UNIVERSITÄT DUISBURG ESSEN | PHYSIK

Physikalisches Kolloquium

Mittwoch, 24.10.2018
13:00 Uhr
Hörsaal MC 122

A New Class Of Inherently Nanolaminated Magnetic Materials: Magnetic MAX Phases

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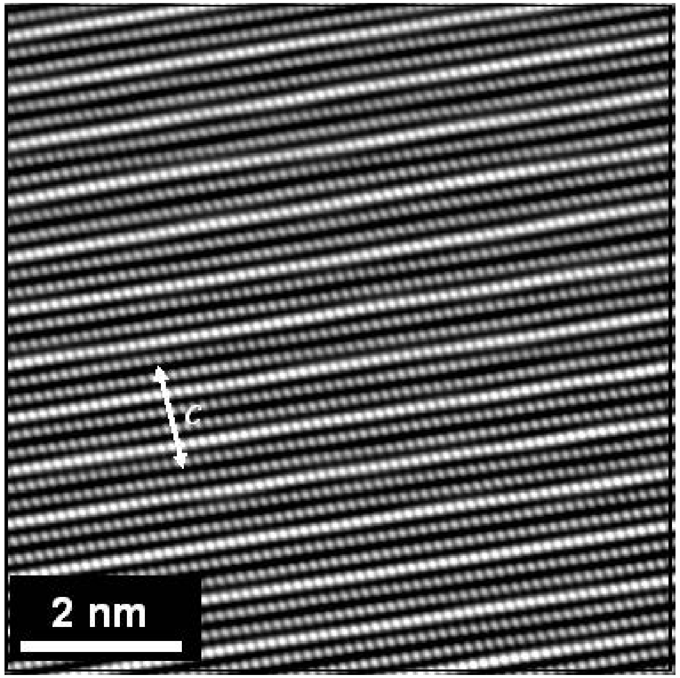

MAX phases (Mn+1AXn, n = 1, 2, or 3) are inherently nanolaminated hexagonal compounds composed of early transition metals M (Sc, Ti, V, Cr, …), A-group elements (Al, Ga, Ge, …) and X (C or N). Besides such ternary Mn+1AXn compounds many stable quaternary alloy phases with isostructural solid solutions in the M, A, and X sites exist [1]. These materials have a high decomposition temperature, are resistant to oxidation and thermal shocks and have strong damage tolerance, while being lightweight and elastically rigid. At the same time, similar to metals, MAX phases are good electric and thermal conductors [1]. Due to anisotropic electronic structure the thermal and electrical conductivities are anisotropic: higher conductivity within the basal plane and lower conductivity along the c-axis [2].

In 2013, following predictive material stability calculations, the new class of magnetic MAX phases has been discovered [3]. The magnetic order is stabilized by substituting or composing the M-element by/with Mn in quaternary (Mx-1Mnx)2AC (M = Cr or Mo and A = Al, Ge, Ga) and ternary Mn2GaC compounds. Magnetic MAX phases have become an exponentially growing field of fundamental research due to their tunable complex magnetic behavior and possible applications in magnetic wear resistant coatings, magneto-calorics and spin transport applications [4, 5]. Due to their laminar structure decomposition into quasi 2D layers appears feasible and might turn this material into a magnetic 2D material ("MXene" [6]), which can compete with the currently investigated Graphene and Chalcogenide derivatives.

In this talk, an overview of current achievements and understanding of the fundamental properties of selected magnetic MAX phases as well as a critical discussion on the perspectives and future challenges [6, 7] to make this class of materials applicable in spin based technologies will be given.

1. M. W. Barsoum, 2013: John Wiley & Sons.
2. T. Ouisse, et al., Mater. Res. Lett. 5, 365 (2017).
3. A. S. Ingason, et al., Phys. Rev. Lett. 110, 195502 (2013).
4. Iu. P. Novoselova, et al., Sci. Rep. 8, 2637 (2018).
5. R. Salikhov, et al., J. Appl. Phys. 121, 163904 (2017).
6. B. Anasori, et al., Nature Reviews 2, 16089 (2017).