NAPLES, ITALY 23-27 JUNE
DSL2025 NAPLES
21st International Conference on Diffusion in Solids and Liquids

ABSTRACT

Defect Engineering and Surface Chemistry of Mxenes for Enhanced Electromagnetic Shielding and Thermal Management

Chong Min Koo

School of Advanced Materials Science and Engineering, Sungkyunkwan University, Suwon, Jangan-gu 16419, Republic of Korea.

Defect Engineering and surface chemistry play a crucial role in determining the physicochemical, electrochemical, and optoelectronic properties of MXenes, as well as their environment stability and processability. MXenes, a rapidly growing family of two-dimensional transition metal carbides, carbonitrides, and nitrides, have the general formula Mn+1XnTx where M represents transition metal(s), X is carbon or nitrogen, Tx denotes surface terminal groups (e.g., –OH, -O and -F), and n ranges from 1 to 4. Due to their excellent electrical conductivity and tunable composition and surface chemistry, MXenes hod great promise for electronic, electrochemical, optoelectronic, and energy applications. However, precisely controlling atomic defects and surface chemistry remains challenging, particularly due to difficulties in managing vacancy and oxygen substitution defects in both precursors and final MXenes, as well as inherent limitation associated with top-down synthesis. Furthermore, complex oxidation states and diverse surface functional groups complicate surface modification, constraining their properties, processing, stability, and practical applications. This presentation will highlight recent advancements in refining the surface chemistry and defect engineering of MXenes, addressing key challenges to enhance their stability and functional performances.

[1] A.B. Black, C.D. Grey and E.F. White, J. Appl.Phys., 50, 1234 (1990).
[2] S. Wang, in Focus on Multidimensional Microscopy, Vol.1, p.567, P.C. Cheng, Ed. (World Scientific, Singapore, 1999).
[1] A. Iqbal, F. Shahzad, K. Hantanasirisakul, M. K. Kim, J. Kwon, J. Hong, H. Kim, D. Kim, Y. Gogotsi, and C. M. Koo, Science 369, 446 (2020).
[2] F. Shahzad, M. Alhabeb, C. Hatter, B. Anansori, S. M. Hong, C. M. Koo, and Y. Gogotsi, Science 353, 1137 (2016).
[3] A. Iqbal, H. Kim, J. M. Oh, J. Chae, J Kim, M. Kim, T. Hassan, Z. Gao, J. Lee, S. J. Kim, D. Kim, Yury Gogotsi*, Hanjung Kwon, Chong Min Koo, Small Methods, e2201715 (2023).
[4] A. Iqbal, J. Kwon, T. Hassan, S. W. Park, W. H. Lee, J. M. Oh, J. Hong, J. Lee, S. M. Naqvi, U. Zafar, S. J. Kim, J. H. Park, M. K. Kim, and C. M. Koo, Adv. Funct. Mater., 36, 2409346 (2024).
[5] T. Hassan, J. Kim, H. N. Manh, A. Iqbal, Z. Gao, H. Kim, N. Hussain, S. M. Naqvi, S. Zaman, M.

Narayanasamy, S. U. Lee, J. Kang, and C. M. Koo, ACS Nano 18, 23477 (2024).
[6] T. Oh, S. Lee, H. Kim, T. Y. Ko, S. J. Kim, C. M. Koo, Small 18, 2203767 (2022).
[7] T. Y. Ko, D. Kim, S. J. Kim, H. Kim, A. S. Nissimagoudar, S. C. Lee, X. Lin, P. T. Cummings, S. Doo, S. Park, T. Hassan, T. Oh, A. Chae, J. Lee, Y. Gogotsi, I. In and C. M. Koo, ACS Nano 17, 1112 (2023).
[8] D. Kim, T. Y. Ko, H. Kim, G. H. Lee, S. Cho, and C. M. Koo, “ ACS Nano 13, 13818 (2019).
[9] Z. Deng, L. Li, P. Tang, C. Jiao, Z.Z. Yu, C.M. Koo, H.B. Zhang, ACS Nano 16, 16976 (2022).
[10] Z. Gao, A. Iqbal, T. Hassan, S. Hui, H. Wu, C. M. Koo, Adv. Mater. 36, 2311411 (2024).
[11] S. Jung, Y. S. Kim, Y. N. Kim, S. Jeong, S. M. Naqvi, T. Hassan, M. Narayanasamy, S. Cho, Y. C. Jung, J. Kim, C. M. Koo, Adv. Mater. 36, 2408674 (2024).