

New Nanomaterial MXenes: Opening Exciting Technological Horizon

Prof. Dr. A.K.M. Azharul Islam, FInstP, CPhys

Professor Emeritus & Former Vice Chancellor
International Islamic University Chittagong

Abstract: Discovery of MXenes, derived from parent 3D MAX phases, constitutes a major breakthrough in materials science. These nanomaterials are a family of atomically thin, two-dimensional (2D) transition metal carbides and nitrides with many attractive properties. Not only are the materials just a few atoms thick, their structures show the potential to surpass current materials in terms of their properties and the way these could be used.

2D MXenes are at the forefront of materials research in the last few years due to their exotic electrical and optical properties and interesting mechanical properties deriving from their atomically thin dimensions. The isolation and synthesis of several of these nanomaterials have opened a 'new exciting platform to layer-by-layer materials and hybrid device engineering that enables the exploration and tailoring of superior or hitherto unknown properties and that promises a range of new technologies'.

MXenes are electronically conductive multilayer similar to multilayer graphene and found useful for a wide range of applications including electronic devices, sensors (chemical, environmental, and biological), reinforcement for composites, and energy storage materials and so on. Recently the application developments of the nanomaterials on energy storage, electromagnetic interference shielding, transparent conductive electrodes and field-effect transistors, optoelectronic and other applications have been widely reported. Very recent study on Ti_3C_2 MXene reveals potential of nanomaterial as a novel ceramic photothermal agent used for cancer therapy. The same 2D nanomaterial is resistant to biofouling and offer bactericidal properties with application in water desalination/purification membranes. The MXene-based piezoresistive sensor also can detect human being's subtle bending-release activities and other weak pressure. It can be used to harvest wasted frictional energy, for example, from muscle contractions during typing or walking.

The present author's contribution in the parent 3D MAX materials is continuing for the last six years which has now been extended to these 2D nanomaterials. This review will mostly highlight the achievements and prospects of this new exciting horizon, rather than the details of theoretical and experimental methodology.



Biography: Prof. Dr. A.K.M. Azharul Islam, Professor Emeritus and former Vice-Chancellor of International Islamic University Chittagong, was born in Bogra, Bangladesh on 2nd November 1946.

Academic Qualifications: Prof. Islam was graduated in Physics from the University of Rajshahi. He secured First Class and First position in both B.Sc. Hons. & M.Sc. He has successfully pursued DIC from Imperial College of Sci. & Tech., London in the year 1969. He was awarded Ph. D. in 1972 from London University.

Prof. Islam's field of research areas are: (i) Elementary particle physics during 1967 - 1978, (ii) Condensed Matter Physics with current interest in Superconductivity, defects of solids, electronic structure of materials, MAX phases and 2D MXenes.

National and International Awards:

- 1961: Haji Mohd. Mohsin Prize and Bogra Textile Mill Prize for result at Matriculation in the East Pakistan Secondary Education Board, Dhaka
- 1964: Governor's First Prize, Air Travel and Certificate for National level Essay Competition in the then East Pakistan
- 1966: University Habib Bank Gold Medal and Book prize for B.Sc. Hons result
- 1967: University Habib Bank Gold Medal and Book prize for B.Sc. Hons result
- 1968: Presentation of Insignia of the then Pakistan Civil and Military Award as well as President's Medal for Pride of Performance at PG stage (Gold Medal, US\$ 1000 Prize Money and National Tour)
- 1968: Government Merit Scholarship for PhD at Imperial College of Sci. & Tech, London University
- 1969: Gold Medals at Rajshahi University Convocation (in absentia) for achieving Faculty First Positions at both B.Sc. Hons and M.Sc Examinations

- 1991: Prime Minister honors in a Ceremony at Dhaka – as Supervisor of UGC PhD Research Fellows
 1997: UGC Research Award in Physics– Awarded by the Education Minister of Bangladesh
 2001: ISESCO Laureate – ISESCO International Science Award for Meritorious Research Achievements in the field of Physics (US\$ 5000, Certificates + Tour & others)
 2006: Bangladesh Academy of Sciences Gold Medal Award 2006 (Awarded by Hon'ble President of Bangladesh)
 2010: International CSE Award (2010) as an Editor of Science Journal of the Third World on the occasion of 52nd Annual Conference of the Council of Science Editors (Atlanta, 14-18 May 2010)
 2016: United Group Outstanding Research Award 2016 – (Awarded by the Education Minister at Dhaka, 22 April 2016)
 2016: UGC Reception for author of University Text book (Crest & Certificate by the Education Minister, Government of Bangladesh)
 2017: United Group Outstanding Research Award 2017 – (to be awarded in a ceremony at Dhaka).

Professional Experience: Prof. Islam served Rajshahi University as a Lecturer in Physics from January 1968. He became Professor in early 1984. During his long 45-year teaching career he served as:

- Chairman, Department of Physics, Dean, Faculty of Science, Rajshahi University.
- Member of Senate, Syndicate, Academic Councils of Rajshahi and other Universities.
- Member, Board of Governors, RCMP, Chittagong University.
- Editor-in-Chief, Journal of Scientific Research; Member, Editorial Board, 'Journal of Bangladesh Academy of Sciences', 'Rajshahi University Studies'.
- Reviewer of more than twenty International Journals, and eight national journals.

Publications and Research Guidance: Professor Islam already guided 93 research students for their M.Sc, M.Phil and Ph.D works – currently guiding 4 research students including 2 MPhil/Ph.D students.

Total number of Publications is 280 – Among these are **195 research publications** mostly in International Journals (Visit: https://www.researchgate.net/profile/A_K_M_Islam3/publications); **72 general articles** published on Science, Education and National & International issues; **13 books** (published nationally and in India & New York); He has edited Proceedings of International Workshop (catalogued by US Library of Congress, ICTP & other libraries of the world, <https://lccn.loc.gov/99938837>). His book “**Bedevelled world**” on contemporary socio-political events was published by Global Media Publications (New Delhi, India, 2008, 324 pages), see OCLC WorldCat **Bedevelled world**.

Co-discoverer of a Perovskite-type oxide Superconductor with Japanese physicists (for more information visit: http://www.spring8.or.jp/en/news_publications/press_release/2014/140303/)

Prof. Islam carried out research as a Post-doctoral Fellow at Imperial College (London); J. J. Thomson Laboratory (Reading University, UK) on Royal Society Fellowship. He has also worked as visiting scientist at: (i) University of Cambridge (U.K), (ii) Jawaharlal Nehru Centre for Advanced Research, Bangalore (India), and (iii) ICTP (Italy) as a Regular Associate and then as a Senior Associate; (iv) Yamanashi University, Japan, under joint UGC-Japan research project.

Conferences and Seminars: Prof. Islam so far visited 28 countries and attended 54 international conferences; Organized two international workshops (participants from 15 countries) in 1996 and 1998.

Prof Islam is an elected Fellow of (i) The Institute of Physics (London), and (ii) Bangladesh Academy of Sciences. He is also Member of different professional bodies such as: (i) The New York Academy of Sciences, (ii) The American Physical Society, (iii) AAAS (USA), (iv) The Asian Physical Society, (v) The Bangladesh Physical Society (Vice-President for two years), (vi) Bangladesh Association for the Advancement of Science. He is also a Life Member of Bangla Academy (Dhaka) and a few other Societies.