The Warwick-A*STAR Research Attachment Programme (ARAP) offers **fully funded four year PhD studentships**, in **Interdisciplinary Research**. We provide an exciting opportunity for students to grow as experimental scientists, undertaking research to the highest international standards whilst working for extended periods in collaborating laboratories at the University of Warwick and an A*STAR research institute in Singapore. Projects are designed and supervised jointly by a Warwick and an A*STAR supervisor and training and support is given at both locations. Students typically spend Years One and Four at Warwick and Years Two and Three in Singapore. (https://warwick.ac.uk/fac/sci/med/study/arap/about/)

Project title	**Warwick supervisor**	**Singapore supervisor(s)**
Physics		
Innovative Design and Precision Characterization: Unleashing the Potential of Next-Gen Piezoelectric Thin Films for High-Speed Wireless Communication	Dr Peng Wang	Dr Huajun Liu

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Interested applicants can send their CV, personal statement, covering letter and contact names for 2 referees toarap@warwick.ac.uk no later than 15th Jan 2025, with interviews in the third week of Feb.

Innovative Design and Precision Characterization: Unleashing the Potential of Next-Gen Piezoelectric Thin Films for High-Speed Wireless Communication

As the world enters the era of 5G wireless network, the critical role of high-speed wireless communications is more important than ever to enable exciting applications such as autonomous vehicles, virtual reality, and Internet of Things (IoT). The key device that controls the speed of wireless data transfer is the radio frequency filters, among which acoustic wave based filter is the best product with small footprint and low cost. To achieve high speed wireless data transfer, piezoelectric thin films with higher electromechanical coupling coefficients are desired. In this project, thin films with much higher coupling coefficients than the current market products will be developed. This will serve as the hardware foundation for high-speed wireless network for 5G and IoT.

This project aims to develop high-performance piezoelectric thin films ($NaNbO_3$) as shown in Fig. 1 for next generation wideband acoustic filters via combining innovative thin-film design with atomic-resolved structural characterization. We will design novel nanostructures and crystalline phases, grow high-quality $NaNbO_3$ thin films, and subsequently fabricate acoustic resonator devices using photolithography and etching methods. The growth condition will be further optimized by the performance of the devices that is evaluated by acoustic filter tests. To understand the fundamental mechanism of macroscopic performance, we will carry out a systematic study of the structure and electronic properties of the thin films using 4D STEM (Fig. 2) and directly image the polarization, electric field and charge density distribution with atomic resolution. Combining *in-situ* TEM, the dynamic behaviors of nanostructures in the devices, including the nucleation and growth of domains during switching under applied electrical field or mechanical stress will be fully characterized. By leveraging world-leading expertise in the fields and the state-of-the-art research facilities, oxide Growth Facility at the A*STAR and electron microscopy RTP at the University of Warwick, our goal is to perform cutting-edge research and exploit the developments in next generation piezoelectric thin films for high-speed wireless communications.

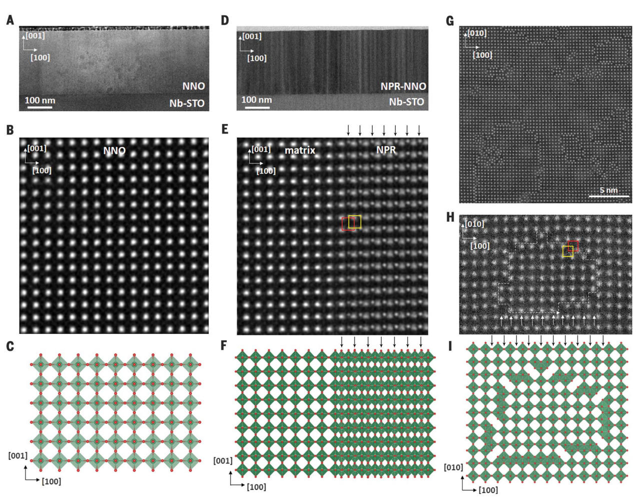

Fig. 1 Atomic Structure of $NaNbO_3$ thin film[1]

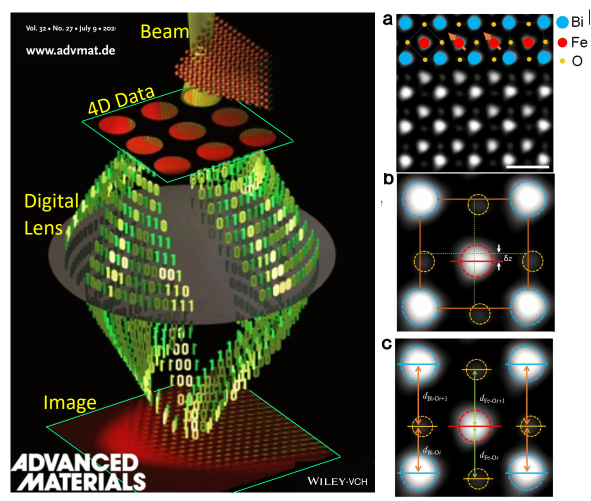

Fig. 2 4D-STEM imaging [3] and the polarization mapping of $BiFeO_3$ [2,4]`

References : [1] Science **369**, 292, (2020). [2] Nature **570**, 87, (2019). [3] Advanced Materials, e1903747, (2019). [4] Nature Communications **13**, 5116, (2022).