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Artificial graphene in nanopatterned GaAs Quantum Wells[1]

SHENG WANG, DIEGO SCARABELLI, Department of Applied Physics, Columbia University, ANTONIO LEVY, Department of Physics, Columbia University, LOREN PFEIFFER, KEN WEST, Department of Electrical Engineering, Princeton University, VITTORIO PELLEGRINI, Italian Institute of Technology, Genoa, Italy, MICHAEL J. MANFRA, Department of Physics and Astronomy, and School of Materials Engineering, and School of Electrical and Computer Engineering, Purdue University, SHALOM WIND, Department of Applied Physics, Columbia University, ARON PINCZUK, Department of Physics and Department of Applied Physics, Columbia University — Electrons in graphene have linear energy-momentum dispersion, making them massless Dirac fermions. An alternative way to achieve massless Dirac-fermions in a controlled and tunable manner is to construct a honeycomb lattice potential for a 2D electron gas in a semiconductor quantum well. We report realization of very short period (as small as 40 nm) honeycomb lattice pattern using e-beam lithography and drying etching on a GaAs quantum well and spectroscopy data of electron states under this potential modulation. The study is carried out using photoluminescence and light scattering at low temperature (about 4K). Inter mini-band transitions are observed by resonant inelastic light scattering and interpreted with calculated mini-band structure. Control over parameters such as Fermi level should permit manipulation of massless fermions. This will provide a platform for novel behavior such as topological states in a semiconductor quantum simulator.

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