



2D transition metal carbides (MXenes) and their composites

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Abstract: Two-dimensional (2D) transition metal carbides and nitrides, called MXenes, are becoming one of the largest family of 2D materials with more than thirty synthesized compositions [1]. MXenes have shown outstanding performance in many applications including energy storage, catalysis, electromagnetic interference shielding, wireless communication, water purification, sensors, reinforcement in composites, and biomedical applications. In MXenes, $n+1$ layers of an early transition metal (such as Ti, V, Nb, Ta, Mo, Cr) cover n layers of carbon or nitrogen ($n = 1 - 4$), such as Ti_2C , Mo_2C , Ti_3C_2 , Ta_4C_3 , and Mo_4VC_4 . These 2D metal carbide flakes are covered with surface terminations, such as hydroxyl, oxygen, or fluorine, which add hydrophilicity to MXene surfaces [2]. Most of the synthesized MXenes to date, have high electrical conductivities (e.g., $\sim 10,000$ S/cm for Ti_3C_2), and high elastic properties. For example, the measured Young's modulus of a Ti_3C_2 single flake is ~ 330 GPa, which is the highest among the values reported for other solution-processed 2D materials, including graphene oxide.

In this talk, I will describe the advances and challenges in the synthesis and fundamental understating of 2D MXenes with a focus on their applications in metal and ceramic composites and present an outlook for several opportunities in this large family of 2D materials.

1. B. Anasori, Y. Gogotsi, ACS Nano, 13, 8 (2019).

2. B. Anasori, M. R. Lukatskaya, Y. Gogotsi, Nature Reviews Materials, 2, 16098 (2017).

Biography: Babak Anasori is an Assistant Professor in the Department of Mechanical and Energy Engineering at Purdue School of Engineering and Technology in IUPUI. He received his PhD at Drexel University in 2014 in Materials Science and Engineering, the birth place of MXenes. Babak is one of the co-inventors of ordered double-transition metal MXenes, as a result of his postdoctoral research. His current research focuses on synthesis and characterizations of novel MXenes and their metal and ceramic composites. He has co-authored over 110 refereed publications (h-index: 48) and he is among the Global Highly Cited Researchers 2019 recognized by the Web of Science. Babak has received several national and international awards for his research and artistic way of presenting science including NSF/Science Visualization Challenge in 2011 and 2013, Diamond ranking in ACerS Graduate Excellence in Materials Science (GEMS) in 2012, and Materials Research Society (MRS) Postdoctoral Award in 2016. Babak has originated and organized multiple international student competitions, including NanoArtography and Science in Video (SciVid) in the MRS Fall Meetings. He is currently the chair of the Early Career Professionals Subcommittee of MRS.