COLLEGE OF ENGINEERING

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University of Nebraska-Lincoln
Department of Chemical and Biomolecular Engineering

MXenes on the march: beyond graphene and into the real world

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Co-hosted by Dr. Siamak Nejati, Chemical and Biomolecular Engineering and the Nebraska Center for Materials & Nanoscience UNL

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Abstract

Two-dimensional (2D) materials with a thickness of a few nanometers or less can be used as single sheets due to their unique properties or as building blocks, to assemble a variety of structures. Graphene is the best-known example, but several other elemental 2D materials (silicene, borophene, etc.) have been discovered. Numerous compounds, ranging from clays to BN and transition metal dichalcogenides, have been produced as 2D sheets. By combining various 2D materials, unique combinations of properties, which are not available in any bulk materials, can be achieved. The family of two-dimensional (2D) transition metal carbides and nitrides, MXenes, has been expanding rapidly since the discovery of Ti_3C_2 in 2011 [1]. About 30 different MXenes have been synthesized, and the structure and properties of numerous other MXenes have been predicted using density functional theory calculations [2]. The availability of solid solutions on M and X sites, control of surface terminations, and a recent discovery of multi-element layered MXenes (e.g., Mo_2TiC_2) offer a potential for synthesis of dozens of new distinct structures. MXenes' versatile chemistry renders their properties tunable for a large variety of applications. Oxygen or OH terminated MXenes, such as $Ti_3C_2O_2$, have redox capable transition metals layers on the surface and offer a combination of high electronic conductivity with hydrophilicity, as well fast ionic transport. This makes them promising candidates for energy storage and related electrochemical applications, but their applications in optoelectronics, electromagnetic interference shielding, plasmonics, sensors, water purification and desalination, electrocatalysis, medicine and other fields are equally exciting [2].

1. M. Naguib, et al., Two-Dimensional Nanocrystals Produced by Exfoliation of Ti_3AlC_2, *Advanced Materials*, **23**, 4248 (2011)
2. B. Anasori, M. R. Lukatskaya, Y. Gogotsi, 2D metal carbides and nitrides (MXenes) for energy storage, *Nature Reviews Materials*, **2**, 16098 (2017)

Biography

Yury Gogotsi is Distinguished University Professor and Bach Endowed Professor of Materials Science and Engineering at Drexel University. He is the founding Director of the A.J. Drexel Nanomaterials Institute and Associate Editor of ACS Nano. He works on nanostructured carbons and two-dimensional carbides for energy related and biomedical applications. His work on selective extraction synthesis of carbon and carbide nanomaterials with tuneable structure and porosity had a strong impact on the field of capacitive energy storage. He has co-authored 2 books, more than 500 journal papers and obtained more than 50 patents. He has received numerous national and international awards for his research. He was recognized as Highly Cited Researcher by Thomson-Reuters in 2014-2017, and elected a Fellow of AAAS, MRS, ECS, RSC, ACerS, NANOSMAT Society and a member of the World Academy of Ceramics. He also serves on the MRS Board of Directors.