Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

A novel ground state of the $(2\sqrt{3}x2\sqrt{3})R30^\circ$ Sn double layer on Si(111) induced by modulation hole-doping FANGFEI MING, DANIEL MULUGETA, PAOLO VILMERCATI, University of Tennessee, Knoxville, HANNO H. WEITERING, University of Tennessee, Knoxville and Oak Ridge National Laboratory, PAUL C. SNIJDERS, Oak Ridge National Laboratory — Charge doping provides a tuning knob of the delicate interactions between spin, orbital, charge and lattice degrees of freedom in low-dimensional systems, which dictate many intriguing quantum phenomena. Using scanning tunneling microscopy/spectroscopy, we characterize the $(2\sqrt{3}x2\sqrt{3})R30^\circ$ Sn double layer grown on a $(\sqrt{3}x\sqrt{3})$-B reconstructed Si(111) surface, where 1/3 monolayer B dopants resides in the subsurface layer without forming direct chemical bonds with the Sn layer. The B atoms donate holes to the Sn double layer and shift the Fermi level toward the valence band edge. Surprisingly, it further induces a fraction of the $2\sqrt{3}x2\sqrt{3}$ phase to gradually transform to a new $4\sqrt{3}x2\sqrt{3}$ phase below 80 K. The two phases coexist down to 2.5 K, indicating a phase-separated ground state for the hole doped Sn double layer, in contrast to a homogenous $2\sqrt{3}x2\sqrt{3}$ phase for the undoped one. The new $4\sqrt{3}x2\sqrt{3}$ phase has a larger band gap than the $2\sqrt{3}x2\sqrt{3}$ phase and the valence band edge shifts a few tens meV away from the Fermi level to higher binding energy, suggesting that the transition to the $4\sqrt{3}x2\sqrt{3}$ structure is accompanied by an electronic structure rearrangement.

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Date submitted: 13 Nov 2014 Electronic form version 1.4