Fabrication and Functionality of Complex Oxide Superlattices

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In this talk, we focus on three-constituent magnetic oxide superlattice (‘tricolor’ superlattice), where the asymmetric stacking like ABCABC artificially breaks the space-inversion symmetry. The purpose of the study is to realize artificial polar ferromagnets. The polar/noncentrosymmetric magnets, represented by multiferroic compounds, recently attract a considerable interest, because we can expect novel phenomena, such as magneto-electric (ME) effect, or magnetization-induced second harmonic generation (MSHG). In the artificial superlattice, the gigantic MSHG was first realized with a ‘tricolor’ consisting of a ferromagnet La$_{0.6}$Sr$_{0.4}$MnO$_3$ and band insulators LaAlO$_3$ (LAO) and SrTiO$_3$ [H. Yamada, et al., APL 81, 4793 (2002), Y. Ogawa, et al., PRL 90, 217403 (2003)]. From the temperature dependence of MSHG in this superlattice, we found that the MSHG originate from the interface magnetism. By utilizing the MSHG as a probe for interface magnetism, we optimized the various oxide interfaces, leading to the discoveries of huge tunneling magnetoresistance in a junction with engineered interfaces [H. Yamada et al., Science 305, 646 (2004)], or enhanced optical ME effect in the ‘tricolor’ superlattice composed of LaMnO$_3$, SrMnO$_3$ and LAO. In those functionalities, crucial roles are played by the interface effects characteristic of correlated electron oxides, such as charge transfer or orbital-state-mediated magnetism [H. Yamada, et al., APL 89, 052506 (2006)].

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