

R. Ramesh

“Coupling Magnetism to Electricity in Multiferroic Heterostructures”

Complex perovskite oxides exhibit a rich spectrum of functional responses, including magnetism, ferroelectricity, highly correlated electron behavior, superconductivity, etc. The basic materials physics of such materials provide the ideal playground for interdisciplinary scientific exploration. Over the past decade we have been exploring the science of such materials (for example, colossal magnetoresistance, ferroelectricity, etc) in thin-film form by creating epitaxial heterostructures and nanostructures. Among the large number of materials systems, there exists a small set of materials which exhibit multiple order parameters; these are known as multiferroics. Using our work in the field of ferroelectric and ferromagnetic oxides as the background, we are now exploring such materials as epitaxial thin films, as well as nanostructures. Specifically, we are studying the role of thin-film growth, heteroepitaxy, and processing on the basic properties as well as the magnitude of the coupling between the order parameters. In our work we are exploring the switchability of the antiferromagnetic order using this coupling.

What is the importance of this work?

Antiferromagnets are pervasive in the recording industry. They are used as exchange biasing layers in magnetic tunnel junctions, etc. However, to date there has been no antiferromagnet that is electrically tunable. We believe that the multiferroic BiFeO_3 is one compound where this can be observed at room temperature. The next step is to explore the coupling of a ferromagnet to this antiferromagnet through the exchange biasing concept. Ultimately, this will give us the opportunity to switch the magnetic state in a ferromagnet (and therefore the spin polarization direction) by simply applying an electric field to the underlying antiferromagnetic ferroelectric. In this talk, I will describe our progress to date on this exciting possibility.



R. Ramesh is the Director of the SunShot Initiative in the U.S. Department of Energy.

He is currently on leave from the University of California, Berkeley, where he is the Plato Malozemoff Chair Professor in Materials Science and Physics. Prior to that he was Distinguished University Professor at the University of Maryland College Park. His Berkeley research is on the basic and applied science of complex functional oxides. He is the recipient of several professional recognitions, including the Humboldt Senior Scientist Prize, Fellowship of the American Physical Society Materials Research Society and American Association for the Advancement of Science, the MRS Turnbull Prize, and the APS McGroddy New Materials Prize. In 2011, he was elected to the National Academy of Engineering.

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