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Magnetism in 2D Flatlands

Eui-Hyeok Yang

Stevens Institute of Technology, USA

Abstract

The two-dimensional (2D) atomic crystals exhibiting magnetic properties provide an ideal platform for exploring new physical phenomena in the 2D limit. This new approach represents a substantial shift in our ability to control and investigate nanoscale phases. Experimental studies have shown doping of dissimilar atoms into transition metal dichalcogenides to create 2D dilute magnetic semiconductors, which are a promising candidate for spintronics applications. The success of these previous attempts, however, was fairly limited, resulting in either a Curie temperature well below room temperature or random local clustering of magnetic precipitations, i.e., lacking uniformity for integration into devices. Here our work demonstrates a 2D dilute magnetic semiconductor at room temperature via an in situ synthesis and characterization of Fe-doped MoS2 monolayers. We simultaneously achieve the in situ doping of Fe and the growth of MoS2 monolayers via low-pressure vapor deposition growth. Using advanced characterization techniques, we show that Fe incorporates substitutionally into Mo lattice sites, and probe ferromagnetism at room temperature. This new class of van der Waals ferromagnets finds critical applications, including on-chip magnetic manipulation of quantum states or in spintronics.

Biography:

EH Yang is a Professor of the Mechanical Engineering Department at Stevens Institute of Technology. The first to receive a MEMS Ph.D. in his native South Korea, he joined Stevens in 2006 following tenure as a senior member of the engineering staff at NASA Jet Propulsion Laboratory, where he was awarded, among other honors, the Lew Allen Award for Excellence for developing MEMS-based actuators and microvalves for large-aperture space telescopes and deformable mirrors capable of correcting for optical aberrations to improve high-resolution imaging. Dr. Yang has secured more than 35 federal grants and contracts totaling approximately $8.5 million, including funding from the National Science Foundation, Air Force Office of Scientific Research, National Reconnaissance Office, US Army, and NASA. Dr. Yang's professional service credits include editorial or editorial board positions for several journals, including Nature's Scientific Reports and multiple track chair positions for ASME International Mechanical Engineering Congress and Exposition (IMECE). He has produced more than 300 journal papers, conference proceedings, and presentations and has delivered 86 keynote or invited talks. He holds 17 issued or pending patents in the fields of micro- and nanotechnology. Dr. Yang was a featured Micro- and Nano- Systems Engineering and Packaging track plenary speaker at IMECE in 2018. He received the Award for Research Excellence at Stevens in 2019. Dr. Yang has been elected a Fellow of the National Academy of Inventors, the highest professional distinction for academic inventors. He has also been elected a Fellow of the American Society of Mechanical Engineers (ASME) for his extensive contributions to the fields of micro- and nanotechnology.

Speaker Publications:

1. K. Kang, S. Fu, K. Shayan, S. Dadras, A. Yoshimura, S. Chen, Y. Xiong, K. Fujisawa, W. Zhang, M. Ter-rones, V. Meunier, A.N. Vamivakas, S. Strauf, E. H. Yang. (2020). "The Effects of Fe-doping on Magnetism in MoS2 and WS2 Monolayers", Nanotechnology.
2. S. Fu, K. N. Kang, K. Shayan, A. Yoshimura, S. Dadras, X. Wang, L. H. Zhang, A. Jindal, X. Li, S. Chen, A. Pasupathy, N. Vamivakas, V. Meunier, S. Strauf and E. H. Yang. (2020). "Enabling room temperature ferromagnetism in monolayer MoS2 via in situ iron-doping", Nature Communications, (11), 2034.
3. J. Kashyap, E. H. Yang, and D. Datta. (2020). "The Mechanisms of Wrinkle Formation, Evolution, and Collapse in Graphene due to Diffused Water between Graphene and Substrate", Scientific Reports, (10), 11315.

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