PhD advert template – 2021 entry

Supervisor name/s	Kamal Asadi
Email contact	Ka787@bath.ac.uk
Department	Physics
Title of project This should be as specific as possible. Generic titles such as PhD in Computer Vision will not be accepted.	**Unravelling the kinetic of dipole (polarization) switching in ferroelectrics**
Preferred start date	Monday 4 October 2021
Overview of the research Max 350 words (do not include scientific characters or pictures)	The emergence of the big-data era calls for paradigm change in the way of storage as well as processing of information. New circuit building-blocks are required to overcome the intrinsic inefficiency of transistors in our present von Neumann computing architectures. Various physical properties have been exploited for novel memories that could enable energy- and area-efficient in-memory computing for non von-Neumann architectures. Ferroelectric materials have been considered among the key enablers for information processing in memory platforms for neuromorphic computing. A prerequisite is deterministic creation of multiple partial polarization states, which, however, is still a standing challenge due to the inherent bi-stability of ferroelectric switching and the lack of solid fundamental understanding of the polarization dynamics in ferroelectric materials. The polarization switching is believed to be through nucleation of domains with reverse polarization upon application of an electric field, and subsequent growth of nucleated domains, and is dominated by the motion of domain walls. Partial ferroelectric polarization in neuromorphic devices means increasing the size of one polar region at the expense of another, and hence controlling the movement of a domain walls separating these regions. Despite the success of the nucleation and growth (NG)-based models in interpreting polarization dynamics, these models still lack fundamental insight, for instance, how thermodynamic governs the emergence of domains with reverse dipoles, and how such domains grow, decompose or merge in time. Such lack of fundamental understanding is a limiting factor towards the full exploitation of the ferroelectric materials in neuromorphic applications. The objective of this project is to develop a theoretical model that employs the thermodynamics of the nucleation process and growth dynamic of the nucleated domains and then experimentally validate the model to fully capture the polarization dynamics in ferroelectric materials. The project is a combination of theory, experiment and computational work. The ideal candidate has a background in one of the following disciplines condensed-matter physics, solid-state physics, materials science, computational physics/chemistry/materials science, and electronic engineering.
References (optional) If required, you may include a small number of recent publications	a) L. W. Martin, *et al*., *Nat. Rev. Mater.* **2** (2017) 16087. b) R. Xu, *et al*., *Nat. Commun.* **10** (2019) 1282. c) S. Lie, *et al*., *Nature* **534** (2016) 360. d) Y. Shin, *et al*., *Nature* **449** (2007) 881. e) K. Asadi, *Appl. Phys. Rev.* **7** (2020) 021307. e) M. H. Amiri *et al*., *Adv. Funct. Mater.* **30** (2020) 2003085. f) S. Anwar, *et al*., *ACS Macro Lett.* **8** (2019) 525. g) D. Zhao etal., *Phys. Rev. B* **92** (2015) 214115.
Industrial partner (if any) Give details of any industrial collaboration in the project	
Candidate requirements Give details of academic background/experience required	A candidate with background in a) physics/solid-state physics, or b) electronic engineering with a focus on electronic devices, or c) physical chemistry. The ideal candidate is also familiar with scientific computational programs.
Application process	Formal applications should be made via the University of Bath's online application form for a PhD in Physics (full-time)
Funding eligibility *Note from the Doctoral College: this information is based on*	This project is for self-funded students only.

current expectations and we will ensure that the text reflects the latest government guidance at the time of advertising.	
Programme Please select ONE	☐ PhD in Biochemistry ☐ PhD in Biology ☐ PhD in Chemistry ☐ PhD in Computer Science ☐ PhD in Mathematics ☐ PhD in Statistics ☐ PhD in Pharmacy & Pharmacology ☒ PhD in Physics

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Discipline and subject (taken from FindAPhd)

Insert an X in the box next to all that apply (max 10)

Biological & Medical Sciences		**Chemical Sciences**		**Physical sciences**		**Engineering**	
	Agricultural Sciences		Agricultural Chemistry	X	Applied Physics	X	Acoustics
	Biochemistry		Analytical Chemistry		Astrophysics		Aeronautical, Maritime and Transport Engineering
	Bioinformatics		Biochemistry		Atmospheric Physics		Biomedical Engineering
	Biomedical Engineering		Chemical Engineering		Atomic Physics		Chemical Engineering
	Biophysics		Chemical Toxicology		Biophysics		Civil & Structural Engineering
	Biotechnology		Computational Chemistry	X	Condensed Matter Physics	X	Electrical & Electronic
	Botany / Plant Science		Electrochemistry		Fluid Dynamics		Energy
	Cancer / Oncology		Environmental Chemistry		Geophysics		Environmental Engineering
	Cardiovascular Science		Food Chemistry		Low-temperature Physics		Manufacturing
	Cell Biology / Development		Geochemistry	X	Materials Science	X	Materials Science
	Ecology & Conservation		Inorganic Chemistry		Medical / Biomedical Physics		Mechanical Engineering
	Endocrinology		Macromolecular Chemistry		Metrology	X	Nanotechnology
	Evolution		Materials Science		Nuclear Physics		Nuclear Engineering
	Food Science / Nutrition		Organic Chemistry		Optical Physics		Petrochemical Engineering
	Forensic Science		Pharmaceutical / Medicinal Chemistry		Particle Physics		Semiconductors
	Genetics	X	Physical Chemistry		Plasma Physics		Software Engineering
	Immunology		Synthetic Chemistry		Quantum Physics		Telecommunications
	Marine Biology	**Earth Sciences**			Radiation	**Social Science & Health**	
	Medical/Biomedical Physics		Agronomy & Soil Science	X	Semiconductors		Anthropology
	Medical / Clinical Science		Atmospheric Physics	X	Solid state Physics		Architecture & the Built Environment
	Medical Imaging		Climatology & Climate Change		Theoretical Physics		Education
	Microbiology		Ecology & Conservation	**Maths & Computing**			Gender & Sexuality
	Molecular Biology		Ecotoxicology & Pollution		AI & Machine Learning		Health Sciences
	Neuroscience / Neurology		Environmental Chemistry		Applied Mathematics		Psychology
	Obstetrics, Gynaecology & Reproduction		Environmental Engineering		Bioinformatics		Public Health & Epidemiology
	Ophthalmology & Visual Science		Environmental Science	X	Computational Chemistry		Social Work, Social Policy & Administration
	Palaeobiology		Geochemistry		Computer Science & IT		Sociology
	Parasitology		Geography		Data Analysis		
	Pathology		Geology		Information Science		
	Pharmacology / Toxicology		Geophysics		Mathematics		
	Pharmacy / Pharmaceutics		Hydrology		Operational Research		
	Physiology & Sports Science		Meteorology		Software Engineering		
	Psychology & Psychiatry		Oceanography		Statistics		
	Public Health & Epidemiology		Palaeontology				
	Structural Biology						
	Virology						
	Zoology/Animal Science						