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Electrostatic tuning between 1-dimensional and 2-dimensional electron gases DIGBIJOY NATH, PIL SUNG PARK, MICHELE ESPOSTO, The Ohio State University, DAVID BROWN, STACIA KELLER, UMESH MISHRA, University of California, Santa Barbara, SIDDHARTH RAJAN, The Ohio State University, THE OHIO STATE UNIVERSITY TEAM, UNIVERSITY OF CALIFORNIA, SANTA BARBARA TEAM — Although low dimensional systems such as 1-D and 2-D electron gases have been separately studied in details, a system enabling co-existence of both dimensions is still challenging to achieve. Such a system where the dimensionality can be tuned between 1-D and 2-D electrons can be an extremely promising platform to explore new phenomena. Here we investigate a novel system based on vicinal GaN-based heterostructure where we exploit its polarization charges to demonstrate for the first time, direct electrostatic tuning of the dimensionality of electrons between 1-D and 2-D. This tuning is achieved by adjusting the Fermi level with applied gate bias. A capacitance-voltage profiling to probe the Fermi occupation function of electron gas was used to demonstrate distinct signatures of the density of states for both the dimensions at room temperature. We developed a 2-sub-band model consisting of 1-D and 2-D sub-bands to describe the behavior of the electron gas, which is in excellent agreement with our experimental data, confirming the co-existence of electrons of both dimensions. This demonstration of co-existence of 1-D and 2-D electrons and the ability to tune between their dimensions at room temperature could open new research paths for low-dimensional physics besides enabling devices with added functionalities.

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