between spatial resolution, sample preparation complexity, and non-destructive measurement.

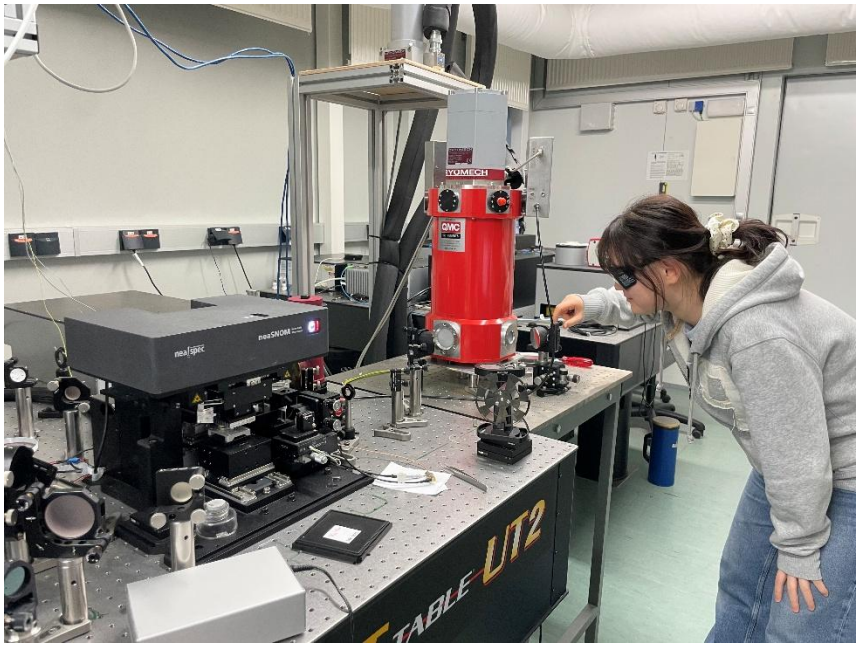

Figure 1. Dr Xinyun Liu aligning the terahertz s-SNOM.

In this study, by carefully selecting ion species and host substrates, s-SNOM enables probing of implantation profiles via phonon-assisted and carrier-assisted contrasts. The complementary s-SNOM capabilities of the Boland group at the University of Manchester and Professor Hillenbrand's group allow for comprehensive characterisation of ion-

implanted regions. This approach provides an alternative method with high surface sensitivity (<100 nm), minimal sample damage, and simplified preparation requirements. Importantly, the results from s-SNOM characterisation can be directly fed back into the ion implantation process, facilitating optimisation of ion beam alignment and processing parameters.

During this visit, several ion-implanted samples were measured using state-of-the-art s-SNOM systems. These measurements enabled detailed investigation of ion implantation profiles in both in-plane and out-of-plane directions. The study demonstrates the potential of s-SNOM as a powerful tool for nanoscale characterisation of implanted regions, offering high spatial resolution and sensitivity to local optical and electronic properties.

Overall, the support provided by this award has strengthened both the quality and impact of my research, while fostering collaborations that will continue to be beneficial beyond the duration of the visit.

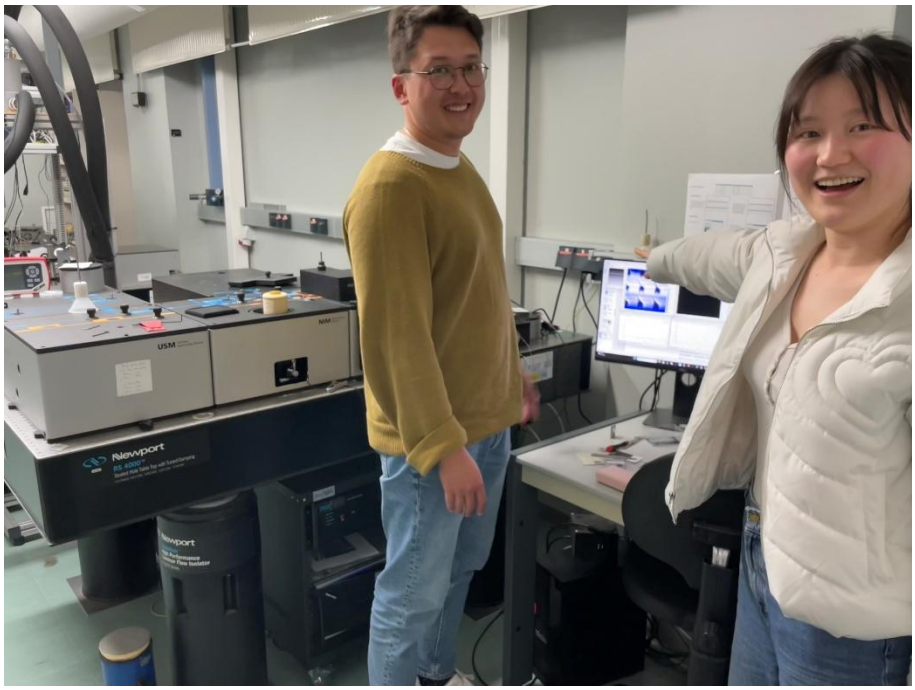

Figure 2. Dr Xinyun Liu and Dr Andrei Bylinkin in lab measuring the Silicon Carbide sample implanted with Bismuth.