Graphene Nanoribbons, Transition Metal Chalcogenides and MXenes for Electronic Applications

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This talk will be focused on the synthesis and characterization of emerging two-dimensional semiconductor materials and heterostructures for electronic applications. In the first part of this talk I will discuss bottom-up synthesis of atomically precise graphene nanoribbons (GNRs). Theoretical studies showed that narrow GNRs possess interesting electronic and magnetic properties that strongly depend on the ribbon's width and edge structure. GNRs with various structures can be synthesized with atomic precision and fine-tuned properties by coupling properly designed molecular precursors and planarization of the resulting polymers. I will describe a scalable bottom-up solution approach for atomically precise GNRs that is based on Yamamoto coupling of pre-synthesized molecular precursors followed by cyclodehydrogenation using Scholl reaction [1]. The GNRs can be processed into uniform conductive thin films, which could be employed in highly efficient gas sensors and electronic nose systems [2].

With recent synthetic advances, transition metal chalcogenides (TMCs) have been actively explored for electronic and optoelectronic applications, such as high on-off ratio transistors and photodetectors. In the second part of this talk I will demonstrate that TMCs also have a great promise for memory applications. I will discuss electronic and memory properties of field-effect transistors (FETs) based on monolayer or few-layer MoS_2 or WSe_2 on ferroelectric substrates. These devices exhibit large hysteresis of electronic transport with high on-off ratios. They also have a number of advantages and unique features compared to their graphene-based counterparts as well as commercial ferroelectric random-access memories (FeRAMs), such as nondestructive data readout, low operation voltage, wide memory window and the possibility to write and erase them both electrically and optically [3].

In the final part of my talk I will discuss the results of electrical characterization of emerging 2D materials, such as TiS_3 [4], which was theoretically predicted to exhibit high electron mobility, and Ti_3C_2 MXene, a promising material for energy storage [5].

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Bio: Alexander Sinitskii received his B.S., and Ph.D. degrees in Materials Science from Moscow State University. After postdoctoral studies at Rice University in Houston, TX he moved to the University of Nebraska – Lincoln, where he is currently an Associate Professor of Chemistry. His research program is addressing the synthesis and properties of low-dimensional materials with potential applications in nanoelectronics, chemical sensing and energy storage. Sinitskii has published over 100 papers in peer-reviewed journals and is a co-inventor on 8 patents. He received several awards for his research and teaching, including a 2015 NSF CAREER Award and a 2017 UNL College of Arts and Sciences Distinguished Teaching Award.