Using Engineered Interfaces and Strain-Gradient Regions to Design Properties in Electroceramics

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We materials scientists understand that for current electroceramic materials, it is difficult to achieve either simultaneous enhancement of directly-opposed properties, new physical properties, or ultrahigh properties. So, what can we do to develop new and innovative materials? We believe that future electroceramic materials can be designed on the basis of the "interface engineering" with strain-gradient regions; this is a new frontier for the field. Domain engineering is one means of "interface engineering" with strain-gradient regions, based on homo-interfaces between domains with different crystallographic orientations. Interfaces such as non-180° ferroic domain walls are very effective in enhancing dielectric and piezoelectric properties, as is shown by the large dielectric and piezoelectric enhancements for PZN-PT and PMN-PT single crystals. We will present some applications of "ferroic homo-strained interfaces" for electroceramics with enhanced properties. On the other hands, ferroic homo-strained interfaces are strongly dependent on temperature; for example, above the Curie temperature, these interfaces disappear. Thus, it is possible that hetero-strained interfaces may enable property enhancement with less temperature and DC-bias dependence. For thin film science, there are many reports about "hetero-strained interfaces", but the literature is much smaller for bulk materials. Novel electroceramics with a high density of "hetero-strained interfaces" may become new frontier materials with enhanced properties. For this purpose, we must develop new and innovative preparation methods. We would like to propose some new ways to prepare the materials for future material frontier. We hope that this presentation can be useful for young scientists.

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