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Polarization-driven topological insulator transition in a GaN/InN/GaN quantum well[1] M.S. MIAO, Q. YAN, C.G. VAN DE WALLE, Materials department and materials Research Lab, University of California Santa Barbara, California 93106-5050, USA, W.K. LOU, L.L. LI, K. CHANG, SKLSM, Institute of Semiconductors, Chinese Academy of Sciences, Beijing 100083, P. R. China — Topological insulators (TIs), a new state of quantum matter, have recently attracted significant attention, both for their fundamental research interest and for their potential device applications. Although many families of TI materials have been found, the realization of TI in conventional semiconductors remains elusive, mainly due to their sizable gaps and small spin-orbit interactions (SOI). Based on advanced first-principles calculations combined with an effective low-energy k·p Hamiltonian, we show that the intrinsic polarization of materials can be utilized to simultaneously reduce the energy gap and enhance the SOI, driving the system to a TI state. The proposed system consists of ultrathin InN layers embedded into GaN, a layer structure that is experimentally achievable. We found that the TI transition happens at GaN/InN/GaN quantum well with 3 to 4 InN atomic layers. Since polarization fields occur in many materials, a similar mechanism may apply to other systems as well. Our approach may pave the way toward integrating controllable TIs with conventional semiconductor devices.

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