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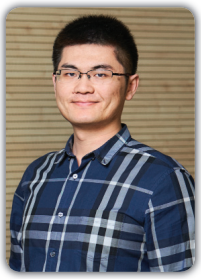

Yang Bai

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A narrow band gap, strong ferroelectric perovskite oxide opening up next-generation opto-ferroelectric and energy harvesting devices

For nearly 40 years, narrow band gap semiconductors and strong ferroelectrics are considered separate material families. Narrow band gap semiconductors are widely used as solar cells and optical sensors. Strong ferroelectric materials have the potential to induce strong piezoelectricity. They are core components for thermal and kinetic sensors, actuators, transducers and energy harvesters. Some simple and pre-mature photoferroelectrics, i.e. ferroelectrics exhibiting photovoltaic effect (e.g. $BaTiO_3$, $BiFeO_3$, $LiNbO_3$ and (Pb, La) (Zr, TiO_3), have been theoretically investigated since the 1970s. However, they either have a wide band gap or a weak ferroelectricity leading to inefficient photovoltaic effects or insensitivity to light/electric/strain excitations, respectively. This issue has then hindered the practical use of these photo-ferroelectrics in potential multi-functional devices.

In this talk, a novel multi-functional perovskite material will be presented, which merges the two fields of narrow band gap semiconductors and strong ferroelectrics for the first time. The composition is a widely used lead-free ferro-/piezoelectric composition, $(K_{0.5}Na_{0.5})$ NbO_3 (KNN), doped by $Ni2^+$ and with oxygen vacancies present in the structure (abbreviated as KNBNNO hereinafter). The KNBNNO is able to exhibit a narrow band gap of 1.6 eV (compared to > 4 eV) whilst maintaining the parental, KNN-level ferroelectric, piezoelectric and pyroelectric properties. Such multi-functional properties enable the KNBNNO to be simultaneously used for visible-range (solar) photovoltaic and ferro-/piezo-/pyroelectric effects. It is the first materials of its kind discovered in history.

Together with its microstructure and working principles, demonstrations will also be shown in this talk for practical applications of the KNBNNO. These include a single-component, multi-source energy harvester-sensor integration system based on only one material, and an opto-ferroelectric component with interactions between light and domain walls for e.g. light-re-writable data storage distinguishing wavelengths.

Speaker Biography

Yang Bai is a tenure track assistant professor for small-power self-sufficient sensor system in microelectronics research unit, University of Oulu, Finland. He obtained his bachelor's degree in 2011 at Tianjin University, China, and PhD degree in 2015 at University of Birmingham, United Kingdom. In 2016, he was granted a Marie Sklodowska-Curie individual fellowship under European Union's Horizon 2020 research and innovation program. He is also an elected committee member of the IOP (Institute of Physics) energy group, UK. His research interests include multi-functional perovskites, photo-ferroelectrics, ferroelectric and piezoelectric materials and energy harvesting technology.

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