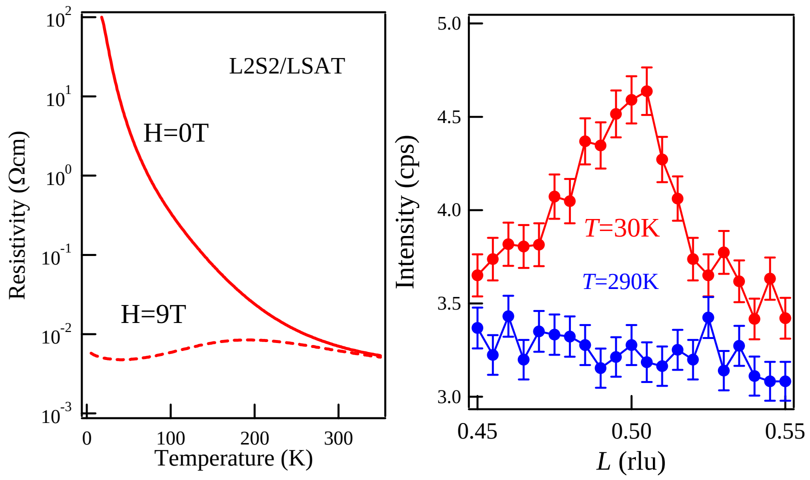
Magnetic structure of $LaMnO_3$-$SrMnO_3$ superlattice showing large magnetoresitance

H. Yamada[1], H. Nakao[2], K. Iwasa[3], A. Sawa[1], Y. Murakami[2]
[1]AIST [2]KEK-PF [3]Tohoku Univ.

The interface-specific electronic phase is one of the most exciting topics in the field of oxide electronics. The oxide superlattices composed of $LaMnO_3$ (LMO) and $SrMnO_3$ (SMO) have attracted much interest from this viewpoint, because the various magnetic and electronic properties are created from antiferromagnetic insulating components.

Recently we fabricated high-quality LMO-SMO superlattices on lattice-matched LSAT (001) substrate, as confirmed with synchrotron XRD at BL-4C, Photon Factory KEK. Although earlier studies of the LMO–SMO superlattices showed that short-period superlattices are ferromagnetic metal as a result of charge-transfer, as expected from alloy (La,Sr)MnO_3, we demonstrated that the sample with very flat interfaces was an insulator, even when the LMO and SMO layers are as thin as 2 unit cells (u.c.) [L2S2]. Interestingly, this "good" L2S2 superlattice exhibited magnetic-field-induced insulator-to-metal transition [Left Fig.], which can never been realized in alloy (La,Sr)MnO_3 [Yamada et al., PRB 81, 014410(2010)] .

In order to elucidate the large MR effect in the L2S2 superlattice, we performed neutron scattering study with TOPAN at JRR-3, Tokai. We observed magnetic ordering below 180 K. The magnetic diffraction appeared along the stacking direction at (0 0 0.5) [Right Fig.], which was suppressed under magnetic field. These results suggest that the magnetic interaction between atomic layers is antiferromagnetic, but becomes ferromagnetic by applying magnetic field.



Figs:
Resistivity [left] and neutron diffraction [right] for LMO(2uc)-SMO(2uc) superlattice