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# Notice for the PhD Viva Voce Examination

Ms Madhushree R, Registration Number: 2290008, PhD Scholar at the Department of Chemistry, School of Sciences, CHRIST (Deemed to be University) will defend her PhD thesis at the public viva-voce examination on Wednesday, 08 April 2026 at 11.30 am in Room No. 044, Ground Floor, R&D Block, CHRIST (Deemed to be University), Bengaluru - 560029, Karnataka, India.

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| **Title of the Thesis** | : | **Modification of Chromium MXenes for Effective Water Electrolysis and Supercapacitor Applications** |
| **Discipline** | : | **Chemistry** |
| **External Examiner - I** | : | **Dr Kavita A Pandey**<br>Scientist C<br>Centre for Nano and Soft Matter Sciences (CeNS)<br>Shivanapura, Dasanapura Hobli<br>Bengaluru North - 562162<br>Karnataka |
| **External Examiner - II** | : | **Dr Vinod C Prabhakaran**<br>Sr Principal Scientist and Professor (AcSIR)<br>CSIR-National Chemical Laboratory<br>Dr Homi Bhabha Road<br>Pune - 411008<br>Maharashtra |
| **Supervisor** | : | **Dr Sunaja Devi K R**<br>Professor<br>Department of Chemistry<br>School of Sciences<br>CHRIST (Deemed to be University)<br>Bengaluru - 560029<br>Karnataka |

The members of the Research Advisory Committee of the Scholar, the faculty members of the Department and the School, interested experts and research scholars of all the branches of research are cordially invited to attend this open viva–voce examination.

**Registrar (Academics)**

**Place:** Bengaluru
**Date:** 23 March 2026

# ABSTRACT

MXenes, a novel class of two-dimensional materials, have garnered significant attention since their discovery in 2011 due to their exceptional tunable physicochemical properties, making them promising candidates for electrocatalysis and energy storage. This thesis details the design, synthesis, and application of Cr2CTx MXene obtained from the Cr2AlC MAX phase, aiming to modulate its structural and functional features. A scalable fabrication strategy enabled the production of well-defined, accordion-like Cr-MXene, which was systematically characterized through comprehensive spectroscopic and microscopic analyses. Electrochemical studies revealed that soft chemical modifications using different etching media, including HF, LiF/HCl, and NaOH, significantly influence both hydrogen and oxygen evolution performance, as well as supercapacitive behavior. Further enhancement was achieved by integrating carbon nanofibers (CNFs), where the interconnected fibrous network in the Cr2CTx/CNF composite improved both electrochemical and electrocatalytic activity. To harness synergistic effects, a heterojunction was engineered with spinel NiFe2O4, forming Cr2CTx/NiFe2O4, which exhibited bifunctional catalytic activity toward both HER and OER along with notable pseudocapacitive performance. In addition, a double-transition-metal MXene, Cr2MoC2Tx, was synthesized, introducing dual active sites and bimetallic functionality that further enhanced its electrochemical and electrocatalytic properties. Overall, this work advances MXene research by addressing key challenges related to scalability, structural stability, and multifunctional performance.



**Keywords:** $Cr_2CT_x$ MXene; Modified $Cr_2CT_x$ MXene; Energy storage; Supercapacitors; Water electrolysis; Hydrogen evolution; Oxygen evolution.


**Publications:**


1. **Madhushree R**, Sunaja Devi K. R., Chaithra K. P., Vinod T. P. and B. Saravanakumar; Unveiling the supercapacitive behavior of electrospun $Cr_2CT_x$/carbon nanofiber membrane; Nanoscale Advances; 2025; 7: 6791. https://doi.org/10.1039/D5NA00753D

2. **Madhushree R**, Sunaja Devi K. R.; Exploring Pseudocapacitive Performance in $Cr_2CT_x/NiFe_2O_4$ Composite: Experimental Insights; Dalton Transactions; 2025; 54: 6653. https://doi.org/10.1039/D5DT00446B

3. **Madhushree R**, Sunaja Devi K. R. and Dephan Pinheiro; Exploring the Influence of Etching media on the Electrochemical Behavior of $Cr_2CT_x$ MXene; Advanced Sustainable Systems; 2025; 2400865. https://doi.org/10.1002/adsu.202400865

4. **Madhushree R**, Sunaja Devi K. R.; Exploring the Potential Application of $Cr_2AlC$ MAX Phase as an Emerging Electrocatalyst for Overall Water Splitting; Emergent Materials; 2024; 8:5. https://doi.org/10.1007/s42247-024-00815-w

5. **Madhushree R**, Chaithra K. P., Sunaja Devi K. R. and Vinod T. P.; Electrospun nanofibers of 2D $Cr_2CT_x$ MXene embedded in PVA for efficient electrocatalytic water splitting; New Journal of Chemistry;2024; 48: 17159–17166. https://doi.org/10.1039/d4nj02938k

6. **Madhushree R**, Sunaja Devi K. R.; Structural Investigation of $Cr_2CT_x/NiFe_2O_4$ MXene Composite as a Bifunctional Electrocatalyst for Water Splitting; Surfaces and Interfaces; 2024; 52: 104849. https://doi.org/10.1016/j.surfin.2024.104849