**Interfacial engineering for topological surface states and**

**Rise of triangular oxides and “Hydrogenics”**

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**Abstract**:

Since the notion of topological insulator (TI) was envisioned about a decade ago, topology has become a new paradigm in condensed matter physics. Realization of topology as a generic property of materials has led to numerous predictions of classical and quantum topological effects. Although most of the classical topological effects, directly resulting from the presence of the spin-momentum-locked topological surface states, were experimentally confirmed soon after the discovery of TIs, topological quantum effects remained elusive. It turns out that defects, especially interfacial defects, have been the main culprit behind this 1,2. Once these defects are suppressed with various thin film engineering tricks, a series of topological quantum effects such as quantized Faraday/Kerr rotations3, quantum Hall effects1,4, topological quantum phase transitions5, zeroth Landau level physics6 etc. start to emerge. In the second part of the talk, I will present our recent groundbreaking discovery that a simple hydrogenation process converts a highly conducting, yet non-magnetic, triangular oxide into a strong ferromagnet (Curie temperature of 650K) with a clear out-of-plane anisotropy. Considering that such a hydrogenation process is commonly used in the semiconductor industry for surface passivation purposes, this discovery may spark an era of “hydrogenics”, whereby hydrogen is actively utilized to create new magneto-electronic functionalities that do not exist in the parent material.

**Bio Sketch**:

Seongshik Oh has got his BS and MS from Seoul National University in 1992 and 1994 respectively. After serving in South Korean Air Force for three years as a meteorologist, he came to University of Illinois, Urbana-Champaign, in 1997 and got his PhD in 2003 on atomically-engineered complex oxides and high Tc cuprate superconductors. Then he joined the quantum computing team (then led by John Martinis, the leader of the Quantum Computing program at Google) at NIST, Boulder, CO, worked on materials problems of superconducting qubits, and developed the first epitaxial qubit. He then joined Rutgers University in 2007 as an assistant professor, and was promoted to an associated professor in 2013 and to a professor in 2018. He is the recipient of NSF CAREER award in 2009 and EPiQS materials synthesis investigators award by Gordon and Betty Moore Foundation in 2014. He has been also a co-director of Center for Quantum Materials Synthesis funded by Gordon and Betty Moore Foundation and Rutgers University since 2017.

**References**:

1. Koirala, N. *et al.* Record Surface State Mobility and Quantum Hall Effect in Topological Insulator Thin Films via Interface Engineering. *Nano Lett.* **15**, 8245–8249 (2015).

2. Moon, J., Huang, Z., Wu, W. & Oh, S. Pb-doped p-type Bi2Se3 thin films via interfacial engineering. *Phys. Rev. Mater.* **4**, 024203 (2020).

3. Wu, L. *et al.* Quantized Faraday and Kerr rotation and axion electrodynamics of a 3D topological insulator. *Science* **354**, 1124–1127 (2016).

4. Moon, J. *et al.* Solution to the Hole-Doping Problem and Tunable Quantum Hall Effect in Bi2Se3 Thin Films. *Nano Lett.* **18**, 820–826 (2018).

5. Brahlek, M. *et al.* Topological-Metal to Band-Insulator Transition in (Bi1-xInx)2Se3 Thin Films. *Phys. Rev. Lett.* **109**, 186403 (2012).

6. Salehi, M. *et al.* Quantum-Hall to Insulator Transition in Ultra-Low-Carrier-Density Topological Insulator Films and a Hidden Phase of the Zeroth Landau Level. *Adv. Mater.* 1901091 (2019).