Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Optoelectronic Crystal of Artificial Atoms in Strain-Textured MoS_2

ALEX W. CONTRYMAN, HONG LI, ALEX H. FRAGAPANE, Stanford University, XIAOFENG QIAN, SINA MOEINI ARDAKANI, Massachusetts Institute of Technology, YONGJI GONG, XINGLI WANG, Rice University, JEFFREY M. WEISSE, CHI HWAN LEE, JIHENG ZHAO, Stanford University, PULICKEL M. AJAYAN, Rice University, JU LI, Massachusetts Institute of Technology, XIAOLIN ZHENG, HARI C. MANOHARAN, Stanford University — The atomically thin semiconductor MoS_2 possesses exceptional strength and a strain-tunable band gap. When subjected to biaxial elastic strain, monolayer MoS_2 can embed wide band gap variations overlapping the visible spectrum, with calculations showing the modified electronic potential emanating from point-induced tensile strain perturbations mimic the Coulomb potential in a mesoscopic atom. We have realized and confirmed this "artificial atom" concept via capillary-pressure-induced nanoindentation of monolayer MoS_2 from a tailored nanostructure. We demonstrate that a synthetic lattice of these building blocks forms an optoelectronic crystal capable of broadband light absorption and efficient funneling of photogenerated excitons to points of maximum strain at the atom centers. Such 2D semiconductors with spatially textured band gaps represent a new class of materials which may find applications in next-generation optoelectronics or photovoltaics.

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Date submitted: 14 Nov 2014 Electronic form version 1.4