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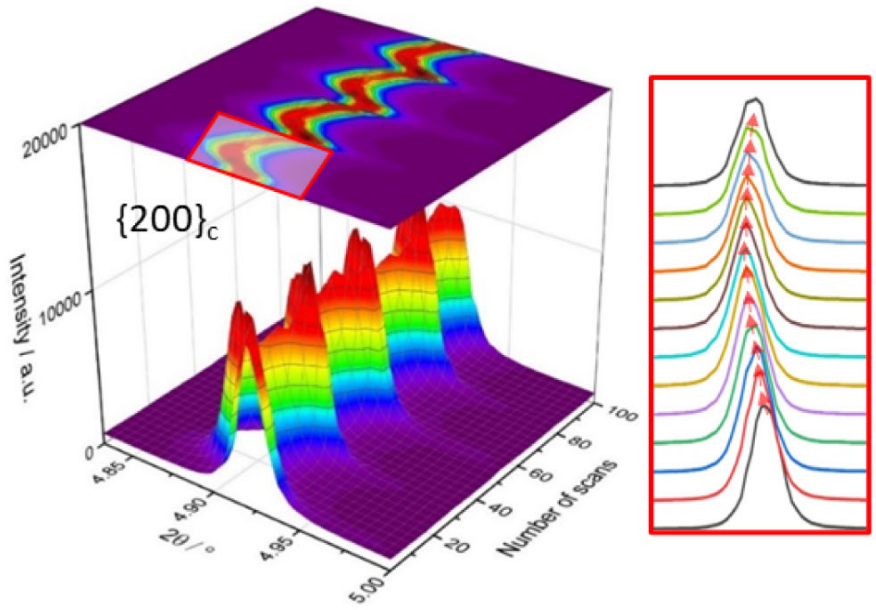

Ge WANG
University of Manchester, UK

Electric field induced strain in pseudo-cubic $BiFeO_3$-based ceramics

2pm - 3pm (Amphi 1 - IUT de Blois : Chocolaterie)

Piezoelectric ceramics (e.g., $Pb(Zr_xTi_{1-x})O_3$, PZT) convert mechanical energy into electrical energy and vice versa, playing a vital role in a wide range of modern applications, such as sensors, actuators, and transducers. Due to global environmental concerns regarding lead toxicity, the development of environmentally friendly, lead-free piezoelectric materials is of utmost urgency. Currently, single crystal materials are used for high-performance actuators, exhibiting a high electro-strain of over 1%.[1] However, the experimental procedures for the growth of single crystals are extremely complicated and different for each type of material, leading to time waste and low production rates. Instead, untextured polycrystalline ceramics are relatively easy to produce, but the electromechanical performance is significantly reduced due to the presence of randomly oriented grains. Among all lead-free piezoelectrics, $BiFeO_3$-based ceramics have been recognised as promising high-temperature piezo candidates with moderate electromechanical properties. For actuators, electric field-induced strain is the most important characteristic, so extensive studies have been devoted to improving the electrostrain of $BiFeO_3$-based ceramics by realising electric field-induced structural transformation and/or large domain switching. For example, a high electrostrain of 0.38% was reported in $0.64BiFeO_3$-$0.36BaTiO_3$ bulk ceramics. [2] The structure was found to transform from pseudo-cubic to rhombohedral at high electric fields, achieving high electrostrain due to irreversible structural transformation and large domain switching. Recently, some of our in-house ceramics, based on $BiFeO_3$-$BaTiO_3$ and $BiFeO_3$-$SrTiO_3$, have been found with optimised electrostrain in a retained pseudo-cubic structure. [3-5] The crystal structure remained pseudo-cubic before, during, and after the application of an electric field, while optimised strain up to 0.4 % was achieved. Advanced structural and microstructural materials characterisation techniques were employed to reveal the existence of multiple, nanoscale, distorted symmetries (~nm) at the local scale with a common average polar axis, which plays a critical role in enhancing overall electrostrain performance and providing a new strategy for designing lead-free piezoelectric materials.

References:

[1] J. Rödel *et al*, Transferring lead-free piezoelectric ceramics into application, J. Eur. Ceram. Soc., 35, 1659-1681 (2015).
[2] J. Chen *et al*, Origin of large electric-field-induced strain in pseudo-cubic $BiFeO_3$-$BaTiO_3$ ceramics, Acta Mater., 197, 1 (2020).
[3] G. Wang *et al*, Origin of the large electrostrain in $BiFeO_3$-$BaTiO_3$ based lead-free ceramics, J. Mater. Chem. A, 7, 21254-21263 (2019)
[4] Z. Lu *et al*, In situ poling X-ray diffraction studies of lead-free $BiFeO_3$-$SrTiO_3$ ceramics, Mater. Today Phys., 19, 100426 (2021).
[5] G. Wang *et al*, Multiple local symmetries result in a common average polar axis in high-strain $BiFeO_3$-based ceramics, Phys. Rev. Lett., 130, 076801 (2023).