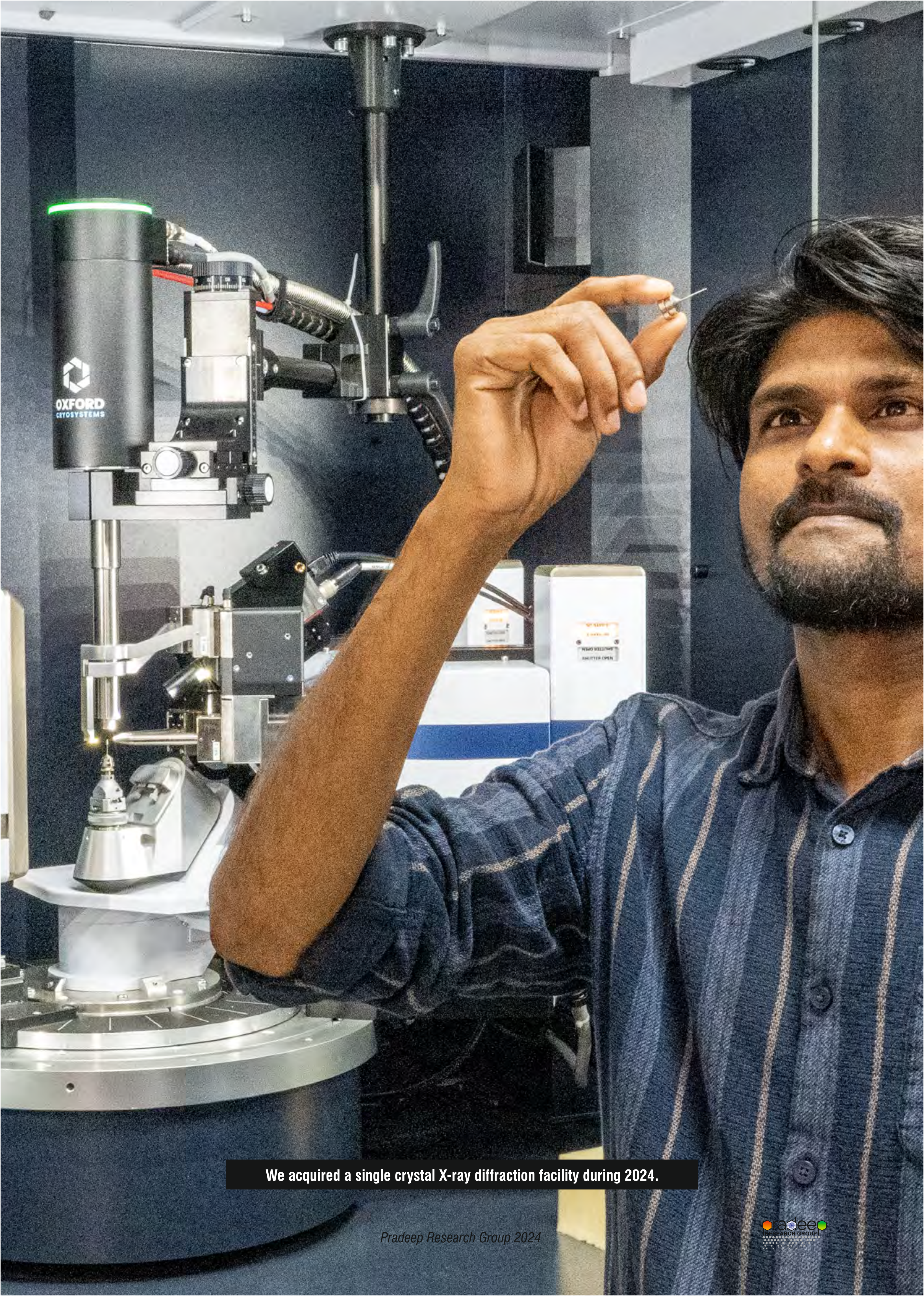
IIT MADRAS

pradeep RESEARCH GROUP

2024



We acquired a single crystal X-ray diffraction facility during 2024.

CONTENTS

Cover Page: The cover presents an artistic view of sand and soil being formed from rocks through microdroplet-weathering proposed by Spoorthi et. al. (page 23). Soil is the mother of fertility, symbolised by the seedling.

Our lab is buzzing with activity all the time.

This brochure presents a pictorial overview of the activities of our research group at IIT Madras (IITM) during the past year. The brochure is in its 14th year.

It highlights the work of the students involved and the experimental infrastructure used in the studies. In addition to publications, it showcases several related aspects such as patents, conference presentations, recognitions, and visits. Business incubation and technology implementation are important components of our work. Some highlights of these are also presented. Overall, it presents a summary of our collective journey during the year.

Each page of the initial few pages, is about a paper. There has been intense hard work behind each one of these papers. Other aspects covered in the brochure are also equally intense in terms of work and dedication. I am glad to see that many departments and research groups in our institute have started making such brochures showcasing their activities in the past few years. A visible change in the research atmosphere is evident because of all these activities.

The highlight of 2024 was our publication in *Science* on the spontaneous disintegration of minerals in charged water microdroplets. It was the first work to be published in *Science* from IITM.

This brochure combines the activities of the Thematic Unit of Excellence on Water Purification Using Nanotechnology and the DST Unit of Nanoscience, both initiated by the Department of Science and Technology under the Nano Mission. Technology implementation was possible due to the support of central and state governments. Several companies and different arms of the Institute helped us. Our incubated companies took these tasks and executed them with perfection. Several of these activities are also done in collaboration with the International Centre for Clean Water (ICCW).

Everything showcased here became possible due to the continued support of the Institute. I thank my coworkers whose collective hard work made everything possible. I also thank my collaborators and funding agencies for the success of the projects.

As I write this message, our group at IIT Madras has entered into its 32nd year. I must say that our work continues as usual. Teaching, research, institution building, technology development, business incubation, mentoring, and interfacing with the community outside continue to be as intense as before.

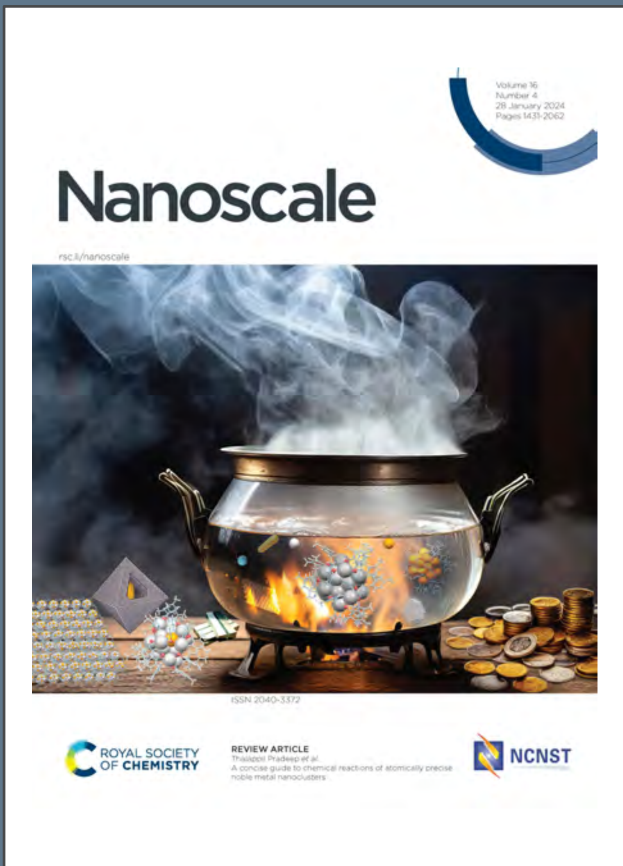
The world came to a standstill for most of 2020-21. Obviously, our work was affected. In fact, the impact continued into 2024. In that period of hardship, students were the biggest losers. Despite the suffering, their devotion was as intense as ever. Words are inadequate to thank them.

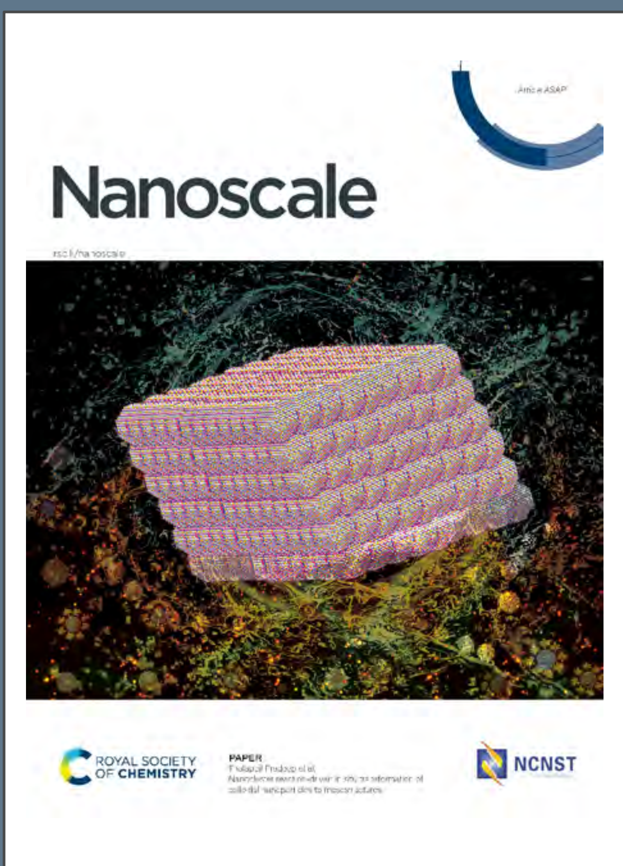
Once again, let me thank everyone.

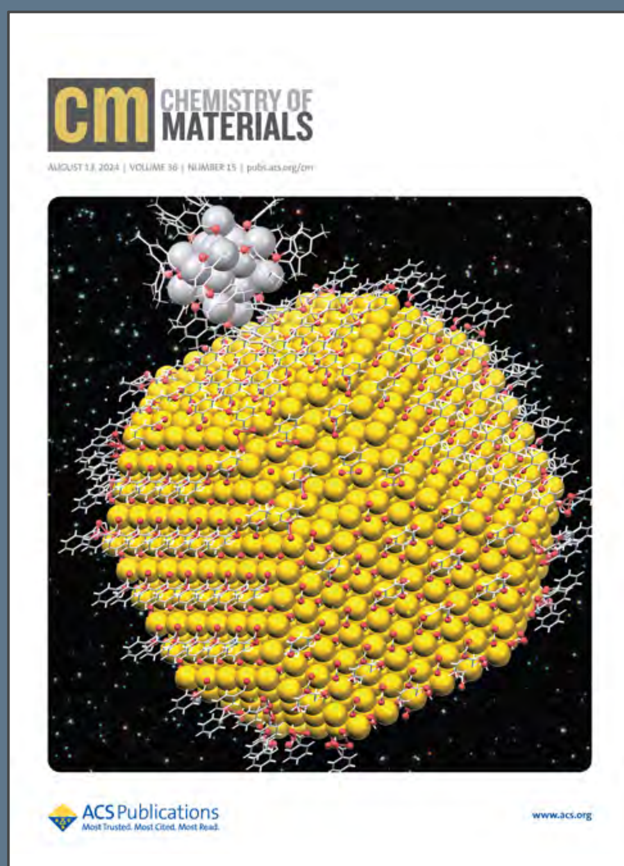
Thalappil Pradeep

February 20, 2025

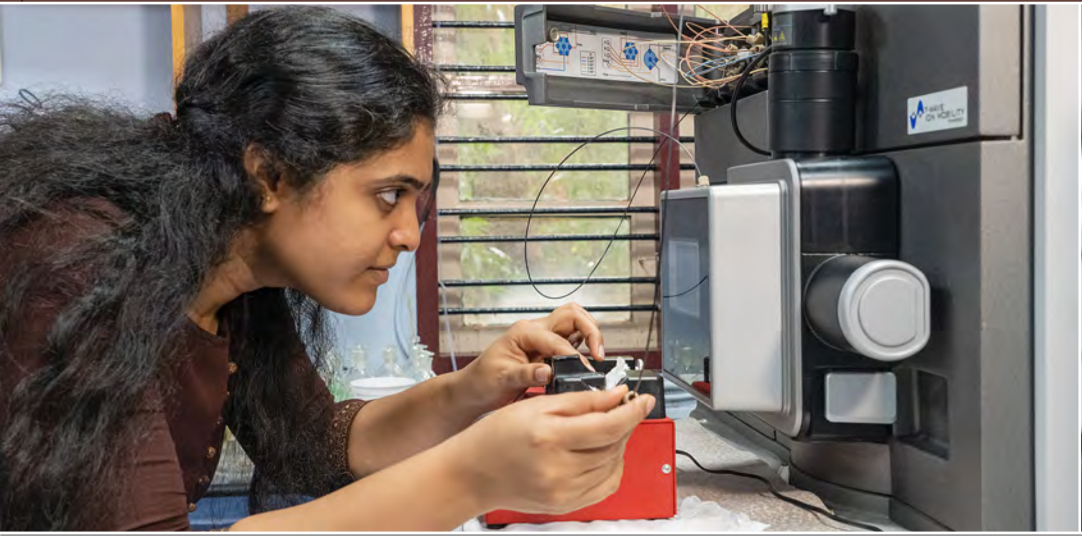
JOURNAL COVERS 2024



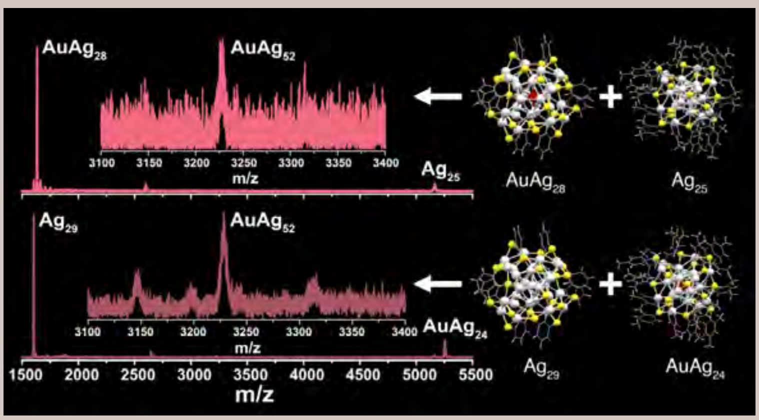




Stable dimer intermediates during intercluster reactions of atomically precise nanoclusters



Swetashree Acharya, Jayoti Roy, Diptendu Roy, Biswarup Pathak, and Thalappil Pradeep;
J. Phys. Chem. C. (just accepted); Accepted 28th Dec 2024 (DOI: 10.1021/acs.jpcc.4c07077)



Intercluster reactions involving atomically precise noble metal nanoclusters (NCs) in solution, closely resembling reactions between molecules, are important for exploring chemistry at the nanoscale. In the present study, we conducted reactions between $[Ag_{29}(1,3\text{-BDT})_{12}]^{3-}$ (1,3-BDT=1,3-benzenedithiol) and center-doped $[MAg_{24}(2,4\text{-DMBT})_{18}]^{q-}$ (q = 1 for M = Ag, Au; and q = 2 for M = Pd, Pt; 2,4-DMBT = 2,4-dimethylbenzenethiol) NCs in solution. For the first time, we report the formation of stable dimers, formed between two NCs with mixed metal-ligand interfaces. The dimeric species formed were $[MAg_{53}\text{-}xBDT_{12}DMBT_{18\text{-}y}]^{3-}$ (x≥ 0 and y ≥ 0), with 16 electrons in their valence shells. Here, the dimers were formed irrespective of the nature of the central atom in the NC, although the compositions were different depending on the central atom. These dimers were stable in solution for ~2 days. The dithiol protected $[Ag_{29}BDT_{12}]^{3-}$ part was more stable in the dimers, during fragmentation than the monothiol protected $[MAg_{24}DMBT_{18}]^{q-}$ part. UV/vis spectroscopic and mass spectrometric analyses, along with density functional theory (DFT) calculations were used to understand the dimers. Our work has highlighted the importance of the cluster interface in the stability of the dimer formed. Probing such stable dimers formed during intercluster reactions can help us understand the reaction mechanism in greater detail.

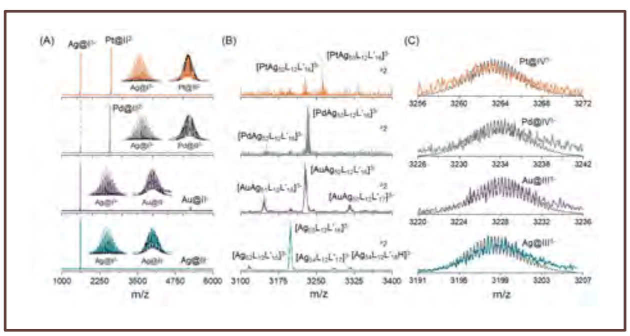


Figure 1: Formation of the dimeric species in all the four cases of reaction between $Ag@I^{3-}$ and $M@II^{q-}$ (M= Ag, Au, Pd, Pt), in 1:1 ratio, in acetonitrile solvent. The spectra were collected 5 minutes after mixing the clusters. (A) Full range mass spectra of the reaction mixture and inset shows the isotopic distribution of both the parent NCs in the reaction mixture. (B) Dimer region, and (C) theoretical and experimental isotopic distributions of the most intense dimeric species in each case. In $Pd@IV^{3-}$ and $Pt@IV^{3-}$, the peaks were not resolved clearly due to poor intensity.

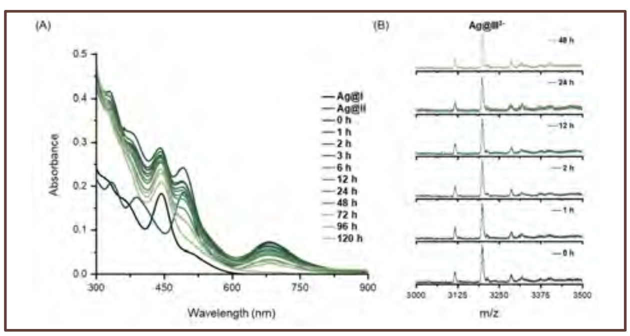
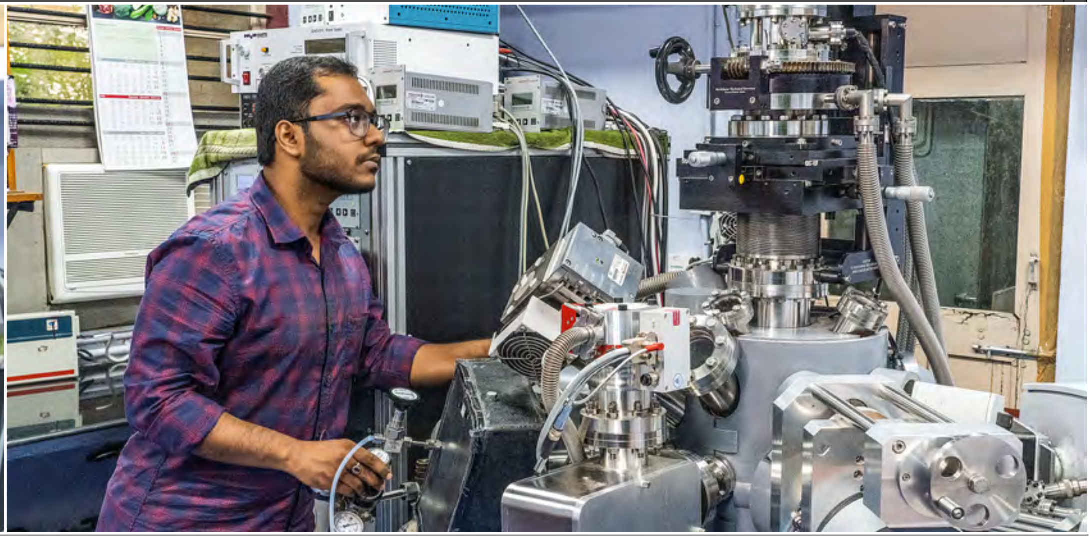
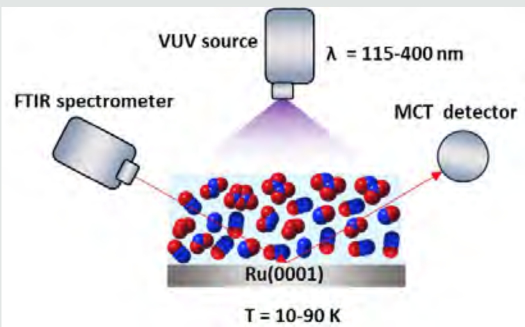


Figure 2: Monitoring the reaction mixture of $Ag@I^{3-}$ and $Ag@II^{-}$ by UV/vis and ESI MS to check the stability of the species formed during the reaction. (A) UV/vis study for the reaction mixture shows mixed features of both the parent NCs up to 48 hours and subsequently the mixed nature started disappearing. (B) ESI MS study showing the stability of the dimers up to 48 hours

Simulated interstellar photolysis of N_2O ice: Selectivity in photoproducts



Bijesh K. Malla, Soham Chowdhury, Devansh Paliwal, Hanoona KM, Gaurav Vishwakarma, Rabin Rajan J. Methikkalam and Thalappil Pradeep;
J. Phys. Chem. C. 2025, 129, 2, 1120–1128 (DOI:10.1021/acs.jpcc.4c06624)



Thermal diffusion and recombination control the kinetics of photochemical reactions of reactive radicals formed by ultraviolet photon irradiation in interstellar ices. Here, we show that upon vacuum ultraviolet photolysis, N_2O ice produces O_3 and several oxides of nitrogen, such as NO, NO_2, N_2O_2, N_2O_3, N_2O_4, and N_2O_5 in interstellar ice mimics. Photoproducts within the bulk and on the surface were analyzed using reflection absorption infrared spectroscopy and Cs^+ ion-based secondary ion mass spectrometry, while desorbed species were studied using temperature-programmed desorption mass spectrometry. Notably, thermal annealing of the photo-irradiated ice to 90 K resulted in a significant increase in NO and N_2O_3. Photoirradiation at 10 K revealed the dominance of three atom photoproducts, such as NO_2 and O_3. In contrast, irradiation at 50 K significantly enhanced the production of four or higher atom photoproducts (N_2O_2, N_2O_3, N_2O_4, and N_2O_5). This behavior is attributed to the restricted diffusion of reactive radicals and unstable oxygen species (O and O_3) at 10 K, which confines radical-radical reactions to three or fewer atom photoproducts, whereas higher temperatures facilitate oxygen and other radical diffusion and recombination, yielding heavier photoproducts. These results throw light on the thermal diffusion effects on the kinetics of photoproducts in interstellar ice mimics.

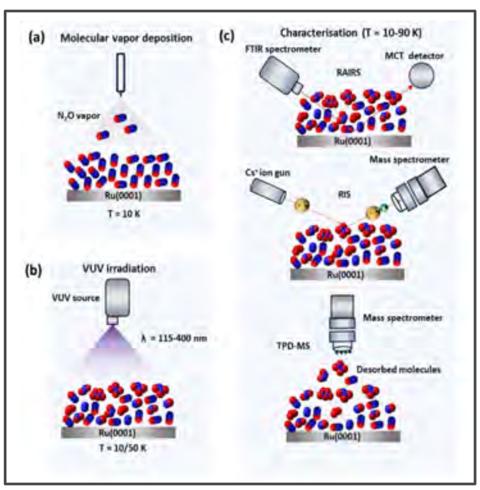


Figure 1: Schematic presentation of experimental protocols used in this study. (a) 150 ML of N_2O ice was created on Ru(0001) substrate by molecular vapor deposition at 10 K. (b) N_2O ice was irradiated with VUV photon by using deuterium lamp. (c) Photoirradiated ice was characterized by RAIRS, RIS, and TPD-MS.

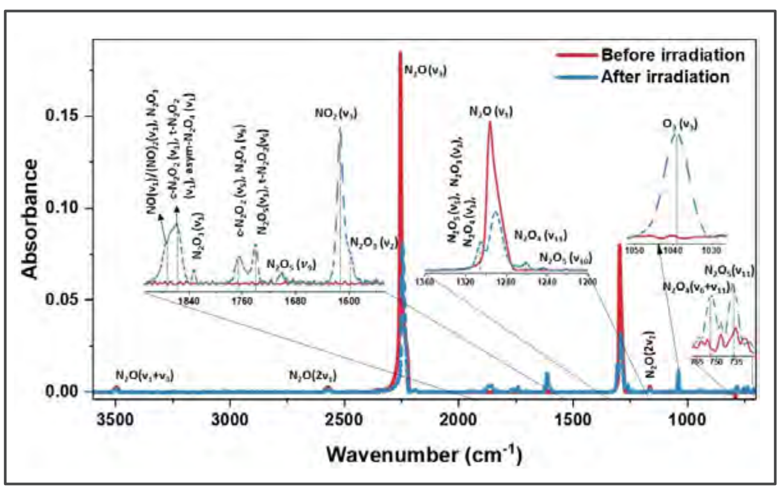
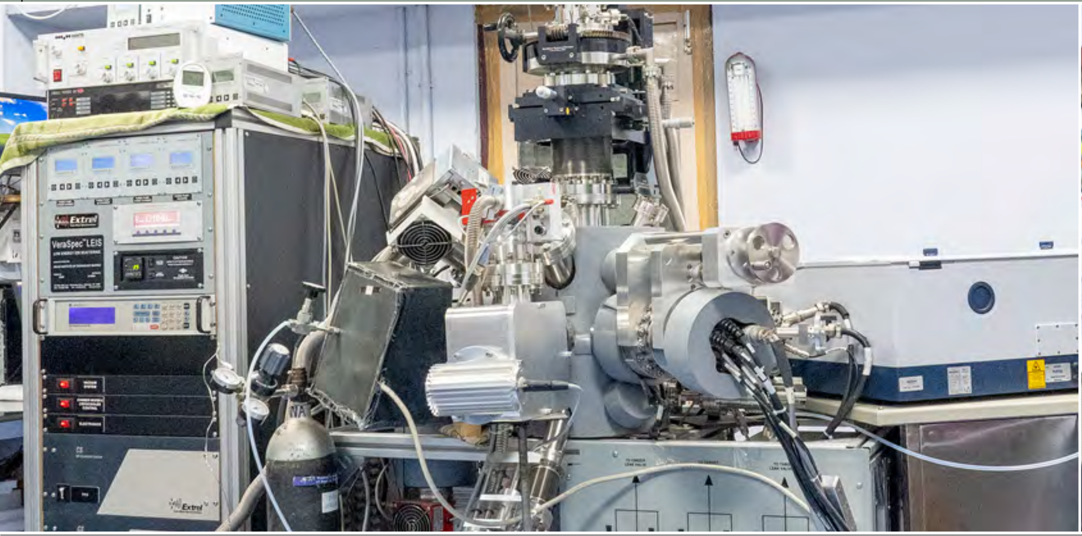
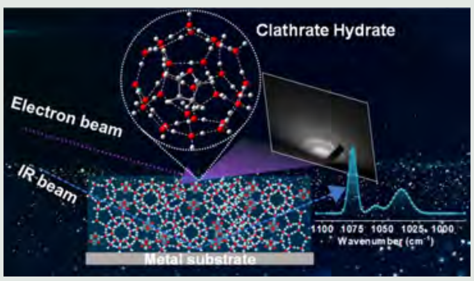


Figure 2: RAIR spectra of 150 ML of N_2O ice before and after 2 h VUV photoirradiation at 10 K in the mid-infrared region.

Growth of clathrate hydrates in nanoscale ice films observed using electron diffraction and infrared spectroscopy



Bijesh Malla, Ding-Shyue Yang, and Thalappil Pradeep;
J. Phys. Chem. Lett. 2025, 16, 1, 365–371 (DOI: 10.1021/acs.jpclett.4c03106)



Clathrate hydrates (CHs) are believed to exist in cold regions of space, such as comets and icy moons. While spectroscopic studies have explored their formation in similar laboratory conditions, direct structural characterization using diffraction techniques has remained elusive. We present the first electron diffraction study of tetrahydrofuran (THF) and 1,3-dioxolane (DIOX) CHs in the form of nanometer-thin ice films under ultrahigh vacuum at cryogenic temperatures. By using reflection high-energy electron diffraction, we show that THF CH grows readily on various substrates during thermal annealing of an amorphous ice mixture of THF and water, and the formation is independent of the nature of the substrate. The growth of DIOX CHs on an Au(111) substrate is similar. Comparison of electron diffraction patterns with calculated XRD patterns indicates that THF and DIOX form structure II CH ($5^{12}6^{4}$) with a lattice constant of ~17.2 Å (cubic, Fd3m). Both CHs were also grown on Ru(0001) and were examined by reflection absorption infrared spectroscopy. A direct comparison of diffraction data with infrared spectra as a function of temperature further demonstrates the strength of multiple probes in examining complex systems possessing diverse molecular interactions.

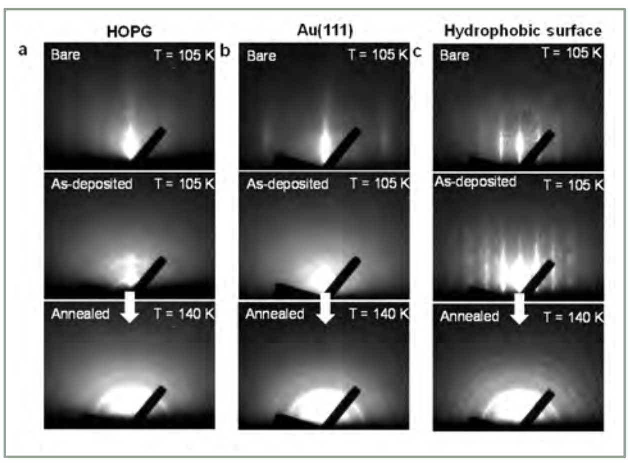


Figure 1: Evolution of ice Ic and THF CH explored with RHEED. (a) Electron diffraction images of as-deposited water on HOPG at 105 K and after annealing to 140 K. (b) Comparison of the experimental radially-averaged electron diffractions of annealed water ice at 140 K with the calculated diffraction peaks (red lines) of ice Ic. (c) Electron diffraction images of as-deposited THF-water ice mixture on HOPG at 105 K and after annealing to 140 K. (d) Comparison of the experimental radially-averaged electron diffractions of annealed THF-water ice at 140 K with the calculated (red lines) diffraction peaks of sII THF CH. Peaks labeled with # are attributed to ice Ic, while that marked with * corresponds to the collection of low-intensity signals of THF CH, shown in the theoretical spectrum. (e) Schematic diagram of the formation of ice Ic on HOPG from vapor-deposited ice. (f) Schematic diagram of the formation of sII THF-CH on HOPG from vapor-deposited ice.

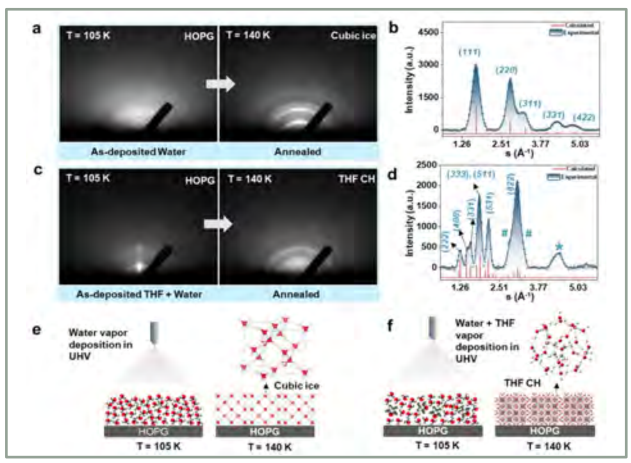
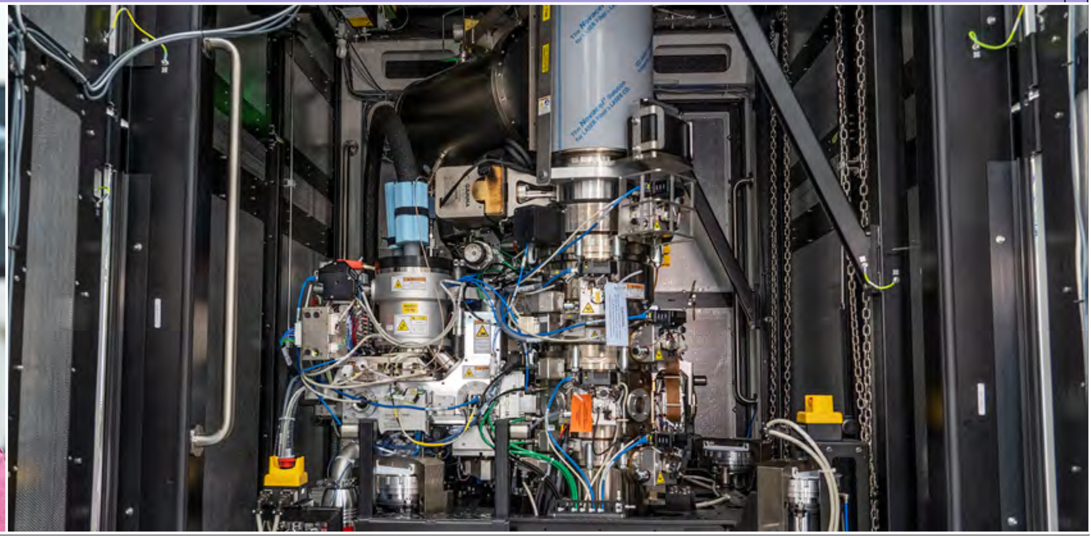
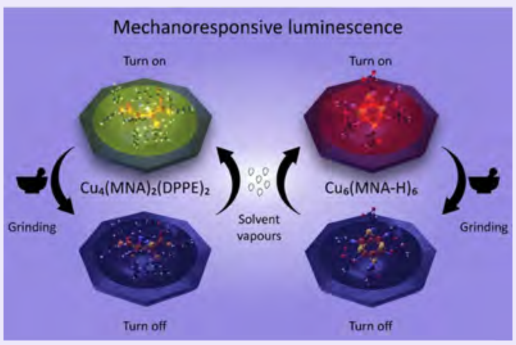


Figure 2: Evolution of THF-CH on HOPG, Au(111), and hydrophobic surface (SAM of 1-octadecanethiol on Au(111)). The RHEED images, displayed vertically, show bare HOPG (a), Au(111) (b), and a hydrophobic surface (c) at 105 K (top row), as-deposited THF-water ice mixture on the respective substrate at 105 K (middle row), and the same ice mixture on the respective substrate after annealing at 140 K (bottom row).

Milling-induced "Turn-off" luminescence in copper nanocluster



Subrata Duary, Arijit Jana, Amitabha Das, Swetashree Acharya, Amoghavarsha Kini, Jayoti Roy, Ajay Kumar Poonia, Deepak Kumar Patel, Vivek Yadav, Biswarup Pathak, P. K. Sudhadevi Antharjanam, Adarsh Kumaran Nair Valsala Devi, and Thalappil Pradeep; *Inorganic Chemistry,63,2024, 18727-18737 (DOI: 10.1021/acs.inorgchem.4c02617)*



Atomically precise copper nanoclusters (NCs) attract research interest due to their intense photoluminescence, which enable their applications in photonics, optoelectronics, and sensing. Exploring these properties requires carefully designed clusters with atomic precision and detailed understanding of their atom-specific luminescence properties. Here, we report two copper NCs, $[Cu_4(MNA)_2(DPPE)_2]$ and $[Cu_6(MNA\text{-}H)_6]$, shortly Cu_4 and Cu_6, protected by 2-mercaptonicotinic acid ($MNA\text{-}H_2$) and 1,2-bis(diphenylphosphino)ethane (DPPE), showing 'turn off' mechanoresponsive luminescence. Single crystal X-ray diffraction (SC-XRD) reveals that in the Cu_4 cluster, two Cu_2 units are appended with two thiols forming a flattened boat-shaped Cu_4S_2 kernel, while in the Cu_6 cluster, two Cu_3 units form an adamantane-like Cu_6S_6 kernel. High-resolution electrospray ionization mass spectrometric (HR ESI-MS) studies reveal the molecular nature of these clusters. Lifetime decay profiles of two clusters show the average lifetimes of 0.84 μs and 1.64 μs, respectively. These thermally stable Cu NCs become non-luminescent upon mechanical milling but regain their emission upon exposure to solvent vapors. Spectroscopic data of the clusters matched well with their computed electronic structures. This work expands the collection of thermally stable and mechanoresponsive luminescent coinage metal NCs, enriching the diversity and applications of such materials.

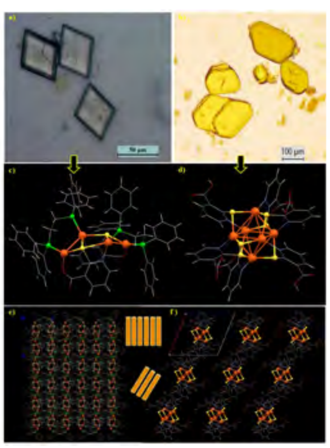


Figure 1: Optical microscopic images of the crystals of (a) Cu_4 and (b) Cu_6 NCs. Single crystal structure of individual (c) Cu_4 and (d) Cu_6 (DMF molecules in Cu_6 NC are removed for clarity). Structured packing (3×3×3 along the b-axis) of (e) Cu_4 and (f) Cu_6 NC, respectively. Atomic color code: orange=Cu, yellow=S, green=P, grey=C, red=O, blue=N and white=H.

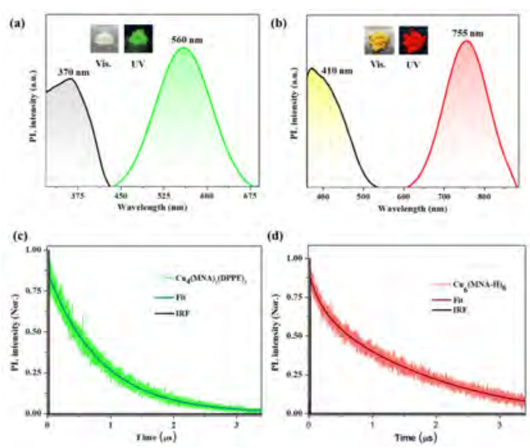


Figure 2: PL excitation and emission spectra of (a) Cu_4 and (b) Cu_6 NCs in solid crystalline state. Insets show the photographs of respective clusters in microcrystalline powder form. Luminescence decay profile of (c) Cu_4 and (d) Cu_6NCs.

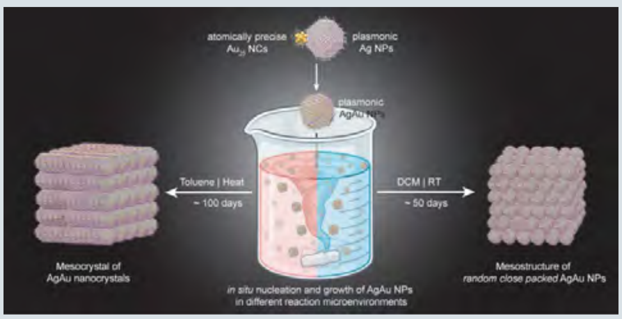
Nanocluster reaction-driven *in-situ* transformation of colloidal nanoparticles to mesostructures

Paulami Bose, Pillalamarri Srikrishnarka, Matias Paatelainen, Nonappa, Amoghavarsha Ramachandra Kini, Anirban Som, and Thalappil Pradeep;
Nanoscale, 2025,17, 803-812. (DOI: 10.1039/d4nr02820a)









Atomically precise noble metal nanoclusters (NCs) are molecular materials known for their precise composition, electronic structure, and unique optical properties, exhibiting chemical reactivity. Herein, we demonstrated a simple one-pot method for fabricating self-assembled Ag–Au bimetallic mesostructures using a reaction between 2-phenylethanethiol (PET)-protected atomically precise gold NCs and colloidal silver nanoparticles (Ag NPs) in a tunable reaction microenvironment. The reaction carried out in toluene at 45°C with constant stirring at 250 revolutions per minute (RPM) yielded a thermally stable, micronsized cuboidal mesocrystals of self-assembled AgAu@PET nanocrystals. However, the reaction in dichloromethane at room temperature with constant stirring at 250 RPM resulted in a self-assembled mesostructure of randomly close-packed AgAu@PET NPs. Using a host of experimental techniques, including optical and electron microscopy, optical absorption spectroscopy, and light scattering, we studied the nucleation and growth processes. Our findings highlight a strategy to utilize precision and plasmonic NP chemistry in tailored microenvironments, leading to customizable bimetallic hybrid threedimensional nanomaterials with potential applications.

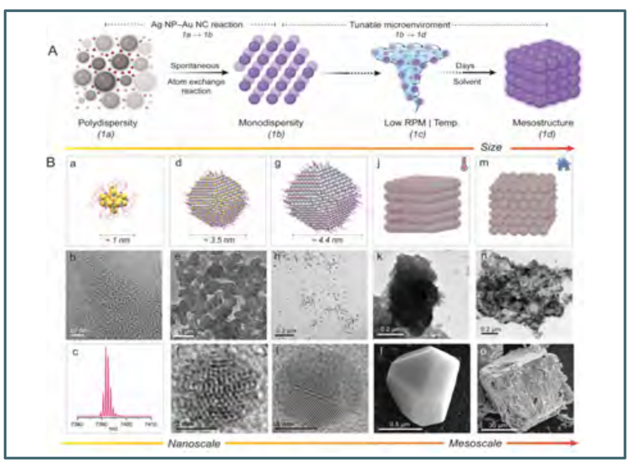


Figure 1: (A) Schematic illustration of the interparticle, polydisperse Ag NPs (grey spheres) and Au NCs (magenta spheres), reaction driving the formation of the mesostructures of bimetallic NPs (purple spheres). (B) Schematic representation and characterization of (a–c) [Au25(PET)18]− NCs, (d–f) AgAu@PET NPs, (g–i) Ag@PET NPs, and mesostructures obtained (j–l) with and (m–o) without heating conditions. PET refers to 2-phenylethanethiol. Color code: grey, Ag; yellow, Au; blue, S; magenta, C; H is omitted for clarity. Please note that the atomic dimensions and ligand attachments are not a true representation. Illustrations are created with a licensed version of BioRender.com.

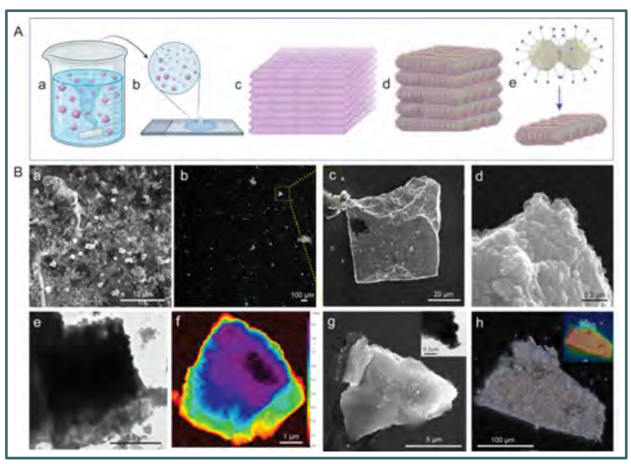


Figure 2: (A) Schematic illustration of the experimental setup (a), sample preparation (b), and typical morphologies (c and d) and morphogenesis (e) of the mesocrystal obtained. (B) FESEM (a, c, and d), dark-field optical microscopy (b), TEM (e), and AFM (f) images of the mesocrystals obtained after ~ 100 days of reaction. Slanted cuboidal-shaped mesocrystals as imaged under FESEM (g) and TEM (in the inset), and an optical microscope in the dark field (h) and the corresponding depth-of-field (in the inset). Color code: grey, Ag; yellow, Au; green, S; pink-blue, ligand. Illustrations are created with a licensed version of BioRender.com.

Enhanced electrical output in an electrostatic generator using charged water

Vishal Kumar, Pillalamarri Srikrishnarka, Ramamurthy Nagarajan, and Thalappil Pradeep;
ACS Sustain. Chem. Eng. 12 (2024) 13106–13115. (DOI: 10.1021/acssuschemeng.4c01860)




Electrostatic charging of water, particularly at the water–hydrophobic interface, continues to perplex researchers despite centuries of work. Recent advancements in energy harvesting, materials synthesis, and sensing employing electrohydrodynamic processes have generated renewed interest in the electrostatic charging of water. This work aims to understand the charging of water from an energy-harvesting perspective. We used a single-electrode electrostatic generator initially to demonstrate enhancement of the electric output with the addition of water. Through several control measurements, we established that the enhancement was a result of the electrostatic charging of water. The role of electrode wettability and pH on the electric output was studied. The effect of pH on the charging of water was correlated with the output voltage. The system was extended to a double-electrode electrostatic generator (DE-EG) to expand the applicability of the technique and increase the output. Using the DE-EG, we demonstrated the influence of an electric field on the charging of water. The electricity thus produced was used to power multiple light-emitting diodes. Furthermore, the technique was employed to treat wastewater containing a dye using a 3D-printed linear actuator. The insights presented are useful in enhancing the performance of water-based EGs and could help to better understand various electrohydrodynamic processes.

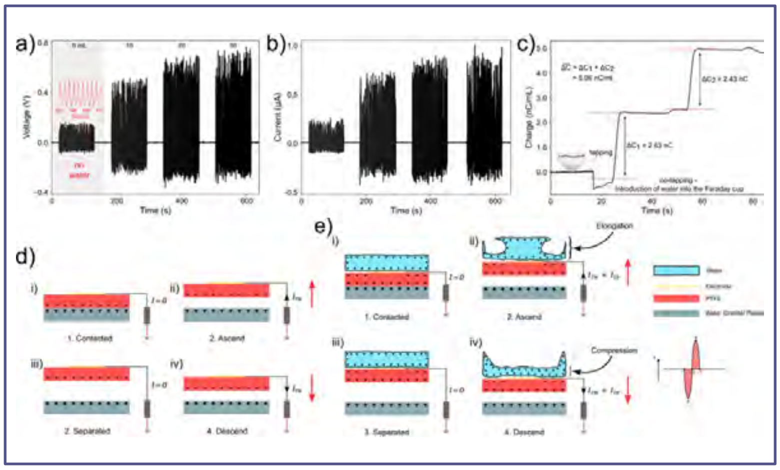


Figure 1: (a) Output voltage of the SE-EG at different volumes of water, and the inset shows the zoomed-in view of the voltage profile at 0 mL, (b) current with sequential addition of water in steps of 10 mL, (c) charge of water when tapped on the granite slab, (d,e) working mechanism of the SE-EG without and with water, respectively.

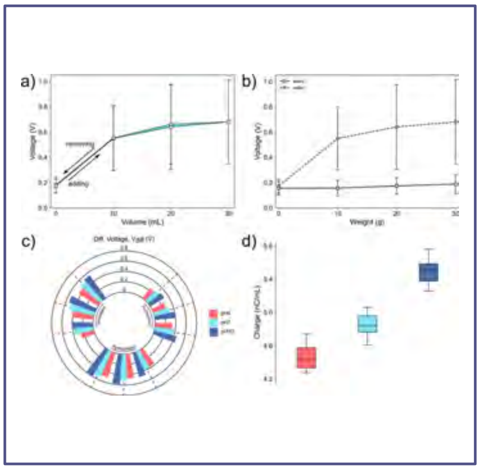
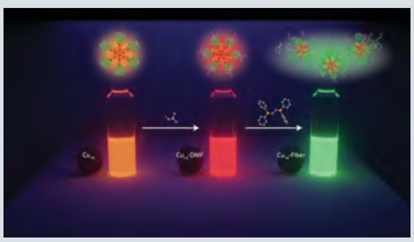


Figure 2: (a) Cyclic testing showing the role of water addition on peak voltage, (b) effect of weight on voltage output, (c) differential voltage, Vdiff, at different pH for electrodes with different wettability, and (d) charge of water at different pH.

Multicolor photoluminescence of Cu_{14} clusters modulated using surface ligands

Arijit Jana, Subrata Duary, Amitabha Das, Amoghavarsha Ramachandra Kini, Swetashree Acharya, Jan Machacek, Biswarup Pathak, Tomas Base, and Thalappil Pradeep;
Chem. Sci. 15 (2024) 13741-13752. DOI: 10.1039/D4SC01566E



Copper nanoclusters exhibit unique structural features and their molecular assembly results in diverse photoluminescence properties. In this study, we present ligand-dependent multicolor luminescence observed in a Cu_{14} cluster, primarily protected by *ortho*-carborane-9,12-dithiol (o-CBDT), featuring an octahedral Cu6 inner kernel enveloped by eight isolated copper atoms. The outer layer of the metal kernel consists of six bidentate o-CBDT ligands, in which carborane backbones are connected through μ_3-sulphide linkages. The initially prepared Cu_{14} cluster, solely protected by six o-CBDT ligands, did not crystallize in its native form. However, in the presence of N,N-dimethylformamide (DMF), the cluster crystallized along with six DMF molecules. Single-crystal X-ray diffraction (SCXRD) revealed that the DMF molecules were directly coordinated to six of the eight capping Cu atoms, while oxygen atoms were bound to the two remaining Cu apices in antipodal positions. Efficient tailoring of the cluster surface with DMF shifted its luminescence from yellow to bright red. Luminescence decay profiles showed fluorescence emission for these clusters, originating from the singlet states. Additionally, we synthesized microcrystalline fibers with a one-dimensional assembly of DMF-appended Cu_{14} clusters and bidentate DPPE linkers. These fibers exhibited bright greenish-yellow phosphorescence emission, originating from the triplet state, indicating the drastic surface tailoring effect of secondary ligands. Theoretical calculations provided insights into the electronic energy levels and associated electronic transitions for these clusters. This work demonstrated dynamic tuning of the emissive excited states of copper nanoclusters through the efficient engineering of ligands.

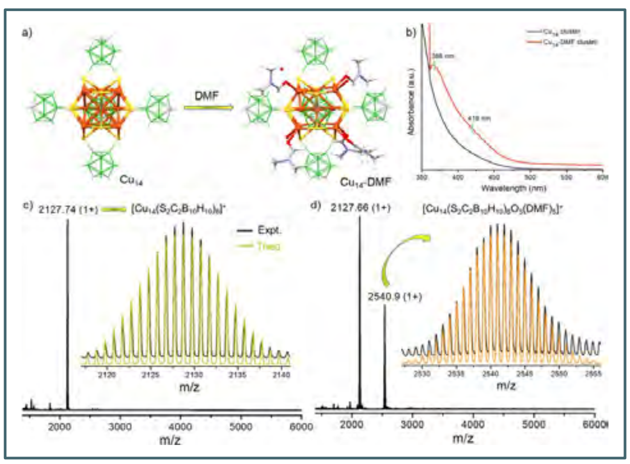


Figure 1: (a) Schematic representation shows the attachment of DMF molecules to the outer shell of the as-synthesized Cu_{14} cluster. Color code: orange, copper; yellow, sulfur; green, boron; grey, carbon; red, oxygen; blue, nitrogen; white, hydrogen. (b) Comparative UV-vis absorption spectra of both clusters. Positive ion-mode ESI-MS spectrum of (c) as-synthesized Cu_{14} without any DMFs (cluster dissolved in DCM or acetonitrile for MS studies) and (d) with five DMFs and three oxygens (after the addition of DMF to the solution). Inset shows exact matching of the isotopic distribution of the experimental peak with the simulated pattern.

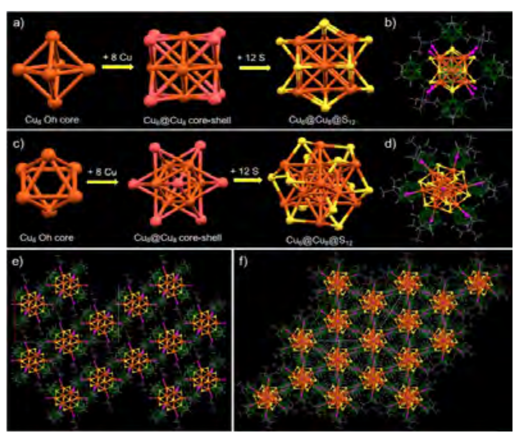
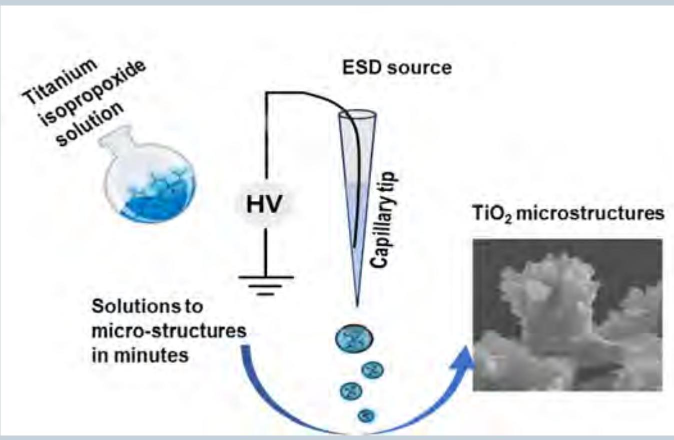


Figure 2: (a and c) Structural anatomy of the Cu_{14}–DMF cluster with an octahedral Cu_6 inner kernel encapsulated by eight Cu atoms resulting in a $Cu_6@Cu_8$ octacapped-octahedral core–shell geometry. Copper sulphide ($Cu_{14}S_{12}$) framework structure, viewed from two different orientations. (b and d) The full molecular structure of the Cu_{14} nanocluster with six primary ortho-carborane-9,12-dithiol ligands and secondary DMF molecules. Supramolecular packing of the same nanocluster viewed along (e). (b and f) c crystallographic orientations. Color code: orange and crimson red = copper, yellow = sulfur, magenta = oxygen, green = boron, grey = carbon, blue = nitrogen, and white = hydrogen.

From solution to microstructures in minutes: microdroplet-derived stand-alone TiO_2 surfaces for simultaneous water harvesting and treatment

Keerthana Unni, Jenifer Shantha Kumar, Anirban Som, Depanjan Sarkar, Thalappil Pradeep;
ACS Sustainable Chem. Eng. 12 (2024) 11957–11967. (DOI: 10.1021/acssuschemeng.4c02806)



We present a straightforward and eco-friendly method to transform a titanium tetraisopropoxide (TTIP) solution into superhydrophobic TiO_2 microstructures by ambient microdroplet deposition. At lower temperatures the micropillars of amorphous TiO_2 act as nucleation sites for condensing humidity to form droplets. However, the microstructures facilitate efficient water runoff despite TiO_2's hydrophilic character by a combination of surface hydrophobicity and gravity. Additionally, the photocatalytic TiO_2 surface resists biofilm formation and degrades the contaminants, offering long-term collection of safe water and its purification, which has been demonstrated with examples. We demonstrate that the microdroplet-based methodology developed for the conversion of solution into microdroplets can also be applied to other metal oxides, including CuO and ZnO, highlighting the universality of the process.

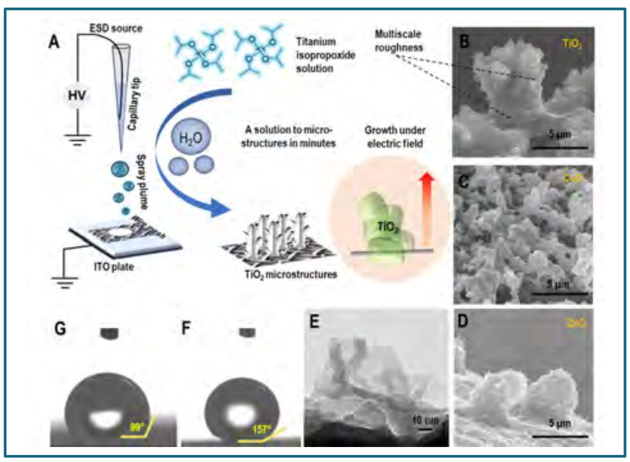


Figure 1: (A) Schematic representation of the ESD fabrication setup used for the microdroplet synthesis of microstructures under ambient conditions. SEM images of (B) TiO_2, (C) CuO and (D) ZnO microstructures. (E) TEM image of TiO_2 microstructure. Contact angle of water on (F) TiO_2 microstructures, and (G) normal SS wire mesh.

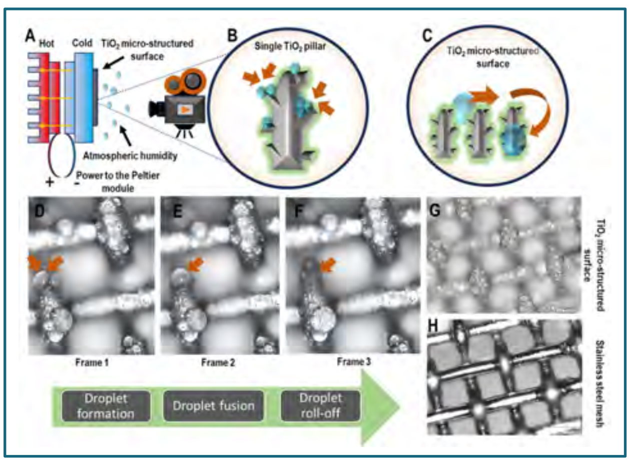
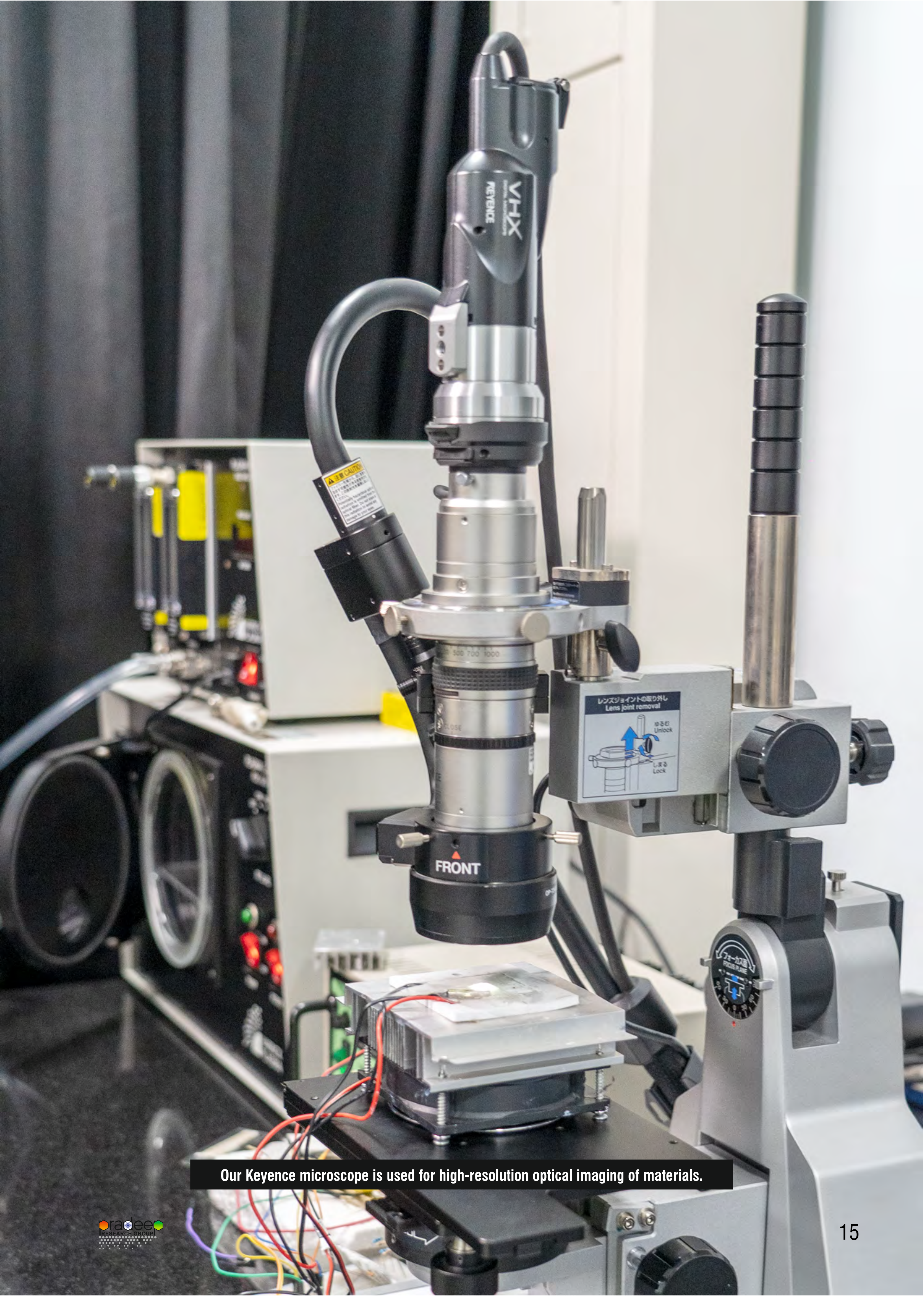
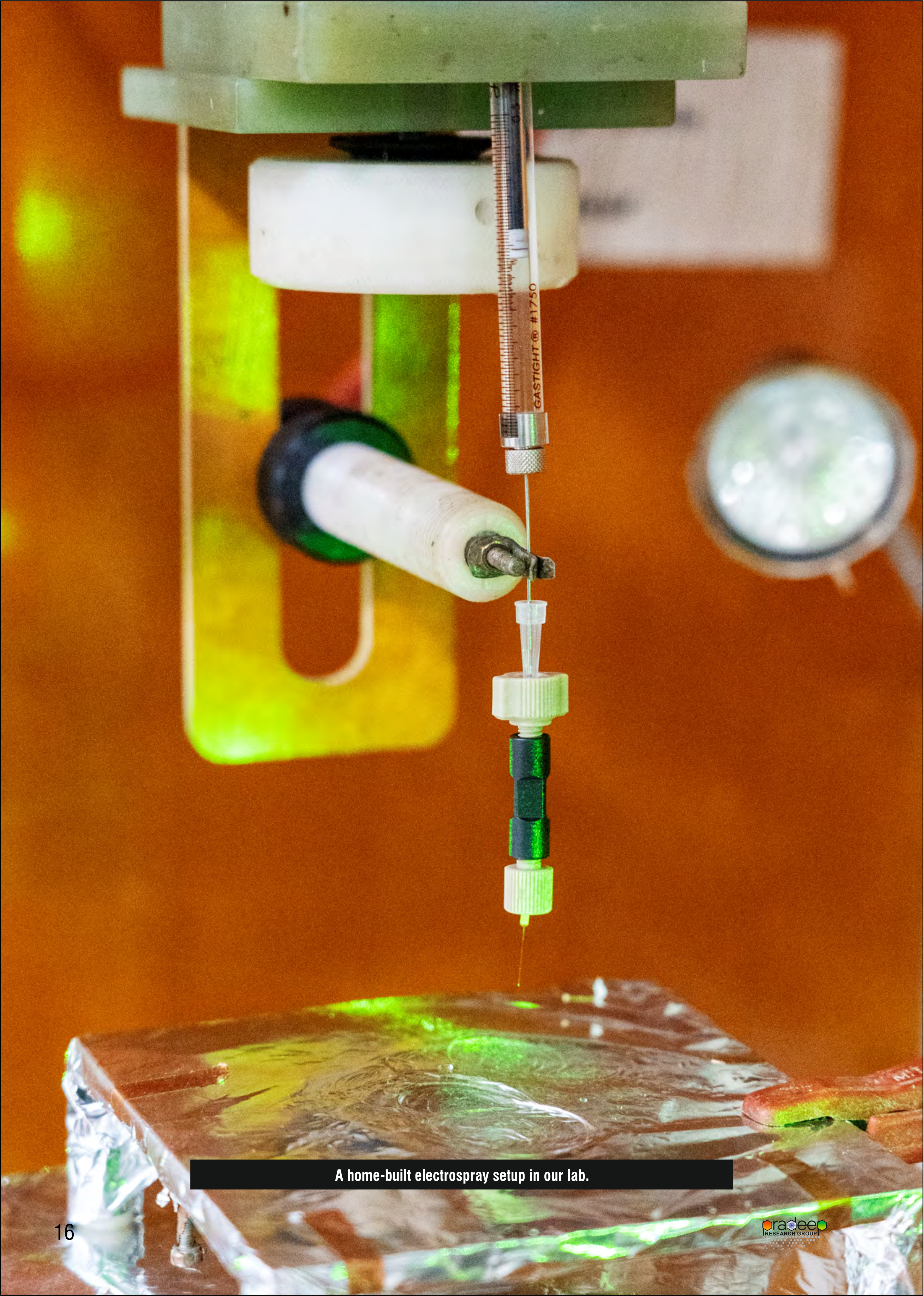


Figure 2: A) Experimental setup for water harvesting. Schematic representation of (B) droplet formation, and (C) droplet roll-off on a single TiO_2 microstructure. Microscopic image of water harvesting, the red arrow indicates the successive events of (D) droplet formation, (E) droplet fusion, and (F) droplet roll-off, on TiO_2 microstructures. Comparison between water harvesting efficiency G) TiO_2 microstructured surface, H) stainless steel mesh, upon exposure to the environment, keeping all parameters the same. Details of the experiment are presented in the main text.



Our Keyence microscope is used for high-resolution optical imaging of materials.

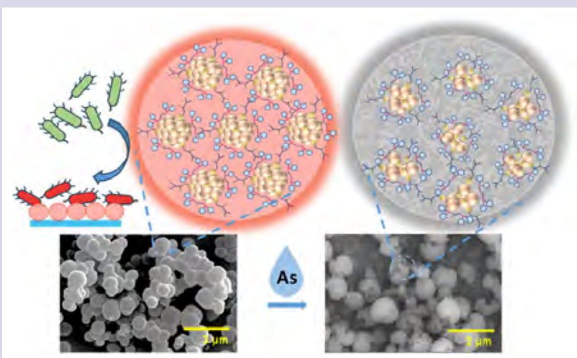


A home-built electrospray setup in our lab.

Cysteine-protected antibacterial spheroids of atomically precise copper clusters for direct and affordable arsenic detection from drinking water

Jenifer Shantha Kumar, Arijit Jana, Jayathraa Raman, Hema Madhuri Veera, Amoghavarsha Ramachandra Kini, Jayoti Roy, Sourav Kanti Jana, Tiju Thomas, and Thalappil Pradeep; *ES&T Letters 11 (2024) 831–837. (DOI: 10.1021/acs.estlett.4c00264)*



Rapid and naked-eye detection of water-borne contaminants using molecularly precise nanomaterials has emerged as a promising strategy to reduce the impact of chemical pollution. This study presents a luminescence-based arsenic (As) sensor, eliminating the need for sample preparation. Incorporating red-emitting spheroidal cluster-assembled superstructures (CASs), comprised of Cu_{17} nanoclusters (Cu_{17}NCs), coprotected by l-cysteine (l-Cys) and 1,2-bis(diphenylphosphino) ethane (DPPE) ligands, the sensor exhibits notable sensitivity toward arsenite (As^{3+}) and (As^{5+}) ions. A detection limit of 1 ppb in tap water was achieved through luminescence-based quenching. Remarkably, it demonstrates selective detection of As amidst common interfering metal ions such as Cd^{2+}, Hg^{2+}, Fe^{3+}, Pb^{2+}, Cu^{2+}, and Cr^{3+}. A sensor disc made of CASs coated on nonwoven polypropylene (PP) mats has been devised for practical field applications. Electron microscopy reveals disrupted morphology of the spheroids due to As interaction. Moreover, the CASs exhibit significant antibacterial efficacy against Gram-negative Escherichia coli and Gram-positive Staphylococcus aureus and antibiofilm properties against Bacillus subtilis. This research highlights the effectiveness of atomically precise clusters for a practical application with direct societal relevance.

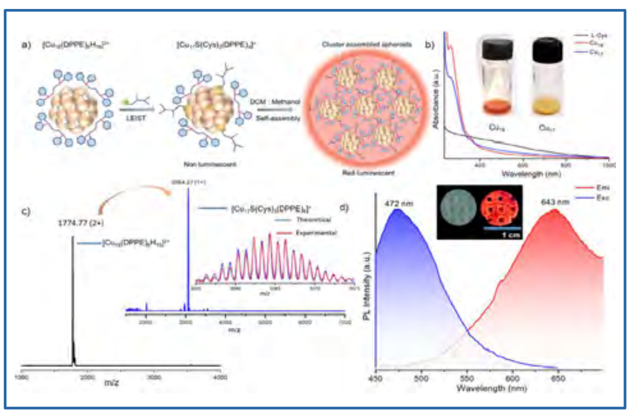


Figure 1: (a) Schematic representation of the synthesis of l-Cys and DPPE-protected Cu_{17}NCs and the self-assembly of the cluster in DCM:methanol (1:1, v/v) solvent mixture. (b) Comparative UV–vis absorption spectra of l-Cys, Cu_{18}, and Cu_{17}NCs. Inset shows the photographs of the respective clusters. (c) Full range ESI MS spectrum of the Cu_{18}NCs and the Cu_{17}NCs in positive ion mode. The inset matches the isotopic distribution of the experimental (blue) and theoretical (red) spectra of Cu_{17}NCs. (d) Photoluminescence excitation and emission spectra of Cu_{17}NCs covered on a PP disc. The inset shows the photograph of the CASs coated on PP mats under daylight (left) and UV light (right).

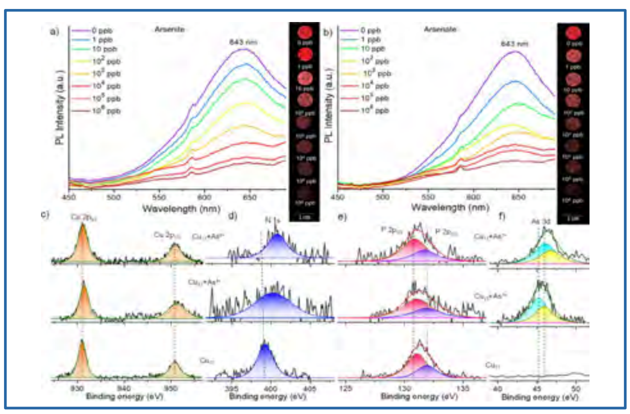


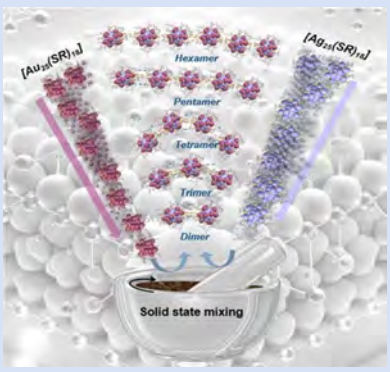
Figure 2: Comparative PL spectra with increasing concentrations of (a) As^{3+} and (b) As^{5+} ions showing the gradual quenching of PL intensity of the PP disc coated with Cu17 NCs. Correlative XPS spectra of Cu_{17} NCs having (c) Cu 2p, (d) N 1s, (e) P 2p, and (f) As 3d regions.

Extensive polymerization of atomically precise alloy metal clusters during solid state reactions

S. Sooraj, Jayoti Roy, Manish Mukherjee, Anagha Jose, and Thalappil Pradeep;
Langmuir 40 (2024) 15244–15251. (DOI: 10.1021/acs.langmuir.4c01737)







Exploring the reactions between atomically precise metal clusters and the consequences of such reactions has been an exciting field of research during the past decade. Initial studies in the area were on reactions between clusters in the solution phase, which proceed through the formation of dimers of reacting clusters. In the present work, we examine the interaction between two atomically precise clusters, $[Au_{25}(PET)_{18}]$ − and $[Ag_{25}(DMBT)_{18}]$ −, in the solid state, where PET and DMBT are 2-phenylethanethiol and 2,4-dimethylbenzenethiol, respectively. The experiments were performed using different ratios of these two clusters, and it was inferred that the kinetics of the reactions were faster compared with reactions in the solution. The metal exchange between these two clusters, due to their interactions in the solid state, leads to the formation of dimers, trimers, tetramers, and polymers of atomically precise alloy metal clusters. We observed polymer entities up to hexamers, which were observed for the first time. Control experiments revealed that metal exchange is a key factor leading to polymerization. Our work points to a new approach for synthesizing polymers of atomically precise alloy metal clusters.

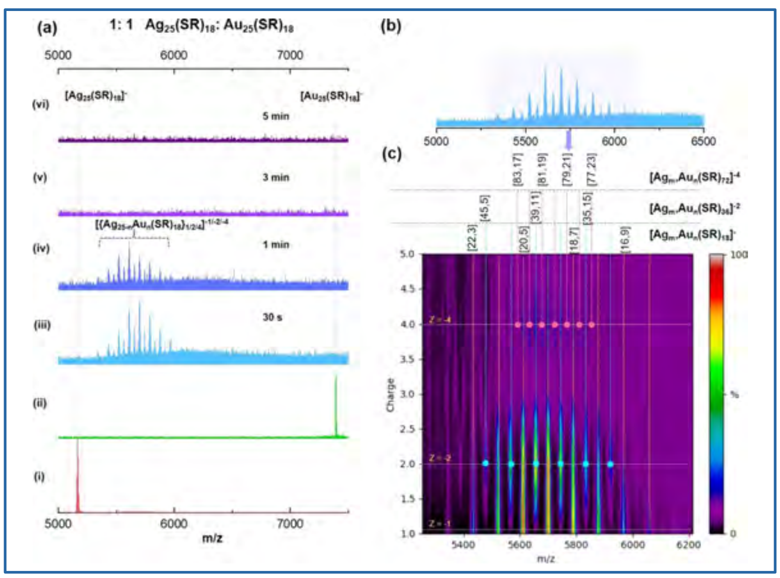


Figure 1: (a) ESI-MS of $Ag_{25}(SR)_{18}$, $Au_{25}(SR)_{18}$, and the time-dependent MS of the 1:1 mixture of $Ag_{25}(SR)_{18}$:$Au_{25}(SR)_{18}$ clusters measured after grinding the mixture. (b) Zoomed-in view of the mass spectrum collected after grinding the mixture for 1 min. (c) Heat map of the mass spectrum collected after grinding the mixture for 1 min (the compositions of various polymer species observed and their charge states marked).

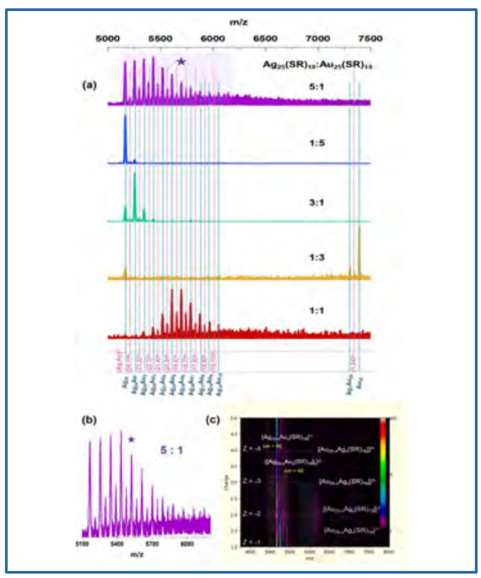
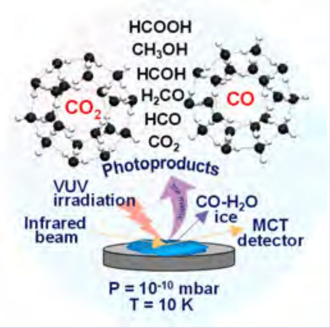


Figure 2: (a) ESI-MS, after 1 min of grinding, of a mixture of $Ag_{25}(SR)_{18}$ and $Au_{25}(SR)_{18}$ at various molar ratios. (b) Zoomed-in mass spectrum for the ratio 5:1 of $Ag_{25}(SR)_{18}$:$Au_{25}(SR)_{18}$. (c) Heat map plot for the ratio 5:1 of $Ag_{25}(SR)_{18}$:$Au_{25}(SR)_{18}$ (the compositions of various polymer species observed and their charge states are marked).

Partitioning photochemically formed CO_2 into clathrate hydrate under interstellar conditions

Gaurav Vishwakarma, Bijesh Malla, Rajnish Kumar and Thalappil Pradeep;
PCCP 26 (2024) 16008-16016. (DOI: 10.1039/D4CP01414F)



Clathrate hydrates (CHs), host–guest compounds of water forming hydrogen-bonded cages around guest molecules, are now known to exist under interstellar conditions. Experimental evidence demonstrated that prolonged thermal treatment of a solid mixture of water and CO_2/CH_4 produces CHs at 10–30 K under simulated interstellar conditions. However, in the current study, we show that CO_2 produced photochemically by vacuum ultraviolet irradiation of H_2O–CO mixtures at 10 K and ~10-10 mbar, gets partitioned into its CH phase and a matrix phase embedded in amorphous ice. The process occurring under simulated interstellar conditions was studied at different temperatures and H_2O–CO compositions. The formation of CO_2 CH and other photoproducts was confirmed using reflection absorption infrared spectroscopy. The UV-induced photodesorption event of CO_2 may provide the mobility required for the formation of CHs, while photoproducts like methanol can stabilize such CH structures. Our study suggests that new species originating during such energetic processing in ice matrices may form CH, potentially altering the chemical composition of astrophysical environments.

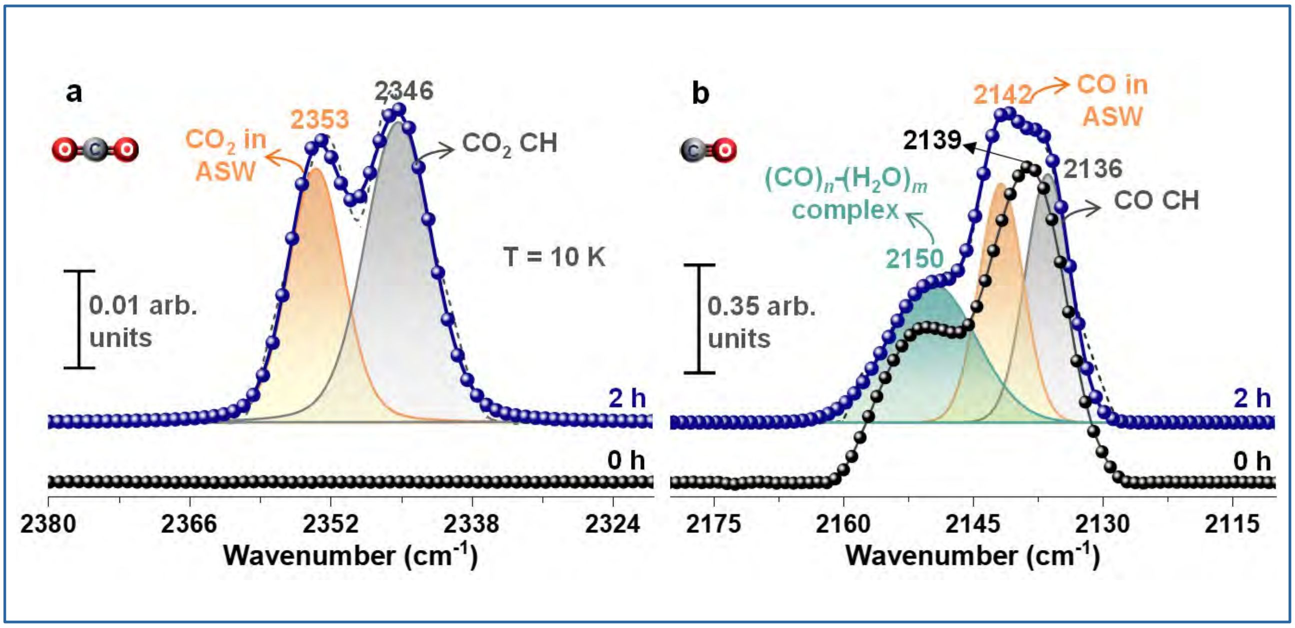
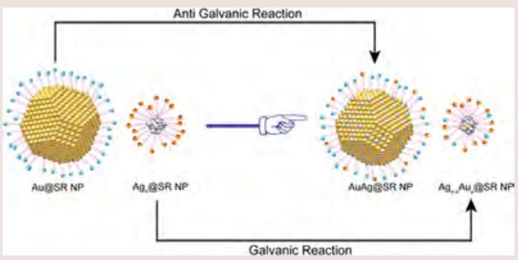


Figure 1: RAIRS analysis of the formation of CO_2 and CO CH. RAIR spectra before (0 h, black curve) and after VUV irradiation (2 h, blue curve) of 100 ML H_2O–CO (7.72) mixture at 10 K in the (a) C=O antisymmetric stretching region of CO_2, and (b) C=O stretching region of CO. While the peak at 2346 cm^{-1} in (a) arises due to the formation of CH of CO_2, the peak at 2136 cm^{-1} in (b) is due to the formation of CH of CO at 10 K. The normalized RAIR spectrum (of 2 h) in (b) was deconvoluted to demonstrate the existence of different CO phases, namely, 2150 cm-1 (CO-H_2O complexes), 2142 cm^{-1} (pure CO), and 2136 cm^{-1} (CO CH). For clarity, the spectra in (b) are normalized to 1 in absorbance.

Interparticle anti-galvanic reactions of atomically precise silver nanoclusters with plasmonic gold nanoparticles: interfacial control of atomic exchange

Paulami Bose, Jayoti Roy, Vikash Khokhar, Biswajit Mondal, Ganapati Natarajan, Sujan Manna, Vivek Yadav, Anupriya Nyayban, Sharma S. R. K. C. Yamijala, Nonappa, and Thalappil Pradeep; *Chem. Mater. 36 (2024) 7581–7594. (DOI: 10.1021/acs.chemmater.4c00620)*



This work demonstrates that antigalvanic reactions (AGRs) between thiol-protected plasmonic gold nanoparticles (NPs) and atomically precise silver nanoclusters (NCs) are an interfacial chemistry-driven phenomenon. We reacted 2,4-dimethylbenzenethiol (DMBT)-protected Au NPs (average diameter of 4.46 ± 0.64 nm) with atomically precise $[Ag_{25}(DMBT)_{18}]^-$ NC and obtained bimetallic AgAu@DMBT alloy NPs. Systematic investigations with optical absorption spectroscopy, high-resolution transmission/scanning transmission electron microscopy, and elemental mapping revealed the reaction-induced morphological and compositional transformation in NPs. Furthermore, we show that such AGRs get restricted when geometrically rigid interfaces are used. For this, we used 1,3-benzenedithiol (BDT)-protected Au@BDT NPs and $[Ag_{29}(BDT)_{12}(TPP)_4]^{3-}$ NCs (TPP = triphenylphosphine). Electrospray ionization mass spectrometric (ESI MS) studies revealed that the interparticle reaction proceeds via metal−ligand and/or metal exchange, depending on the interface. Density functional theory (DFT) calculations and molecular docking simulations were used to understand the interactions and reaction energetics leading to favorable events. Interfacial chemistry of this kind might offer a one-pot synthetic strategy to create ultrafine bimetallic NP-based hybrid materials with potential optoelectronic and catalytic applications.

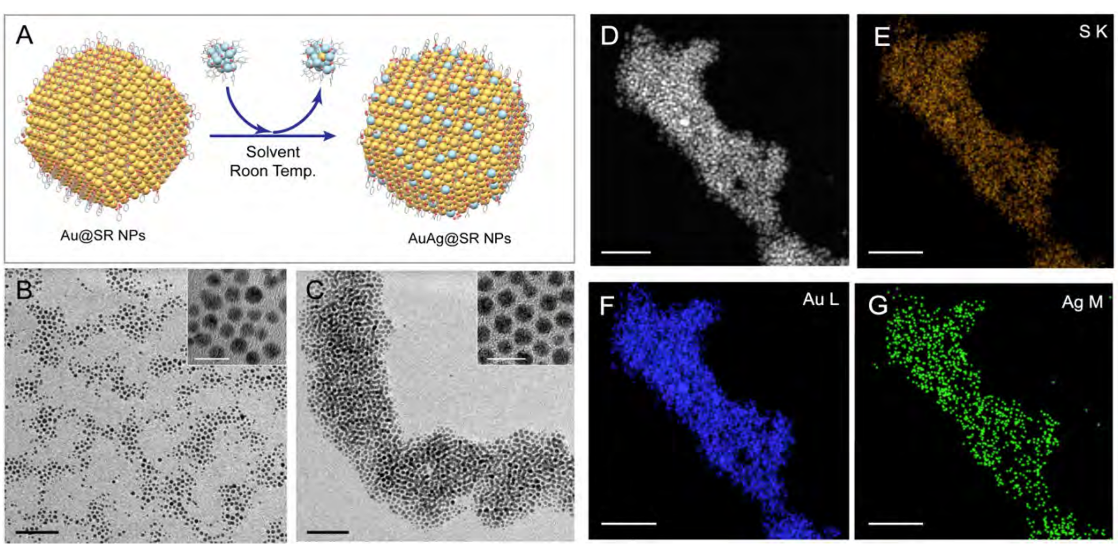
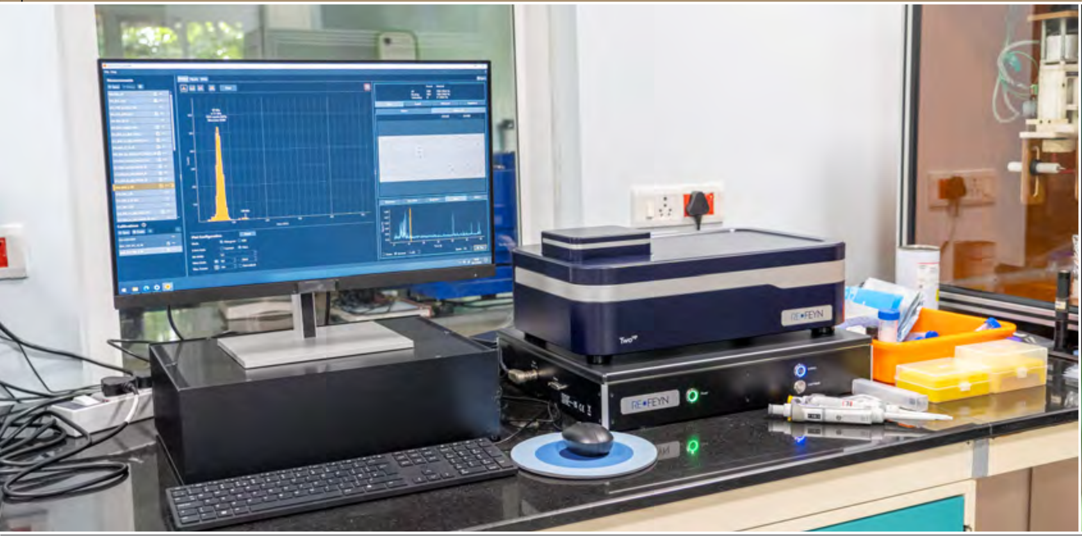
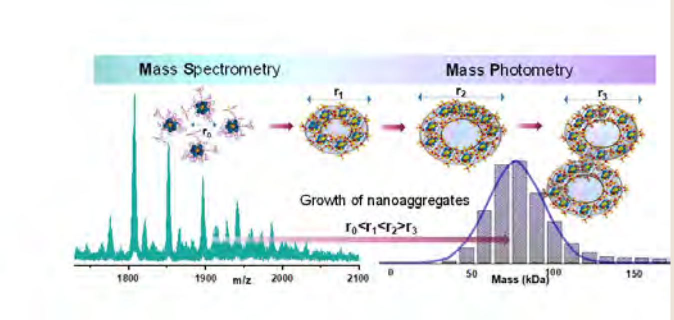


Figure 1: Schematic representation of the interparticle reaction between Au@SR NP and $[Ag_{25}(SR)_{18}]^-$ NC, where SR = 2,4-DMBT (A). TEM images of Au@DMBT NPs before (B) and after (C) the reaction. Dark-field STEM image of the reacted NPs (D) and the corresponding EDS maps of S (E), Ag (F), and Au (G). Scale bars: 50 (B−G) and 10 nm (insets of B and C). Color code in A: yellow, Au; blue, Ag; pink, S; gray, C. H has been omitted for clarity. Note that the ligand structure and anchoring sites are not a true representation of the NP.

Observing atomically precise nanocluster aggregates in solution by mass photometry



Jayoti Roy, Ila Marathe, Vicki Wysocki and Thalappil Pradeep;
Chem. Commun. 60 (2024) 6655-6658. (DOI: 10.1039/D4CC00363B)



We report the first mass photometric characterization of nanoaggregates of atomically precise nanoclusters (NCs) in solution. The differently-sized nanoaggregates of silver–gold alloy NCs, $[Ag_{11-x}Au_x(DPPB)_5Cl_5O_2]^{2+}$ [x = 1–5 and DPPB = 1,4-bis(diphenylphosphino)butane], formed in solution, were examined by mass photometry (MP) with a protein calibration. In addition, we conducted MP studies of varying solvent composition to understand the structural evolution of nanoaggregates. The masses of nanoaggregates were correlated to structures of 15 to 50 nm diameter observed in cryo-electron microscopy.

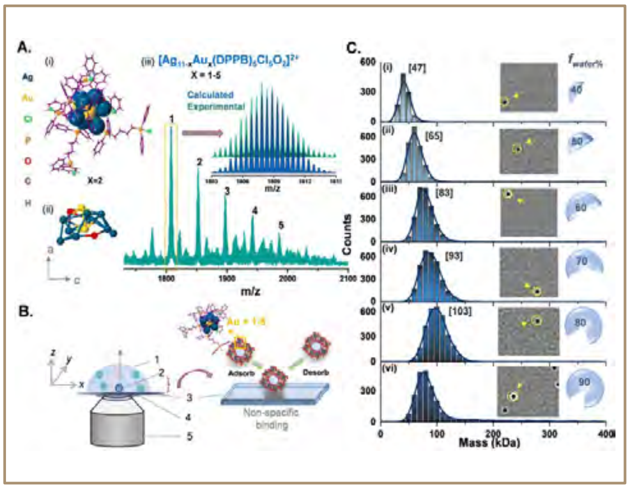


Figure 1: (A) (i) Calculated structure (x = 2), (ii) the metal, Ag_{11}−xAux, core (x = 2), and (iii) ESI MS of $[Ag_{11}$−xAux(DPPB)5Cl5O2$]^{2+}$ (x = 1–5) nanoclusters. In inset, calculated isotopic distribution is stacked with the experimental one. (B) Concept and experimental implementation of MP. Parts in the graphic representation: (1) solvent mixture (sol mix) containing nanoclusters; (2) nanocluster aggregates in solution; (3) glass surface; (4) immersion oil; (5) objective lens. Single-particle landing event on a non-coated cover slide is shown on the right. (C) A stacked plot of the MP histogram of various-sized nanoaggregates with the counts of particle landing events, with varying solvent composition. Mav are shown on the spectra as [xx]. The photographs of single-particle binding events on the glass–sol interface during each set of measurements is shown. The corresponding fwater% of solvent mixture is labelled on each histogram.

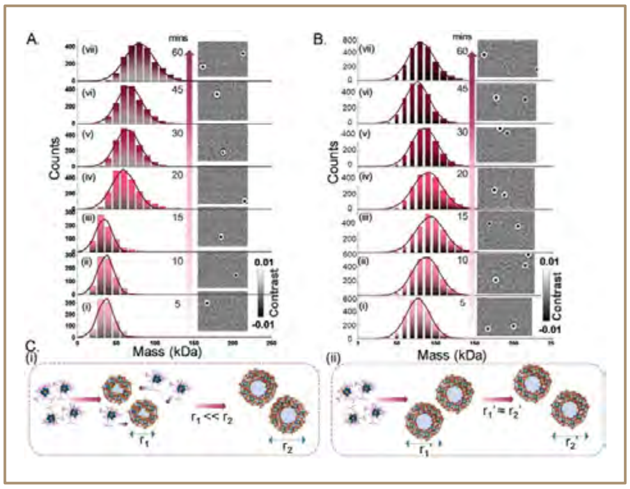
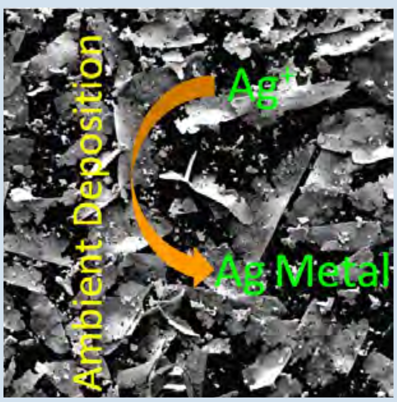


Figure 2: Stacked plots of the time-dependent mass variation of nanoaggregates with normalized counts of single-particle landing events at (A) f40% and (B) f80%, respectively, in MP. The time scale of each stack represents the time of data acquisition at a particular sol mix. The photographs of single-particle landing events at the glass–sol mix interface with increasing time are shown as insets with each measurement. (C) Schematic representation of the variation in diameter of nanoassemblies during NC-aggregation at (i) f40% and (ii) f80% respectively. r1, r1' represent the diameter of the nanoaggregates at the initial stage of growth, and r2, r2' represent the same at the final stage.

Interfacial growth of large area single-crystalline silver sheets through ambient microdroplets

Depanjan Sarkar, Anirban Som, Keerthana Unni, Sujan Manna, and Pradeep Thalappil;
Small, (2024) 2400159. (DOI: 10.1002/smll.202400159)



We report the creation of micrometer-sized sheets of silver at the air-water interface by direct deposition of electrospray-generated silver ions (Ag^+) on an aqueous dispersion of reduced graphene oxide (RGO), in ambient conditions. In the process of electrospray deposition (ESD), an electrohydrodynamic flow is created in the aqueous dispersion, and the graphene sheets assemble, forming a thin film at the air-water interface. The deposited Ag^+ coalesce to make single-crystalline Ag sheets on top of this assembled graphene layer. Fast neutralization of Ag^+ forming atomic Ag, combined with their enhanced mobility on graphene surfaces, presumably facilitates the growth of larger Ag clusters. Moreover, restrictions imposed by the interface drive the crystal growth in two dimensions. By controlling the precursor salt concentration, RGO concentration, deposition time, and ion current, the dimensionality of the Ag sheets could be tuned. These Ag sheets are effective substrates for surface-enhanced Raman spectroscopy (SERS), as demonstrated by the successful detection of methylene blue at nanomolar concentrations.

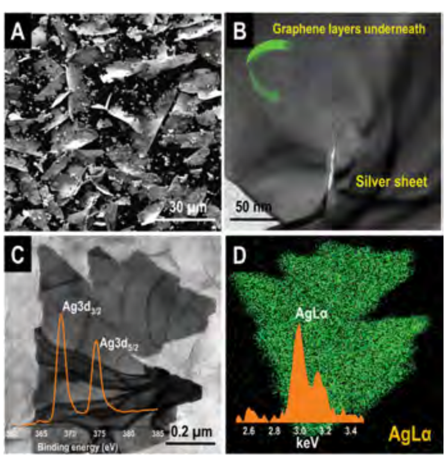


Figure 1: A) SEM image showing Ag sheets synthesized over a large area, B) TEM image of the Ag-sheet revealing its extremely thin nature, with the underlying graphene layers also being observable, C) TEM image showing a large Ag sheet; inset shows an XPS spectrum in the Ag3d region showing that the material is in zero-oxidation state, and D) Energy dispersive spectroscopy (EDS) mapping of the sheet shown in image D; inset of D is the EDS spectrum of the same.

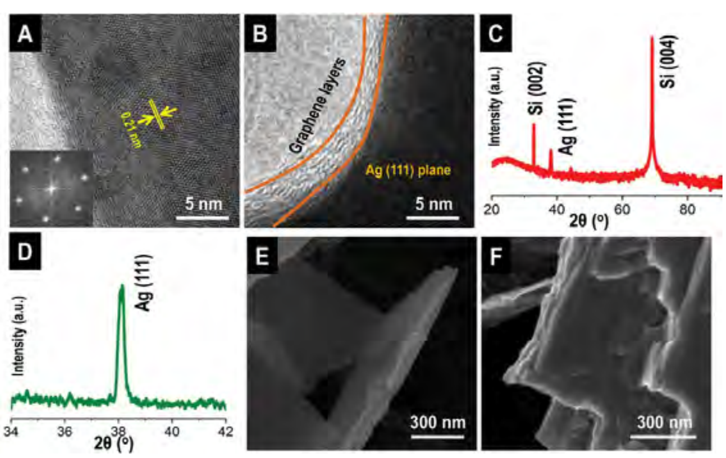


Figure 2: A) HRTEM image of a typical Ag sheet showing Ag (111) plane, these sheets are single crystalline in nature (inset shows the FFT of cubic close packing), B) HRTEM image of an Ag sheet at the edge showing the presence of graphene layers, C) XRD spectrum collected from the as-synthesized Ag sheets, collected over a Si wafer substrate. D) Slow scan XRD spectrum of the Ag (111) region. E) and F) are Field emission scanning electron microscopic (FESEM) images of the Ag sheet showing that these sheets can be very thin or layered in nature depending on the deposition time.

Spontaneous weathering of natural minerals in charged water microdroplets forms nanomaterials

B. K. Spoorthi, Koyendrila Debnath, Pallab Basuri, Ankit Nagar, Umesh V. Waghmare and Thalappil Pradeep;
Science, 384 (2024) 1012-1017. (DOI: 10.1126/science.adl3364)

In this work, we show that particles of common minerals break down spontaneously to form nanoparticles in charged water microdroplets within milliseconds. We transformed micron-sized natural minerals like quartz and ruby into 5- to 10-nanometer particles when integrated into aqueous microdroplets generated via electrospray. We deposited the droplets on a substrate, which allowed nanoparticle characterization. We determined through simulations that quartz undergoes proton-induced slip, especially when reduced in size and exposed to an electric field. This leads to particle scission and the formation of silicate fragments, which we confirmed with mass spectrometry. This rapid weathering process may be important for soil formation, given the prevalence of charged aerosols in the atmosphere.

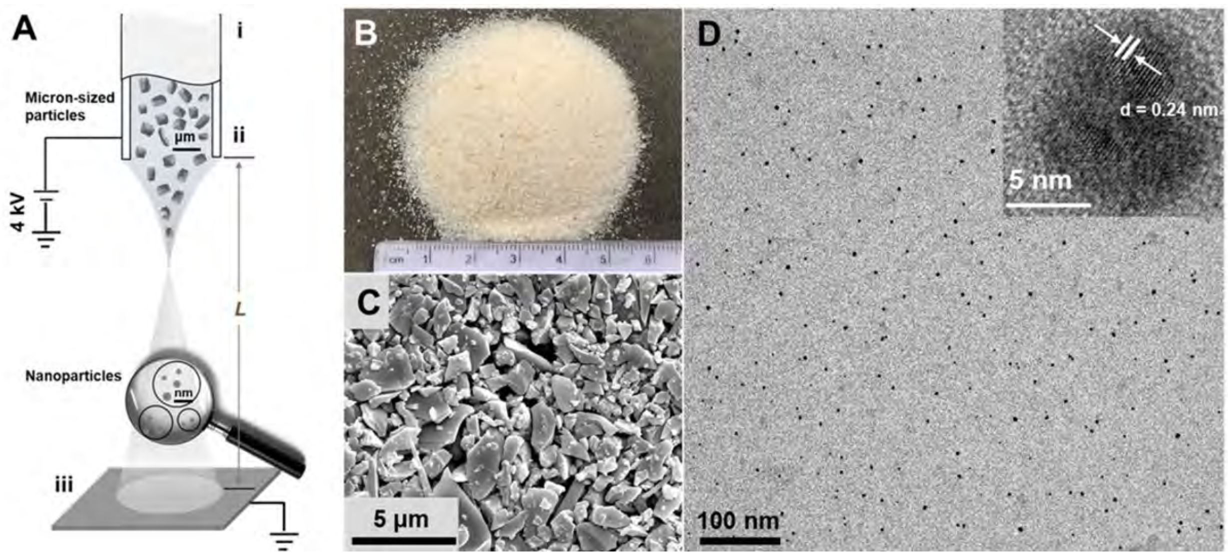
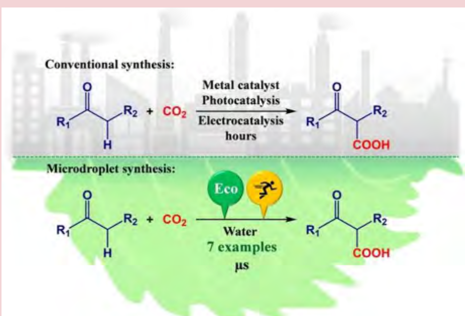


Figure 1: Process of disintegration of natural quartz in microdroplets. (A) Schematic representation of the disintegration of mineral particles in microdroplets. i Electrospray emitter, ii spray capillary of 50μm inner diameter, iii conducting substrate at a distance of L = 1.5 cm from the tip of the emitter. (B) A photograph of the natural quartz. (C) Field emission scanning electron microscopy (FESEM) image of ground and separated natural quartz used for electrospray, showing that the size range of particles is between 1-5μm. A few smaller particles naturally get attached to micron-scale particles even after ultrasonication prior to centrifugation. (D) Transmission electron microscopy (TEM) image of natural quartz after electrospray with a high-resolution image of a particle shown in the inset. The plane shown is (110).

Spontaneous α-C-H carboxylation of ketones by gaseous CO_2 at the air-water interface of aqueous microdroplets

Pallab Basuri, Sinchan Mukhopadhyay, K. S. S. V. Prasad Reddy, Keerthana Unni, B. K. Spoorthi, Jenifer Shantha Kumar, Sharma S. R. K. C. Yamijala, and Thalappil Pradeep;

Angew. Chem. 63 (2024) e202403229. (DOI: 10.1002/anie.202403229)



We present a catalyst-free route for the reduction of carbon dioxide integrated with the formation of a carbon-carbon bond at the air/water interface of negatively charged aqueous microdroplets, at ambient temperature. The reactions proceed through carbanion generation at the α-carbon of a ketone followed by nucleophilic addition to CO_2. Online mass spectrometry reveals that the product is an β-ketoacid. Several factors, such as the concentration of the reagents, pressure of CO_2 gas, and distance traveled by the droplets, control the kinetics of the reaction. Theoretical calculations suggest that water in the microdroplets facilitates this unusual chemistry. Furthermore, such a microdroplet strategy has been extended to seven different ketones. This work demonstrates a green pathway for the reduction of CO_2 to useful carboxylated organic products.

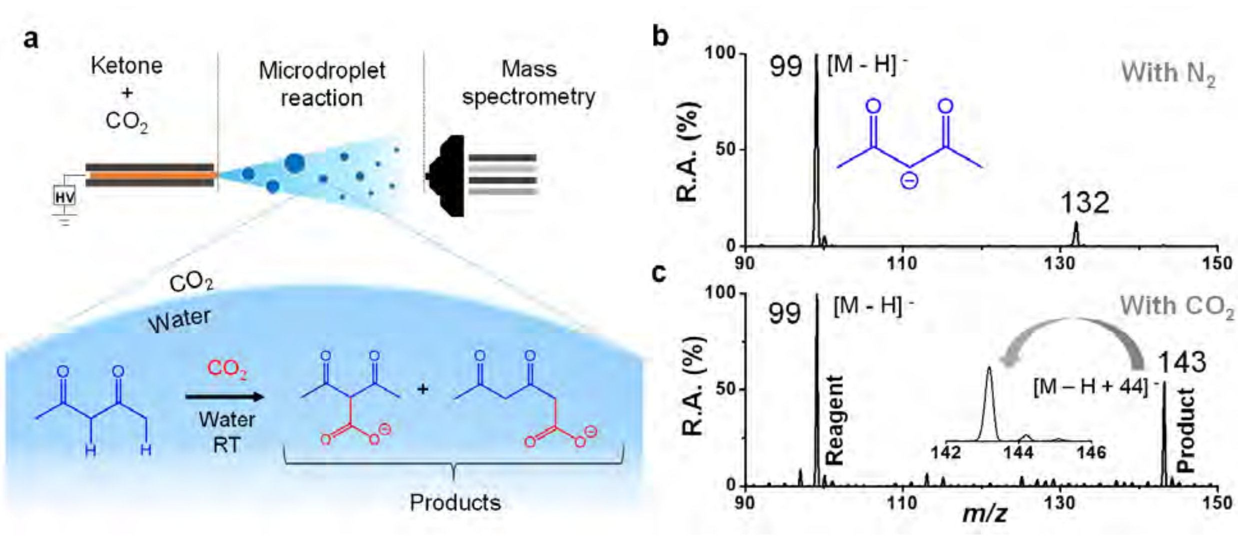
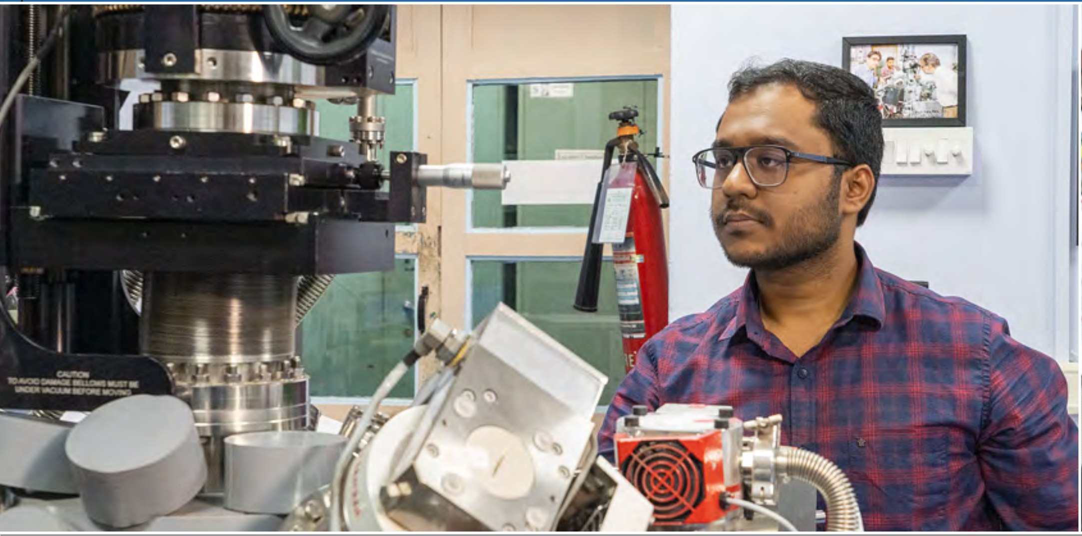


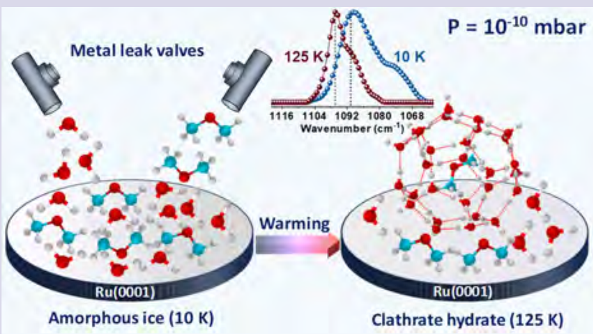
Figure 1: Microdroplet reaction between acetylacetone and CO_2(g). a) Schematic illustration of experimental procedure and reaction scheme of reaction between acetylacetone and CO_2. CO_2 can exist in solution too, in addition to the interface, as it dissolves in water. Mass spectrum of acetylacetone in water 10 mM in a b) nitrogen and c) CO_2-nebulized electrospray. Inset of b shows structure of the species detected corresponding to anion of AcAc. Inset of c shows the zoomed-in spectrum of the peak at m/z 143

Formation and dissociation of dimethyl ether clathrate hydrate in interstellar ice mimics



Bijesh Malla, Gaurav Vishwakarma, Soham Chowdhury, Samir Nayak, Sharma S. R. K. C. Yamijala and Thalappil Pradeep;

J. Phys. Chem. C, 128 (2024) 2463–2470. (DOI: 10.1021/acs.jpcc.3c07792)



Clathrate hydrates (CHs) are believed to exist within interstellar environments, potentially contributing to preserving diverse volatile compounds within icy bodies across the cosmos. In this study, using reflection absorption infrared spectroscopy, we show the formation of dimethyl ether (DME) CH from a vapor-deposited DME-water amorphous ice mixture. Experiments were conducted in an environment mimicking interstellar conditions: ultrahigh vacuum (P ~ 5×10-10 mbar) and cryogenic conditions (T ~ 10-150 K). Thermal annealing of the amorphous ice mixture to a higher temperature (T ~ 125 K) resulted in the formation of CH. Quantum chemical calculations suggested the formation of 51264 cages of structure II CH. Subsequent investigations into the dissociation of DME CH unveiled its transformation into hexagonal ice, requiring a substantial activation energy of 68.04 kJ mol^{-1}. Additionally, confirmation of the formation and dissociation of CH was supported by temperature-programmed desorption mass spectrometry. These results significantly advance our understanding of the existence of CHs under extreme conditions relevant to interstellar medium.

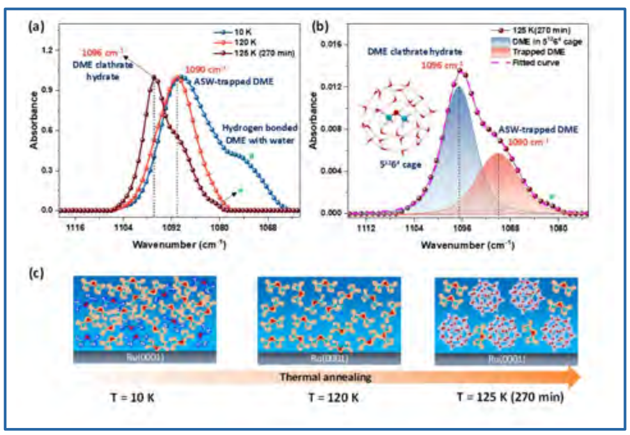


Figure 1: RAIRS study of DME CH. (a) Normalized temperature-dependent RAIR spectra of 300 ML of DME-H_2O (1:5) ice mixture in C-O antisymmetric stretching region of DME. (b) The IR spectrum after 270 min at 125 K is deconvoluted into 2 components, shown in blue (peak centered at 1096 cm^{-1}) and red (peak centered at 1090 cm^{-1}) shades. DFT optimized structure of DME inside $5^{12}6^4$ cage is shown in the inset. The peak labeled as * in the spectrum at 125 K and 270 min is attributed to very tiny amount of dilutes. The ice mixture was co-deposited on Ru(0001) surface at 10 K and annealed to 125 K with a ramping rate of 2 K min-1. (c) Schematic illustration of DME interaction with water at various temperatures. Blue and orange colored DME molecules represent the strong and weak hydrogen bonding nature with water molecules, respectively, and encaged DME inside $5^{12}6^4$ cages are also shown.

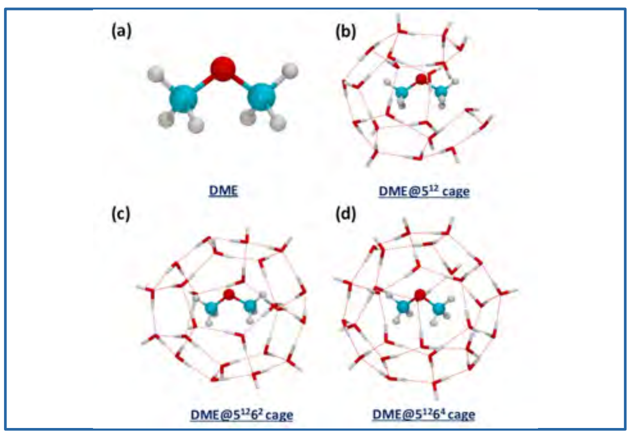
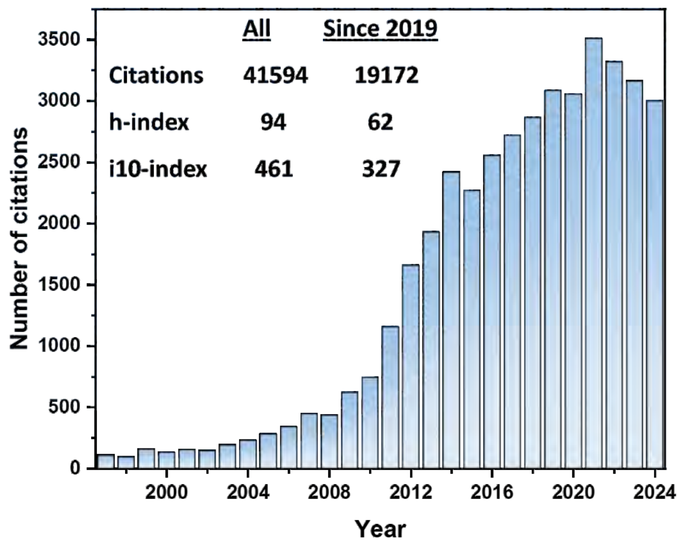


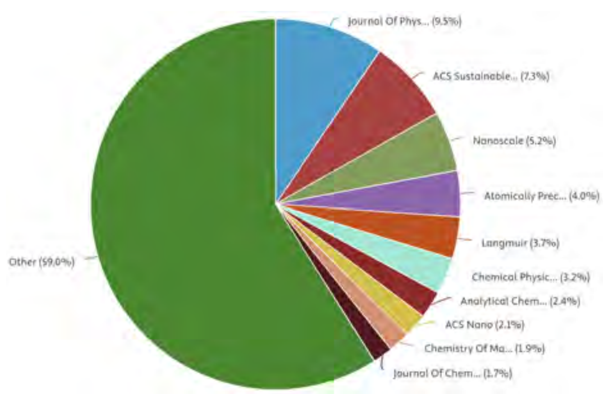
Figure 2: DFT-optimized structures of DME and DME trapped within different CH cages, such as (a) DME, (b) 512 cage, (c) 51262 cage, and (d) 51264 cage. Color code used: cyan, C; red, O; and gray, H.

PUBLICATION ANALYSIS

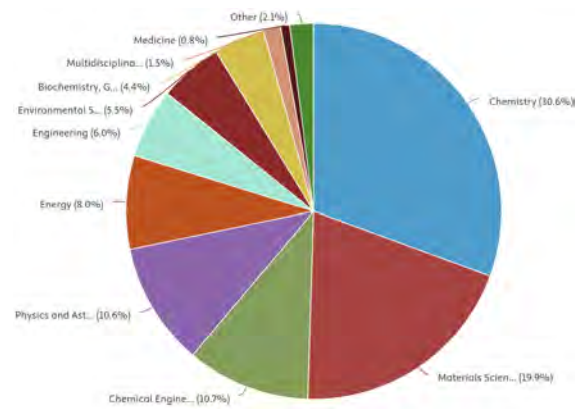


Google Scholar

Scopus - Document by Source



Scopus - Document by Subject



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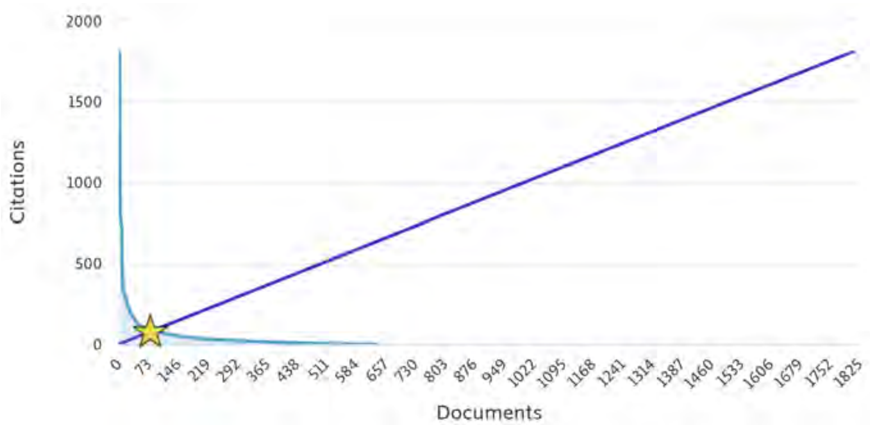


Google Scholar – visited on December 30, 2024.

Scopus – visited on December 30, 2024.

GLIMPSES OF 2024

The Book, “Technological Solutions for Water Sustainability: Challenges and Prospects: Towards a Water-Secure India” edited by Ligy Philip, Thalappil Pradeep, and S. Murty Bhallamudi, was released by Shri M.K. Narayanan, 19th Governor of West Bengal and former NSA, on March 22, 2024.

Inauguration of ANRF National facility of Cryo-EM at IIT Madras, by Prof. Abhay Karandikar, Secretary, DST, along with Prof. V. Kamakoti, Director, IIT Madras, and Prof. T. Pradeep, on August 28, 2024.

Prof. T. Pradeep becomes the 23rd foreign member from India to be elected to the United States National Academy of Engineering (NAE), on September 25, 2024. This is one of the highest professional distinctions. The picture was taken at the dinner of the class of 2024.

Participants of the 2nd edition of the Centre of Excellence International Winter School on Molecular Materials and Functions 2024, IIT Madras held during December 4–8, 2024.

International Advisory Board (IAB) of the Centre of Excellence on “Molecular Materials and Functions”, IIT Madras, held on December 8, 2024. Our co-investigators and several world leaders in the area participated.


India-Germany discussion meeting on International Research Training Groups, fostering new opportunities for bilateral scientific advancements, IIT Madras, December 11, 2024, supported by our DST-DFG project.


IIT Madras organized a hands-on workshop on Microcrystal Electron Diffraction (MicroED) after the 1st International Symposium on Cryo-Electron Microscopy 2024, held during August 11–13, 2024.

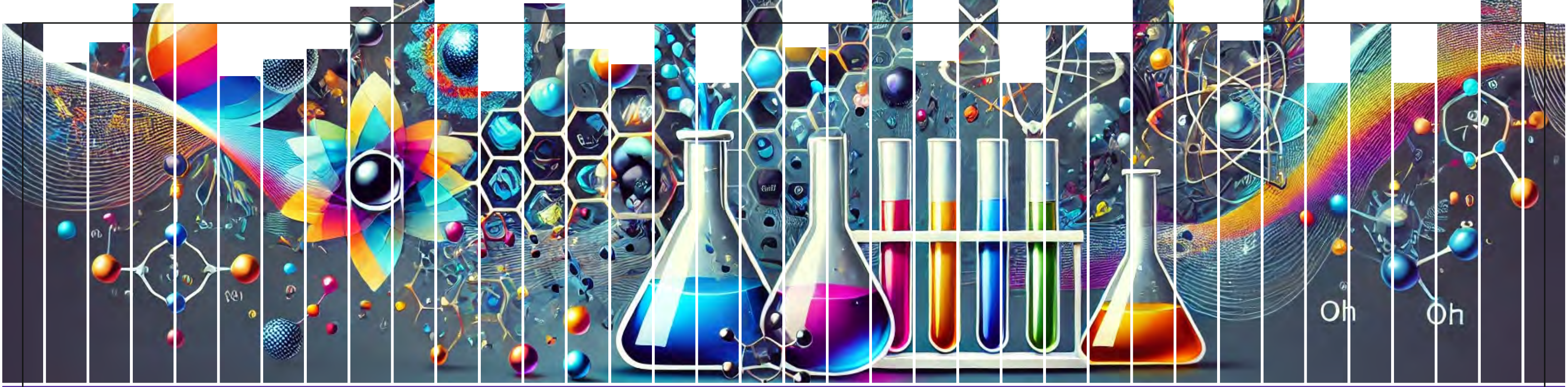
Participants of the 2nd edition of the International Conference on Water for Life 2024, IIT Madras held during December 12–14, 2024.


Participants of the 2nd edition of Centre of Excellence International Conference on Molecular Materials and Functions 2024, IIT Madras held during December 9–11, 2024.

Participants of the 11th edition of AsiaNano Conference on Nanoscience and Nanotechnology, IIT Madras held during September 23–25, 2024.

Participants of the 1st International Symposium on Cryo-Electron Microscopy, IIT Madras, on August 10, 2024.

A turbomolecular pump, part of our ice instrument.

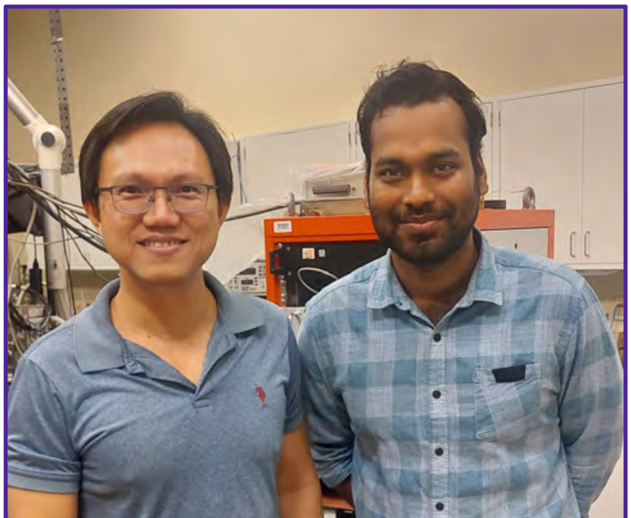


STUDENT ACTIVITIES

1. **Bijesh Kumar Malla** has given an oral presentation on " Photochemistry of Molecular Ices Under Ultrahigh Vacuum and Cryogenic Conditions," at the Physical Research Laboratory, Ahmedabad, India, January 5–7, 2024.
2. **B. S. Sooraj** visited the laboratory of Dr. Rodolphe Antoine, Institut Lumiere Materie, University of Claude Bernard Lyon 1, Lyon, France, January 23–February 8, 2024.

Mr. B. S. Sooraj with Dr. Rodolphe Antoine, Institut Lumiere Materie, University of Claude Bernard Lyon 1, France January, 2024.

3. **Soham Chowdhury** presented a poster titled "Clathrate hydrates in simulated interstellar medium" at the 42nd meeting of the Astronomical Society of India (ASI) 2024, IISc., Bangalore, January 31–February 4, 2024.
4. **Bijesh Kumar Malla** visited Houston to work with Dr. Ding-Shyue Yang at the Department of Physical Chemistry, University of Houston, January–April, 2024.



Mr. Bijesh Kumar Malla with Dr. Ding-Shyue Yang, University of Houston, Houston, January-April, 2024.

5. **Deepak Kumar Patel** presented a poster titled "Macropolyhedral syn-$B_{18}H_{22}$, the 'Forgotten' Isomer" at the Gordon Research Conference (GRC) on Atomically Precise Nanochemistry, Galveston, Texas, USA, February 2–9, 2024.
6. **Anagha Jose** presented a poster titled "Vertically Aligned Nanoplates of Atomically Precise Co_6S_8 Cluster for Practical Arsenic Sensing" at the Gordon Research Seminar (GRS) on Atomically Precise Nanochemistry, Galveston, Texas, USA, February 3–4, 2024.
7. **Swetashree Acharya** has given an oral presentation on "Soft Synthesis of Molybdenum-oxo Clusters and Their Applications for Clean Water" at the Gordon Research Seminar (GRS) on Atomically Precise Nanochemistry, Galveston, Texas, USA, February 3–4, 2024.
8. **Subrata Duary** has given an oral presentation on "A Few Atomic Copper Nanoclusters with 'Turn off' Luminescence by Ambient Mechanical Grinding" at the Gordon Research Seminar (GRS) on Atomically Precise Nanochemistry, Galveston, Texas, USA, February 3–4, 2024.
9. **Swetashree Acharya** presented a poster titled "Formation of Metastable Dimers in the Reactions of Atomically Precise MAg24(DMBT)18 (M= Ag, Au, Pd, Pt) and $Ag_{29}(BDT)_{12}$ Clusters" at the Gordon Research Conference (GRC) on Atomically Precise Nanochemistry, Texas, USA, February 4–9, 2024.
10. **Amoghavarsha R. Kini** presented a poster titled "Nanomechanical Properties of Crystals of Cu_4 with Enhanced Hardness in Low-Density Isomorphs" at the Gordon Research Conference (GRC) on Atomically Precise Nanochemistry, Galveston, Texas, USA, February 4–9, 2024.
11. **Anagha Jose** presented a poster titled "Vertically Aligned

Ms. Anagha Jose with Prof. Jennifer S. Brodbelt, UT Austin, Texas, February 12 - April 29, 2024.

Our 21-year-old TEM is still fully functional.

Vitrobot is used for cryo-EM sample preparation.

Nanoplates of Atomically Precise Co_6S_8 Cluster for Practical Arsenic Sensing" at the Gordon Research Conference (GRC) on Atomically Precise Nanochemistry, Galveston, Texas, USA, February 4–9, 2024.

12. **Subrata Duary** presented a poster titled "A Few Atomic Copper Nanoclusters with 'Turn off' Luminescence by Ambient Mechanical Grinding" at the Gordon Research Conference (GRC) on Atomically Precise Nanochemistry, Galveston, Texas, USA, February 4–9, 2024.
13. **Anagha Jose** visited UT Austin, Texas, to work with Prof. Jennifer S. Brodbelt, February 12–April 29, 2024.
14. **Deepak Kumar Patel** visited Institute of Physics and Institute of Inorganic Chemistry of Czech Academy of Science to work with Dr. Monika Kučeráková and Dr. Tomas Base March–December, 2024.
15. **Riya Dutta** has given an oral presentation at a webinar on Earth Day, organised by ICCW, IIT Madras, April 22, 2024.
16. **Sujan Manna** visited MIT, USA, to work with Prof. Loza Tadesse, Department of Mechanical Engineering, April–July, 2024.

Mr. Sujan Manna with Prof. Loza Tadesse, MIT, USA. April–July, 2024.

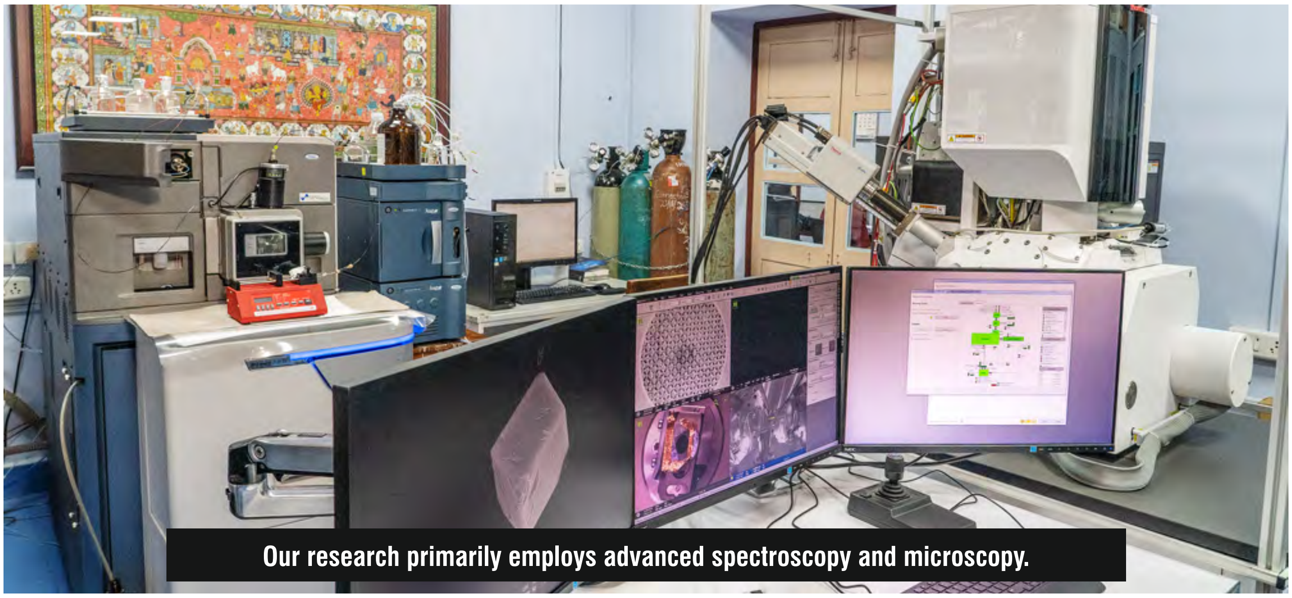
17. **Vivek Yadav** has given an oral presentation on "Atomically Precise Carboranethiol-Protected Ag17, AuAg16, Ag13Cu4 and AuAg12Cu4 Nanocl usters" at the 7th International Symposium on Monolayer-Protected Clusters (ISMPC), Penn State University, USA, June 12–14, 2024.
18. **Vivek Yadav** has presented a poster titled "Atomically Precise Carboranethiol-Protected Ag_{17}, $AuAg_{16}$, $Ag_{13}Cu_4$ and $AuAg_{12}Cu_4$ Nanoclusters" at the 7th International Symposium on Monolayer-Protected Clusters (ISMPC), Penn State University, USA, June 12–14, 2024.
19. **Deepak Kumar Patel** visited the laboratory of Prof. Holger Braunschweig at Julius-Maximilians-University of Würzburg, Würzburg, Germany, June 2024.
20. **Deepak Kumar Patel** visited Karlsruhe Institute of Technology, Germany to work with Prof Manfred M. Kappes, June 2024.
21. **Deepak Kumar Patel** visited the Elettra Synchrotron Trieste facility, Italy and worked with Dr. Monika Kučeráková and Dr. Tomas Base, June 2024.
22. **Vivek Yadav** has presented a poster titled "Atomically Precise Carboranethiol-Protected Ag_{17}, $AuAg_{16}$, $Ag_{13}Cu_4$ and $AuAg_{12}Cu_4$ Nanoclusters" at the Gordon Research Conference (GRC) 2024 on Noble Metal Nanoparticles, Mount Holyoke College in Massachusetts, US, June 16–21, 2024.
23. **S. Sudhir** hosted a four-day program on entrepreneurship conducted by Thinkstartup at IITM Research Park, IIT Madras, July 3, 2024.


Mr. Deepak Kumar Patel with Dr. Monika Kučeráková and Dr. Tomas Base at Elettra Synchrotron Trieste facility in Italy, June 2024.

24. **Keerthana Unni** presented a poster titled "From Solutions to Microstructures in Minutes: Microdroplet Derived Stand-Alone TiO2 Surfaces for Simultaneous Water Harvesting and Treatment" at the 33rd CRSI National Symposium in Chemistry (CRSI-NSC), Hyderabad, July 4–6, 2024.
25. **Soham Chowdhury** has given an oral presentation on "Composition-Dependent Clathrate Hydrate Formation of Trimethylene Oxide and Consequences of Dissociation" in the International Conference on Chemistry and Physics at Low Temperatures – 2024, Niseko, Hokkaido, Japan, July 6–11, 2024.
26. **Bijesh Kumar Malla** has given an oral presentation on "Insights into Interstellar Ice Photochemistry: Cryogenic Laboratory Studies" in the International Conference on Chemistry and Physics at Low Temperatures – 2024, Niseko, Hokkaido, Japan, July 6–11, 2024.
27. **Sujan Manna** presented a poster titled "Surface Enhanced Raman Spectroscopy of Atomically Precise Nanoclusters" at the Gordon Research Conference on Plasmonics and Nanophotonics, Newry, Maine, USA, July 7–12, 2024.
28. **Sujan Manna** gave a talk on "Raman spectroscopy" at the summer school, Tadesse lab, MIT, USA, July 17–18, 2024.
29. **Keerthana Unni** is visiting Purdue University to work with Prof. R. Graham Cooks, Purdue, August 2024–August 2025.
30. **S. Sudhir** conducted a workshop for YouthIdeathon 2024, a Startup Workshop at The Lords International School and Sana Model School, Chennai, August 13, 2024.
31. **Subrata Duary** visited the Stanford Linear Accelerator Center (SLAC), Stanford University, USA, to get trained in cryo-EM (Single Particle Analysis/SPA) technique under the supervision of Prof. Wah Chiu, August–November, 2024.
32. **Sujan Manna** has delivered an invited talk on "Ambient Morphology-Preserved Doping of Cu(0) to Anisotropic Gold Nanoparticles Through Reactions with Atomically Precise Nanoclusters" at the 11th Asian Conference on Nanoscience and Nanotechnology (AsiaNANO) 2024, IIT Madras, September 25, 2024.
33. **Vivek Yadav** has given an oral presentation on "Clustering of Clusters" at the 11th Asian Conference on Nanoscience and Nanotechnology (AsiaNANO) 2024, IIT Madras, September 25, 2024.
34. **Tanmayaa Nayak** presented a poster titled "Cellulose-Derived Nanomaterials for Affordable and Rapid Remediation of Uranium in Water" at the 9th International Congress and Exhibition on Arsenic in the Environment (As 2024), KIIT-DU, Odisha, October

20–24, 2024.

35. **Sonali Seth** presented a poster titled "Biopolymer-Based Adsorbent for Uranium Removal from Water" at the 9th International Congress and Exhibition on Arsenic in the Environment (As 2024), KIIT-DU, Odisha, October 20–24, 2024.
36. **Bijesh Kumar Malla** presented a poster on "Formation of Clathrate Hydrates under Simulated Interstellar Conditions" at the SoPhyc-Physical Chemistry Symposium 2024, IIT Bombay, October 22–25, 2024.
37. **Amoghavarsha R. Kini** has given an oral presentation on "Atomically Precise Nanoclusters: From Structure to Functions" at the Chemistry in-House Symposium (CiHS) – 2024, IIT Madras, October 29, 2024.
38. **Vivek Yadav** presented a poster titled "Atomically Precise Carboranethiol-Protected Ag_{17}, $AuAg_{16}$, $Ag_{13}Cu_4$ and $AuAg_{12}Cu_4$ Nanoclusters" at the Chemistry in-House Symposium (CiHS) – 2024, IIT Madras, October 29, 2024.
39. **B. S. Sooraj** Presented a poster titled "Ligand Dependent Metallicity in Au_{144} Nanoclusters Unveiled by Excited State Electron Dynamics" at the 5th International Conference on Emerging Advanced Nanomaterials (ICEAN 2024), Newcastle, Australia, November 4–8, 2024.
40. **Sujan Manna** presented a poster titled "Surface Enhanced Raman Spectroscopy of Atomically Precise Nanoclusters" at the FCS-OWLS conference, IIT Bombay, November 16–21, 2024.
41. **Atrayee Datta, Anubhav Mahapatra** and **Riya Dutta** visited the Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota, the Spaceport of India, November 21, 2024.
42. **Sonali Seth** presented a poster titled "Biopolymer-Based Adsorbent for Uranium Removal from Water" at the International Winter School 2024 on Frontiers in Materials Science, JNCASR, Bangalore, December 2–6, 2024.
43. **Samapti Mondal** participated in the International Winter School 2024 on Frontiers in Materials Science, JNCASR, Bangalore, December 2–6, 2024.
44. **Swetashree Acharya** has given an oral presentation on "Reactions of Nanoclusters" at the 2nd edition of CoE International Conference on Molecular Materials and Functions – 2024, IIT Madras, December 9–11, 2024.
45. **Amoghavarsha R. Kini** has given an oral presentation on "Nanomechanical Investigations of Crystals of Cu_4 Nanocluster Isomorphs: Enhanced Hardness of the Low-Density Analogue" at the 2nd edition of CoE International Conference on Molecular Materials and Functions – 2024, IIT Madras, December 9–11, 2024.
46. **Vivek Yadav** presented a poster titled "Site-Specific Substitution in Atomically Precise Carboranethiol-Protected Nanoclusters and Concomitant Changes in Electronic Properties" at the 2nd edition of CoE International Conference on Molecular Materials and Functions – 2024, IIT Madras, December 9–11, 2024.
47. **Harshita Nagar** presented a poster titled "Rapid Determination of the Atomic Structure of Small Copper Nanoclusters with MicroED" at the 2nd edition of CoE International Conference on Molecular Materials and Functions – 2024, IIT Madras, December 9–11, 2024.
48. **B. S. Sooraj** has given an oral presentation on "Ligand Dependent Metallicity in Au_{144} Nanoclusters Unveiled by Excited State Electron Dynamics" at the 2nd edition of CoE International Conference on Molecular Materials and Functions – 2024, held at IIT Madras, India, December 9–11, 2024.
49. **Anagha Jose** has given an oral presentation on "Vertically Aligned Nanoplates of Atomically Precise Co6S8 Cluster for Practical Arsenic Sensing" at the 2nd edition of International Conference on Water for Life – 2024, IIT Madras, December 12–14, 2024.
50. **Sinchan Mukhopadhyay** presented a poster titled "Spontaneous αC–H Carboxylation of Ketones by Gaseous CO2 at the Air-water Interface of Aqueous Microdroplets" at the 2nd edition of the International Conference on Water for Life – 2024, IIT Madras, December 12–14, 2024.
51. T**anmayaa Nayak** has given an oral presentation on "Cellulose-Derived Nanomaterials for Affordable and Rapid Remediation of Uranium in Water" at the 2nd edition of the International Conference on Water for Life – 2024, IIT Madras, Chennai, December 12–14, 2024.
52. **Sonali Seth** presented a poster titled "Biopolymer-Based Adsorbent for Uranium Removal from Water" at the 2nd edition of the International Conference on Water for Life – 2024, IIT Madras, December 12–14, 2024.
53. **Vivek Yadav** presented a poster titled "Site-Specific Substitution in Atomically Precise Carboranethiol-Protected Nanoclusters and Concomitant Changes in Electronic Properties" at the Conference on Advances in Chemistry for Energy and Environment (CACEE), TIFR Mumbai, December 16–20, 2024.



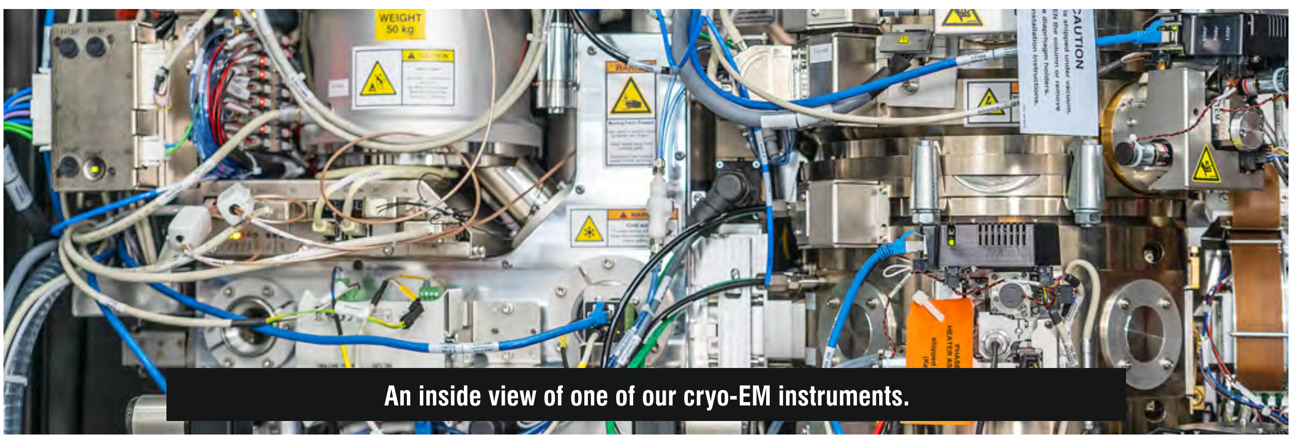
Our research primarily employs advanced spectroscopy and microscopy.

STUDENT RECOGNITIONS

1. **Dr. B. K. Spoorthi** has received the Best Thesis Award of Chemistry Department, IIT Madras at the 2024 convocation, July 19, 2024.

Dr. B. K. Spoorthi has received the Best Thesis Award of Chemistry Department, IIT Madras, July 29, 2024.

2. **Keerthana Unni** has received the best poster Award for "From Solutions to Microstructures in Minutes: Microdroplet Derived Stand-Alone TiO_2 Surfaces for Simultaneous Water Harvesting and Treatment" at the 33rd CRSI National Symposium in Chemistry (CRSI-NSC), Hyderabad, July 4–6, 2024.
3. **Amoghavarsha R. Kini** has received the International Immersion Experience (IIE) travel award 2024, funded by IIT Madras.
4. **Swetashree Acharya** has received the International Immersion Experience (IIE) travel award 2024, funded by IIT Madras.
5. **Riya Dutta** and **Sujan Manna** won the Asian Paint Alchemy competition held in Mumbai, March 15, 2024.
6. **Bijesh Kumar Malla** has received the best poster award for "Formation of Clathrate Hydrate under Simulated Interstellar Conditions" at the Physical Chemistry Chemical Physics (PCCP) at the SoPhyc-Physical Chemistry Symposium 2024, IIT Bombay, India, October 22–25, 2024.
7. **Amoghavarsha R. Kini** won the best oral presentation award for "Atomically Precise Nanoclusters: From Structure to Functions" at the Chemistry in-House Symposium (CiHS)-2024, IIT Madras, October 29, 2024.
8. **Sujan Manna** has received the International Immersion Experience (IIE) travel award 2024, funded by IIT Madras.
9. **Sujan Manna** became one of the top 20 finalists in the 'Science in Focus' competition organized by India Science Fest, IISER Pune, November 2024.
10. **Vivek Yadav** has received the best poster award for "Atomically Precise Carboranethiol-Protected Ag_{17}, $AuAg_{16}$, $Ag_{13}Cu_4$ and $AuAg_{12}Cu_4$ Nanoclusters" at the 2nd edition of CoE International Conference on Molecular Materials and Functions – 2024, IIT Madras, December 9–11, 2024.
11. **S. Sudhir** became one of the finalists in the 'Build to Innovate: Rural-Agri Challenge' by IITM Incubation Cell, June 15, 2024.
12. **S. Sudhir** became the runner up in the 'Next Gen Digital Action', a global youth initiative part of Digital Tech Summit 2024 to enable diverse youth-led ideas, perspectives and action on digital technologies transforming societies, hosted by DTU, Denmark, October 31, 2024.
13. **Harshita Nagar** has received the best poster award for "Rapid Determination of the Atomic Structure of Small Copper Nanoclusters with MicroED" at the 2nd edition of CoE International Conference on Molecular Materials and Functions – 2024, IIT Madras, 9–11, December 2024.
14. **Deepak Kumar Patel** has received the best poster award for "Molecular Rotor with Conformation-Dependent Dipole Moment" at the 2nd edition of CoE International Conference on Molecular Materials and Functions – 2024, IIT Madras, December 9–11, 2024.
15. **Vivek Yadav** won a recognition for asking most interesting questions at the Conference on Advances in Chemistry for Energy and Environment (CACEE), TIFR, Mumbai, December 16–20, 2024.



An inside view of one of our cryo-EM instruments.

ALUMNI NEWS

Dr. Bindhu Alappat has joined as the Vice President of Academic Affairs at Holy Family University, USA.

Dr. Tanvi Gupte has joined as a postdoc at Columbia University, USA.

Dr. Tripti Ahuja has joined as a postdoc in CSIR-CDRI, Lucknow.

Dr. Gaurav Vishwakarma has joined as a postdoc at National University of Singapore.

Dr. Vishal Kumar has joined as a postdoc at National Taiwan University, Taiwan.

Dr. Jayoti Roy has joined as a postdoc at Karlsruhe Institute of Technology, Germany.

Dr. B. K. Spoorthi has joined as a postdoc at Purdue University, USA.

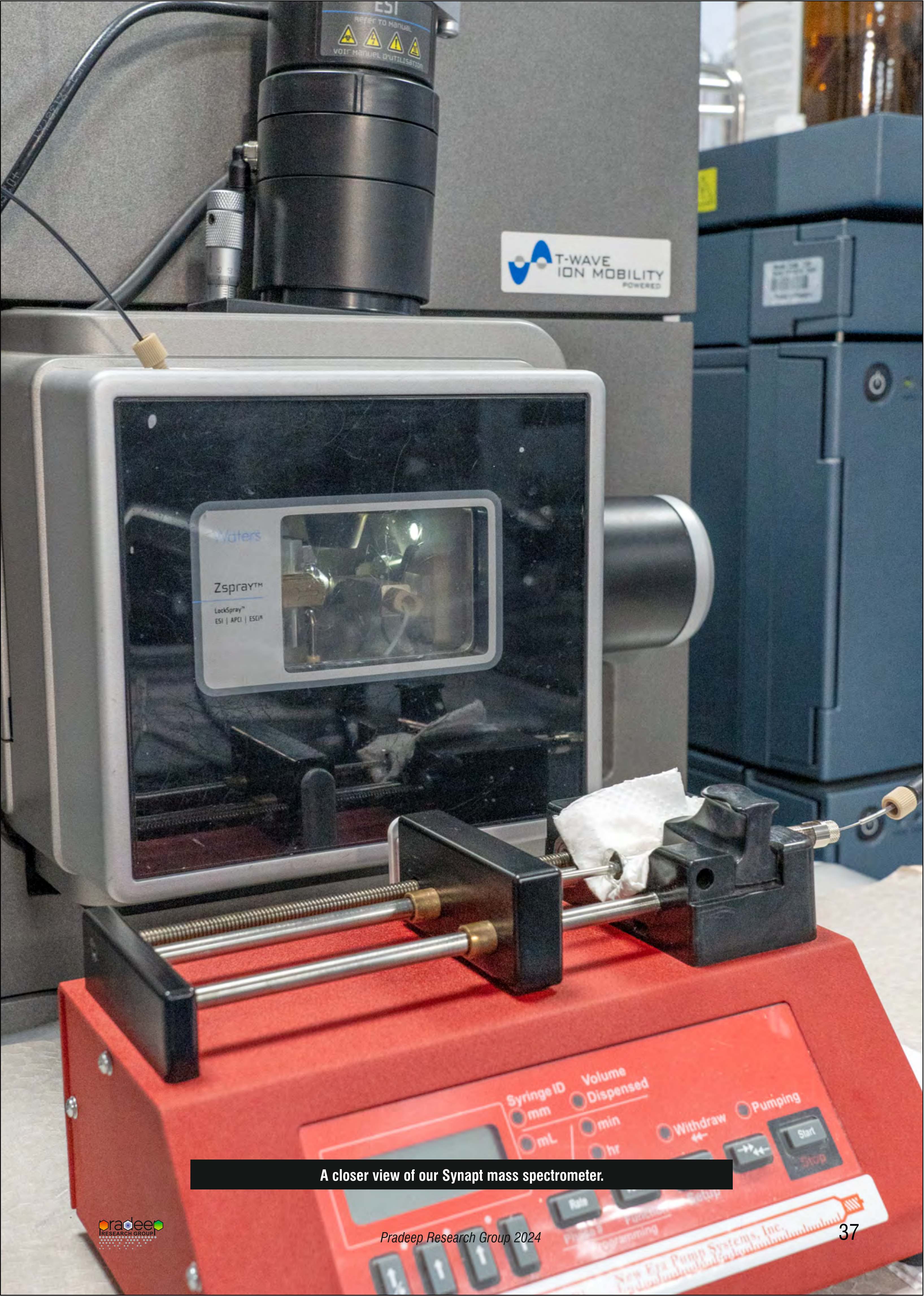
Mr. Devansh Paliwal has joined as a doctoral student at ETH Zurich, Switzerland.

Ms. K. S. Aswathi has joined as a doctoral student at Texas A&M University, USA.

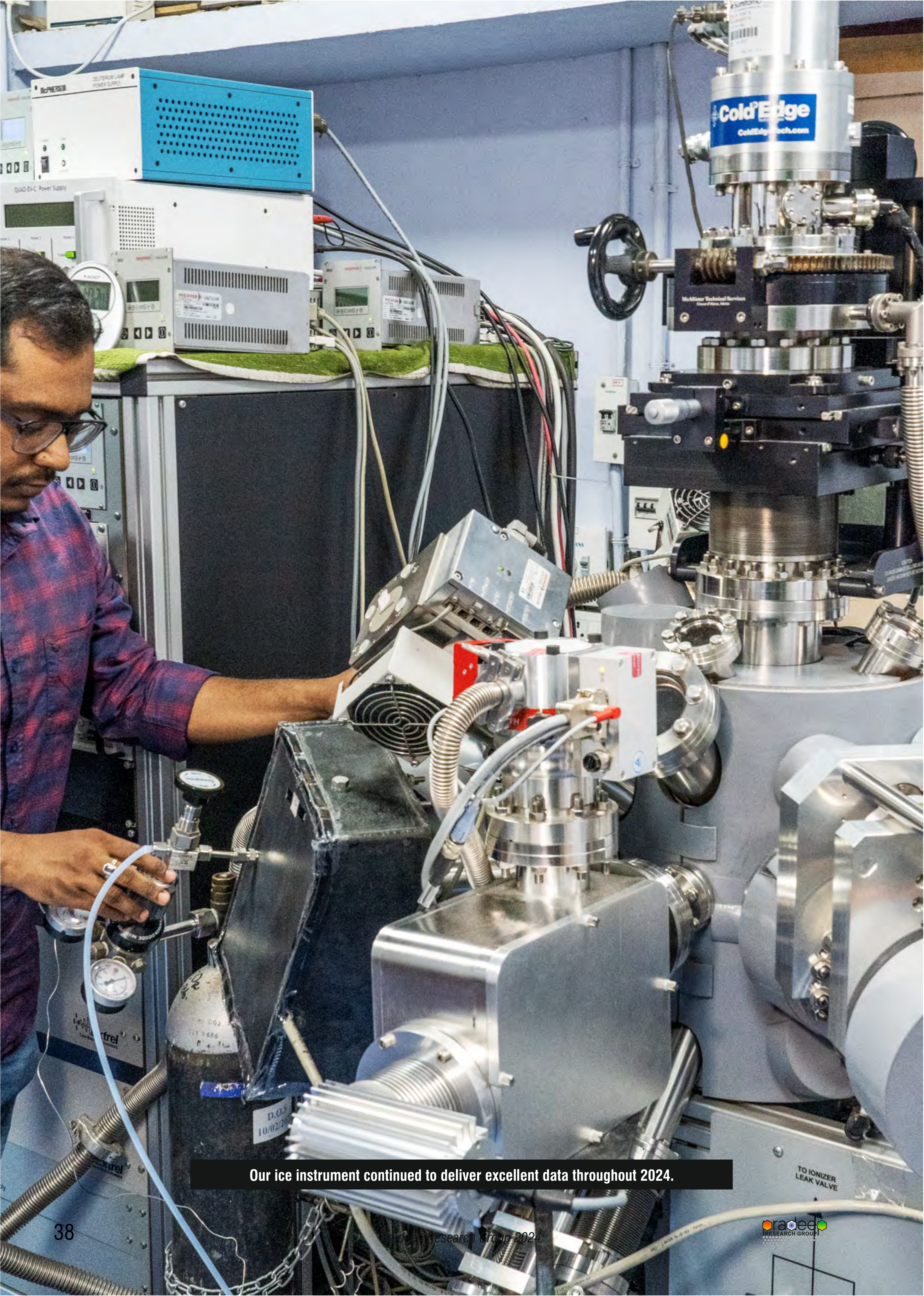
Ms. Karthika Kalyansundar has joined as a doctoral student at Ohio University, USA.

Dr. Anish R. Nath has joined as a senior executive at MRF Limited, Chennai.

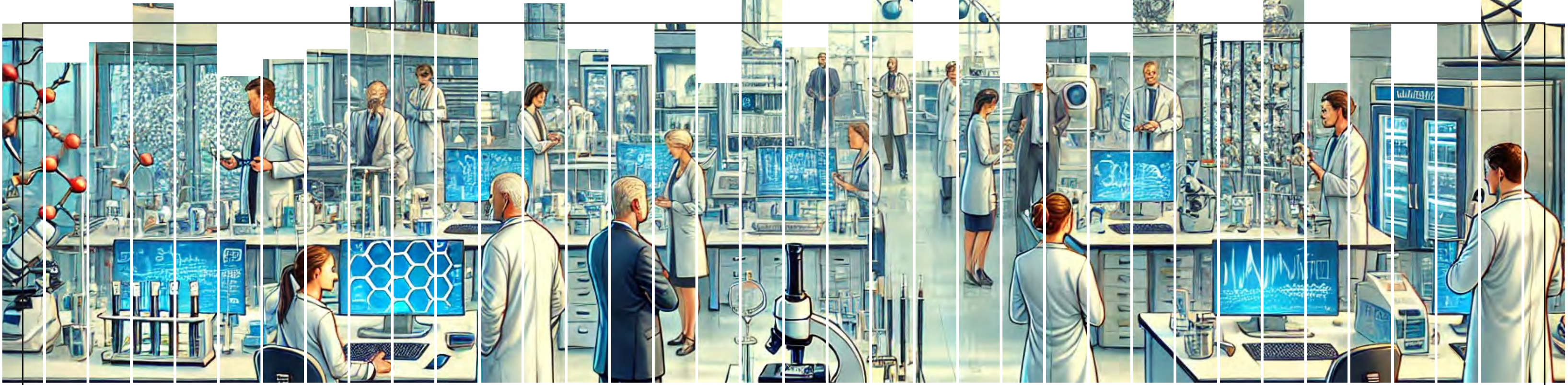
Mr. S. Jayaram has joined as a technical officer - MA3 grade at MRF Limited, Chennai.



A closer view of our Synapt mass spectrometer.



Our ice instrument continued to deliver excellent data throughout 2024.



VISITORS TO OUR LAB

1. Mr. Girish Agarwal, Dr. Pooja Agarwal, Dr. Gaurav Singh and Mr. Faraz Farooqui, Crypto Relief, January 6, 2024.

Prof. T. Pradeep and Gaurav Singh (seated), CEO, Blockchain for Impact, with the team during the launch of 'Q Exactive Plus' as a part of the Waste Water Based Epidemiology (WBE) Project, IIT Madras, January 6, 2024.

2. Dr. Mamata Bangera, Birkbeck, University of London, January 16, 2024.
3. Joseph Cheriyan, Deputy General Manager Secretarial-CSR-ESG, Dr. A. Sreekumaran Nair, Corporate Manager (R&D), MRF, January 19, 2024.

Prof. Roop Mahajan, Former Director of Institute for Critical Technology and Applied Sciences; and Dr. M.K. Padmanabhan, Director of the Virginia Tech, February 10, 2024.

4. Shri Kailash Karthik N, IAS, Mission Director, Jal Jeevan Mission, Assam, Varadharajan Ranganathan, TDK Ventures Innovation Hub, and Dr. Shubhra Shukla, Jivass Technologies, January 25, 2024.
5. Prof. Roop Mahajan, Professor, Department of Materials Science and Engineering, Former Director of Institute for Critical Technology and Applied Sciences, Prof Emeritus Virginia Tech, and Dr. M.K. Padmanabhan, Director of Virginia Tech, India,

Prof. T. Pradeep, with Kailash Karthik N, Mission Director at Jal Jeevan Mission, Varadharajan Ranganathan, TDK Ventures Innovation Hub and Nandakumar E, ICCW, January 25, 2024.

February 10, 2024.

6. Prof. Suresh Bhargava, Distinguished Professor, AM - Member of Order of Australia (Queens Civilian Honour 2022), Director for CAMIC, STEM College, RMIT University, February 22, 2024.

Prof. T. Pradeep, with Prof. Suresh Bhargava, Distinguished Professor, AM - Member of Order of Australia, Director for CAMIC, STEM College, RMIT University, February 22, 2024.

7. ENI team - Sara Scagliotti, Andrea Lainati, Andrea Bartolini, Ilaria Reitano, February 22–23, 2024.
8. Dr. Venugopal Vijaykrishnan, Dr. Gayathri Subramanyam, Dr. Devi Sirisha Janni, ITC Life Science & Technology Centre, Bangalore, March 15, 2024.
9. Ms. Noa Amsalem, Water Attaché- International Development Cooperation (MASHAV) and David Emanuel Kasman, Project Manager from Consulate General of Isreal, March 19, 2024.
10. Dr. Aysha Swapna, Principal of Farook College, Dr. T. Shalina Begum, Dr. Reji Thomas, Mr. Mohammed Nishad Maniparambath, Mrs. S. Bodhy Krishna, Mrs. T. P. Shabna and

Dr. M. Yoosuf Ameen, Farook College, Kerala, March 20, 2024.

Prof. T. Pradeep with Dr. Venugopal Vijaykrishnan, Dr. Gayathri Subramanyam and Dr. Devi Sirisha Janni, ITC Life Science & Technology Centre, Bangalore, March 15, 2024.

11. Shri. M.K. Narayanan, 19th Governor of West Bengal and former NSA, March 22, 2024.
12. Dr. Sudip Chakraborty, Reader F, Harish-Chandra Research Institute (HRI), an Aided Institute of Department of Atomic Energy (DAE), Allahabad, May 5, 2024.

Prof. T. Pradeep, with ENI team members (Ilaria Reitano (left) and Sara Scagliotti, Andrea Lainati, Andrea Bartolini (right), with M. Udhaya Shankar and Prof. T. Pradeep, February 23, 2024.

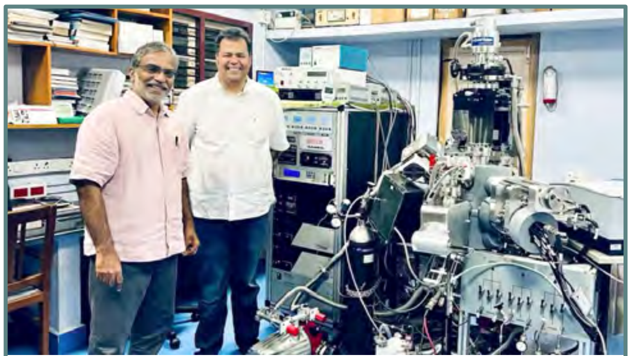
13. Mr. Ramasamy Narayanan, Head, Sustainability; Mr. Nareshkumar Katakam, Senior Manager, Sustainability; Monisha Suyenlai, Assistant Manager, Sustainability, A Sreekumaran Nair, Corporate Manager, R&D; MRF, May 24, 2024.
14. Mr. Bhajan Singh, NSF India, June 5, 2024.
15. Prof. Gaurav Chopra, Associate Professor, Department of Chemistry, Purdue Institutes for Drug Discovery, Cancer Research, Neuroscience, Immunology, Purdue University, June

Prof. T. Pradeep, with Shri. M. K. Narayanan, 19th Governor of West Bengal, March 22, 2024.

Prof. T. Pradeep, with Mr. Ramasamy Narayanan -Head, Mr. Nareshkumar Katakam -Senior Manager, Monisha Suyenlai, Assistant Manager, Sustainability and A Sreekumaran Nair - Corporate Manager, R&D, May 24, 2024.

21, 2024.

16. Dr. Soumyabrata Roy, Research Scientist, Ajayan Research Group, Materials Science & Nanoengineering, Rice University, USA, June 22, 2024.



Prof. T. Pradeep with Prof. Gaurav Chopra, Associate Professor at Purdue University, June 21, 2024.

17. Mr. K.K. Mishra, President of Product & Business Development, Mr. Hemang Patel, G.M (R&D), 20 Microns Nano Minerals Limited, Gujrat, July 23, 2024.
18. Dr. Ajay Chandak, Certified Energy Auditor & Renewable Energy Expert, Chandak Innovations LLP, Shamgiri, August 5, 2024.
19. Suzan Kagan, visiting PhD student from Tel Aviv University, coordinated the course ID5011, People’s Water Data, and also participated in several measurements in the field, August–November, 2024.
20. Prof. Kuruvilla Joseph, outstanding Professor & Dean, Indian Institute of Space Science and Technology (IIST), September 6, 2024.

Suzan Kagan, visiting PhD student from Tel Aviv University, collecting water quality data as a part of the course, 'People's Water Data', August–November, 2024.

Prof. T. Pradeep with Prof. Sabu Thomas, former VC of MG University, September 11, 2024.

21. Prof. Sabu Thomas, former VC of MG University, September 11, 2024.
22. Dr. Tofayel Ahmed, Associate Professor 'E', Saha Institute of Nuclear Physics, October 7, 2024.

Prof. S. Chandrasekaran, Professor of Organic Chemistry, IISc Bangalore, had an interaction with students of the group, November 5, 2024.

23. Prof. S. Chandrasekaran, Department of Organic Chemistry, IISc Bangalore, November 5, 2024.

Prof. Mukundan Thelakkat, Professor of Applied Functional Polymers, University of Bayreuth, Germany, delivered talk at IIT Madras, November 10, 2024.

24. Prof. Dr. Mukundan Thelakkat, Professor of Applied Functional Polymers, University of Bayreuth, Germany, November 10, 2024.

Prof. T. Pradeep and his students with Prof. T. Venkatesan, Director of the Center for Quantum Research and Technology, University of Oklahoma, November 14, 2024.

Prof. T. Pradeep with Padma Vibhushan Dr. R. A. Mashelkar, FRS; Prof. V. Kamakoti, Director of IITM, and Prof. Rajnish Kumar, Director's Office, IIT Madras, December 8, 2024.

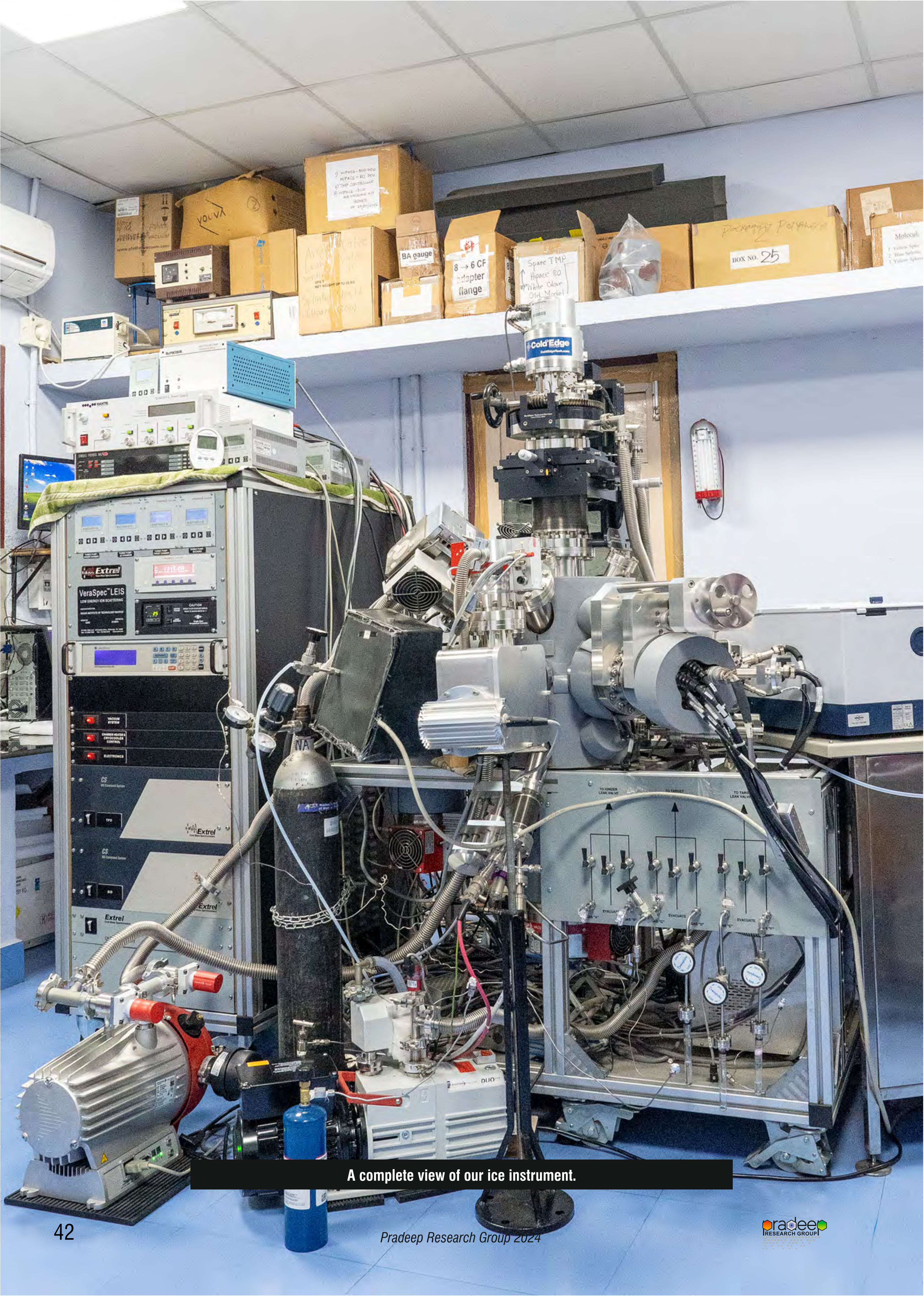
25. Prof. T. Venkatesan, Senior Advisor, office of Vice President for Research and Partnerships, Founding Director of Center for Quantum Research and Technology, Prof. of Physics and ECE, University of Oklahoma, November 14, 2024.
26. Dr. Ruchi Gupta, Associate Professor in Biosensors, Global Engagement Lead for School of Chemistry, University of Birmingham, November 25, 2024.
27. Prof. Arieh Ben-Naim, Department of Physical Chemistry, The Hebrew University of Jerusalem, December 4, 2024.

Prof. Arieh Ben-Naim, Professor at the Hebrew University of Jerusalem, with Prof. K. Mangala Sunder and Prof. T. Pradeep at the Department of Chemistry, IIT Madras, December 26, 2024. He gave two talks in Chemistry on December 23 and 26, 2024.

28. Padma Vibhushan Dr. R. A. Mashelkar, FRS, December 8–9, 2024.

Several other visitors came for the four conferences we conducted during the year.

Prof. Kuruvilla Joseph, Outstanding Professor, Registrar and Dean (Academics) of Indian Institute of Space Science and Technology (IIST) with Prof T. Pradeep, December 16, 2024.



A complete view of our ice instrument.

Prof. PRADEEP'S VISITS

1. Venus Safety & Health Pvt. Ltd., Mumbai, January 2, 2024.

Arvind Raman, Dean of Engineering, Purdue, February 14, 2024.

2. Stella Maris College (Autonomous), Chennai, as the chief guest for the Graduation Day, January 10, 2024.

Researchers at ITC, Bangalore, May 10, 2024.

3. Christ University, Bangalore, to receive the CRS Gold Medal Award in the Symposium: "Science Beyond Boundaries: Invention, Discovery, Innovation and Society - Rasayan 18", January 29, 2024.

4. Department of Chemistry, Purdue University, February 1, 2024 and Environmental and Ecological Engineering, Purdue University, February 2, 2024.

Prof. Graham Cooks, Purdue, after a talk, June 17, 2024.

5. Galveston, Texas, USA, chair of the Gordon Research Conference (GRC) on Atomically Precise Nanochemistry, February 4–9, 2024.

Meeting on WTC project at Nallampatti, Tamil Nadu, August 4, 2024.

Participants at the Gordon Research Conference, Texas, USA, February 4–9, 2024. Prof. Pradeep was the Chair of the conference.

Prof. Horst Hahn at the Advanced Radar Research Centre, University of Oklahoma, September 26, 2024.

6. IIT Bombay, Mumbai, Chair of the Symposium of Cryo-EM Facility, March 8, 2024.
7. Bhabha Atomic Research Centre (BARC), Mumbai, the 3rd DAE-BRNS Symposium on Current Trends in Analytical Chemistry (CTAC-2023), March 8, 2024.

US National Academy of Engineering (NAE) Annual Meeting 2024, with the class of 2024, September 29, 2024.

8. IIT Jammu, 'Abhyuthanam: Academic Leadership Program on behalf of the Ministry of Education of India, March 15–19, 2024.
9. Stella Maris College (Autonomous), Chennai, SMC Research Council Advisory meeting, March 22, 2024.

Krishna Rajan, SUNY Distinguished Professor, Thomas Thundat, SUNY Empire Innovation Professor and Haiqing Lin, Professor, University at Buffalo, October 2, 2024.

10. IISER Pune, progress review meeting of SUPRA, April 9, 2024.
11. INST, Mohali, 18th BoG meeting, April 12, 2024.
12. Delhi, the nominations of INSA Fellowship (IYA, IAF, IDL-1, and

Thomas Thundat, and Amit Goyal, SUNY Empire Innovation Professors, University at Buffalo, October 3, 2024.

IDL-2 for the year 2024), April 24, 2024.

13. Delhi, to receive the Eminent Engineers' Award 2023 - Research & Consultancy category by Engineering Council of India, April 29, 2024.
14. ITC Life Science & Technology Centre, Bangalore, for a guest lecture, May 10, 2024.
15. University of Bayreuth, Germany, May 15–19, 2024.
16. Milan, Italy, Scientific Commission annual meeting of the Prize Commission of Eni Award 2024 edition at FEEM premises, May 20, 2024.

Eni Award 2024 prize giving ceremony. In front of Palazzo del Quirinale in Rome, Italy, October 15, 2024.

17. SANJOG 2024-Workshop for Children of Army JCs/Jawans and Family, IIT Madras, June 9, 2024.
18. Cochin University of Science and Technology, Kerala, to receive the 'Prof. M. V. Pylee Award' for the distinguished academician in India for the year 2023, May 30, 2024.
19. Penn State University, Pennsylvania, USA, the 7th International Symposium on Monolayer Protected Clusters (ISMPC24), June 12–14, 2024.

Prof. Thomas Hirth, Vice President at KIT, and Prof. Manfred M. Kappes, KIT, Germany, October 2024.

Rahul Mammen Mappillai (left), Managing Director, MRF Ltd, October 30, 2024.

20. Visit to Purdue University, June 15–18, 2024.
21. IIST, Thiruvananthapuram, the 11th National Conference on Recent Trends in Materials Science and Technology, June 26, 2024.
22. Calicut University, Kerala, National Conference on Advanced Materials (NCAM) 2024, June 27, 2024.
23. CSIR-CSMCRI Bhavnagar, Gujarat, International Conference on Materials and Membranes for Water and Energy (ICMMWE)-2024, July 10–12, 2024.
24. MIT World Peace University (MIT-WPU), Pune, first National Scientists Round Table Conference (NSRTC 2024) for Viksit Bharat 2047, July 19, 2024.
25. IISER Bhopal, attended the technical review meeting and delivered a talk at the Department of Chemistry, July 29, 2024.
26. Bangalore, as a plenary speaker in the 13th Edition of Bengaluru India Nano, August 3, 2024.
27. Nallampatti, Tamil Nadu, for meeting on WTC project, Au gust 4, 2024.
28. Pondicherry, along with Mr. Ashok Natarajan, meeting with Dr. Dhinadayalan, Secretary PWD, August 21, 2024.
29. Stella Maris College, Chennai, Diamond Jubilee of the Department of Chemistry, August 29, 2024.
30. 19th BoG meeting (online) of INST, Mohali, August 30, 2024.
31. IIT Hyderabad, National Programme on Nano Science & Technology (NPNST), a brainstorming session for the preparation of a vision document on advanced materials, September 2–3, 2024.
32. IIT Kharagpur, institute lecture at the School of Nano Science and Technology, September 5, 2024.
33. University of Oklahoma, to deliver lectures and explore collaborations, September 24–27, 2024.
34. Washington, D.C., USA, invited to the National Academy of Engineering (NAE) Annual Meeting-2024, September 28–30, 2024.
35. University at Buffalo, New York, as a distinguished speaker for the RENEW 'Catalyzing Conversations' talk, October 1–3, 2024.
36. Bangalore, an innovation tour for the course ID5031: Innovation and Entrepreneurship – a multidisciplinary approach, October 8, 2024.
37. Palazzo del Quirinale in Rome, Italy, for the Eni Award 2024 prize giving ceremony, October 14, 2024.
38. Visit to KIT, Germany, as part of the International Excellence Award, October 15–19, 2024.
39. Meeting with Rahul Mammen Mappillai, Managing Director, MRF Ltd, October 30, 2024.
40. Konark, Odisha, for the Chemistry Meet 2024 at Lotus Eco Beach Resort, November 13, 2024.

Prof. Krishna, Dean and Prof. GVR Sharma, Director, Faculty Development at GITAM University, Visakhapatnam, December 4, 2024.

41. Participated in the one-day symposium, in connection with the anniversary celebrations on the completion of the 60th year of the journal Chemical Communications, Royal Society of Chemistry at IIT Madras, November 18, 2024.
42. Sacred Heart College, Thevara, Kerala, as an invited keynote speaker in the 23rd Prof. K. V. Thomas Endowment National Seminar on Frontiers in Materials Science, November 27, 2024.

National Conference on Emerging Frontiers in Chemical Science (EFCS)-2024, Farook College, Kerala, December 2–3, 2024.

43. Farook College, Kerala, chairman of the National Conference on Emerging Frontiers in Chemical Sciences (EFCS), December 2–3, 2024.
44. Conducted International Advisory Board (IAB) of the Centre of Excellence on “Molecular Materials and Functions at IIT Madras, December 8, 2024.
45. Tata Institute of Fundamental Research (TIFR) Mumbai, conference on Advances in Catalysis for Energy an Environment (CACEE-2024), December 16, 2024.
46. GITAM Deemed to be University, Hyderabad, delivered a distinguished lecture followed by interaction with the faculty members to discuss the possibilities of advanced research at GITAM facilities, December 19, 2024.
47. JECRC University, Jaipur, Rajasthan, for the ‘Acharya Prafulla Chandra Ray Memorial Award 2023’ at the 61st ACC 2024 Annual Convention of Chemists and International Conference, December 19–21, 2024 (to be received in 2025).
48. IACS Kolkata, Chem24, December 27, 2024.

Dr. Anil Kakodkar as part of the CACEE-2024 event, TIFR, Mumbai, December 16, 2024.

Prof. PRADEEP’S SERVICES

1. Chairman, Board of Governors, Institute of Nano Science and Technology, Mohali, 2021–2024.
2. Member, Research Advisory Council, Manipal Academy of Higher Education, Manipal Member, 2018–
3. Research Advisory Board, Pandit Deendayal Petroleum University, 2019–
4. Member, Technical Committee for examination and use of innovations and technologies in drinking water and sanitation sector, Department of Drinking Water and Sanitation, Ministry of Jal Shakti, 2019–2024.
5. Associate Editor of the journal, ACS Sustainable Resource Management, 2024–Chemistry of Materials, 2018–; ACS Nano, 2018–; Nanoscale Advances, 2019–; Clean Water, 2020–; Chemical Communications, 2020–2024; Environmental Science: Water Research & Technology, 2023–; ACS Environmental Science and Technology 2024–; The Journal of Physical Chemistry Letters, 2024–

Prof. PRADEEP'S LECTURES

1. Affordable clean water using advanced materials, IITACB Saturday Webinar, January 13, 2024 (webinar).
2. Atomically precise clusters, Rasayan 18, Christ University, Bengaluru, January 29–30, 2024.
3. Atomically precise clusters: new advancements, Department of Chemistry, Purdue University, West Lafayette, February 1, 2024.
4. Affordable clean water using advanced materials, Engineering & Institute of Sustainable Future, Purdue University, West Lafayette, February 2, 2024.
5. Materials for water, Discussion with VT India Centre for Research & Innovation, February 2, 2024 (online).
6. Clathrate hydrates in interstellar environment, Department of Chemistry, University of Houston, Houston, February 9, 2024.
7. Atomically precise clusters: Towards megadalton molecules, 3rd DAE-BRNS Symposium on Current Trends in Analytical Chemistry (CTAC-2023), BARC, Mumbai, March 8, 2024.

Lecture for students at the Department of Medical Sciences & Technology, IIT Madras, November 7, 2024.

8. Research excellence to impact, my story, Malaviya Mission Teacher Training Programme, IIT Madras, March 11–15, 2024.
9. Empowering India: Ideas for action by scientists and engineers, IIT Jammu, March 17, 2024 (with Krishnan Narayanan).
10. Roadmap to impactful innovation: my story, ITC Lifesciences & Technology Centre, Bangalore, May 10, 2024.
11. Affordable clean water using advanced materials, Eni Award Lectures, FEEM premises, Milan, May 21, 2024.
12. Empowering people using advanced materials, Prof. M. V. Pylee Award 2023, CUSAT, Cochin, May 30, 2024.
13. Carboranethiols: versatile ligands for atomically precise clusters, Penn State University, University Park, June 12, 2024.
14. Can microdroplets make soil?, Department of Chemistry, Purdue University, West Lafayette, June 17, 2024.

Delivering 'Catalyzing Conservations' talk on the topic of "Affordable clean water using advanced materials" at the University at Buffalo's RENEW Institute, October 2, 2024.

15. Treatment methods for arsenic, JJM Assam Lecture, IITM, June 20, 2024.
16. Can microdroplets make soil?, 11th National Conference on Recent Trends in Materials Science and Technology – 2024, IIST, Thiruvananthapuram, June 26, 2024.
17. Can microdroplets make soil?, University of Calicut, Calicut, June 27, 2024.
18. Can microdroplets make soil?, International Conference on Materials and Membranes for Water and Energy, CSMCRI, Bhavnagar, July 10–12, 2024.
19. Can microdroplets make soil?, INST Mohali, July 16, 2024.
20. Can microdroplets make soil?, MIT World Peace University, Pune, July 19, 2024.
21. Can microdroplets make soil?, IISER Bhopal, July 29, 2024.
22. Can microdroplets make soil?, Bangaluru India Nano, Bengaluru, August 3, 2024.
23. Treatment methods for arsenic, India-Israel workshop, ICCW, IIT Madras, August 6, 2024.
24. Can microdroplets make soil?, IIT Madras Colloquium, IIT Madras, August 7, 2024.
25. Molecular acorns to institutional oaks, Stella Maris College at 60, Chennai, August 29, 2024.
26. Affordable clean water using advanced materials, FINERAC Presentation, August 29, 2024.
27. Affordable clean water using advanced materials, Teachers' Day Lecture, IIT Kharagpur, September 5, 2024.
28. Can microdroplets make soil?, Chemistry Department, IIT Kharagpur, September 6, 2024.
29. Affordable clean water using advanced materials, University of Oklahoma, Norman, September 25, 2024.
30. Can microdroplets make soil?, University of Oklahoma, Norman, September 27, 2024.

31. Can microdroplets make soil? A path to sustainable nanotechnology, University at Buffalo, Buffalo, October 1, 2024.
32. Affordable clean water using advanced materials, RENEW, University at Buffalo, Buffalo, October 2, 2024.
33. Affordable clean water using advanced materials, As2024, KIT Bhubaneswar, October 2, 2024.

After delivering a talk on "Can water microdroplets make soil?" at the Department of Chemistry, IISER Bhopal, July 29, 2024.

34. Can microdroplets make soil?, KIT South Campus, Karlsruhe, October 17, 2024.
35. Affordable clean water using advanced materials, KIT North Campus, Karlsruhe, October 18, 2024.
36. Can microdroplets make soil? A path to sustainable nanotechnology, W for W Foundation, Webinar, October 25, 2024.
37. Glimpses of my work, lecture for students at the Department of Medical Sciences & Technology, IIT Madras, November 7, 2024.
38. Affordable clean water using advanced materials, (Chemistry) Meet 2024, Connecting at Konark, November 13, 2024.
39. Unlocking entrepreneurial potential in the water sector, ICCW Online, November 16, 2024.
40. Wastewater-based epidemiology, MoHUA - India-Israel Presentation, IIT Madras, November 18, 2024.
41. Carboranethiol-based clusters, EFCS, Farook College, Calicut, December 2–3, 2024.
42. Atomically precise metals clusters, CoE Winter School, IIT Madras, December 4, 2024.
43. Can microdroplets make soil?, CoE Winter School, IIT Madras, December 5, 2024.
44. Carboranethiol-based clusters, 2nd CoE Conference, IIT Madras, December 9–11, 2024.
45. Can microdroplets make soil?, 2nd Water for Life Conference, IIT Madras, December 12–14, 2024.
46. Can microdroplets make soil?, Conference on Advances in Catalysis for Energy and Environment (CACEE-2024), TIFR, Mumbai, December 16–20, 2024.
47. Matter in confinement - Clusters, microdroplets and clean water, Gitam University, Visakhapatnam, December 19, 2024.
48. Can microdroplets make soil?, ICL Presentation, December 24, 2024 – online.
49. Can microdroplets make soil?, Chem 24, IACS, Kolkata, December 27, 2024.

Delivering a guest lecture on "Roadmap to Impactful Innovation" at ITC Life Science & Technology Centre, Bangalore, on May 10, 2024.

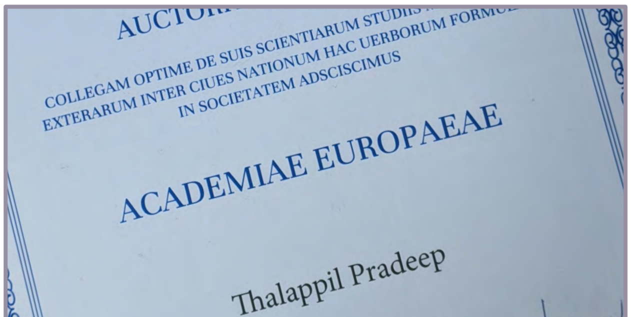
AWARDS and HONOURS

Prof. T. Pradeep being induced as a fellow of the US National Academy of Engineering by its President John L. Anderson and Chair Errol B. Davis, NAS Building, Washington DC, September 26, 2024.

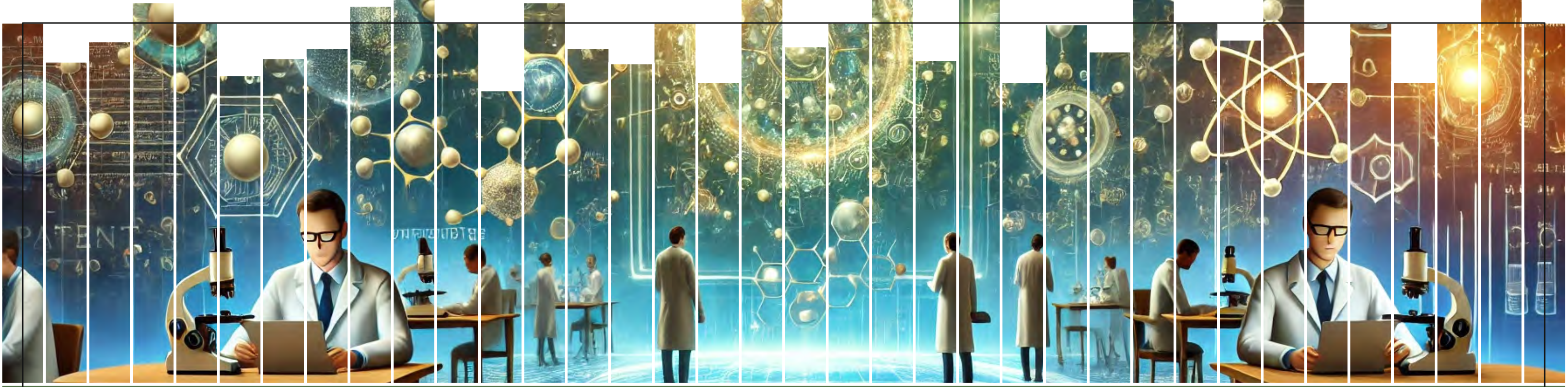
Prof. T. Pradeep was honoured with the prestigious 'CRS Gold Medal' by the Chirantan Rasayan Sanstha for his academic achievements at the symposium on "Science Beyond Boundaries: Invention, Discovery, Innovation, and Society - Rasayan 18", Christ University, Bangalore, January 29, 2024.

Prof. T. Pradeep receiving the 'Prof. M.V. Pylee Award 2023' for the distinguished academician in India, May 30, 2024. It was instituted by the Cochin University of Science and Technology (CUSAT), presented by honourable ministers of Kerala State Dr. R. Bindu and P. Rajeeve and Anil Sahasrabudhe, Chairman, National Educational Technology Forum (NETF), in presence of the VC of CUSAT.

Prof. T. Pradeep receiving the prestigious Eminent Engineer Award 2023 in the Research & Consultancy category of the Engineering Council of India (ECI), New Delhi, April 29, 2024.



Prof. T. Pradeep has been elected as a fellow of Academia Europaea in 2024.



PATENTS

INDIAN PATENTS

1. Synthesis of protein protected luminescent metal clusters and retaining the bioactivity of the protein, Pradeep, Debasmita Ghosh, Mohammad Bodiuzzaman, Anirban Som, Ananya Baksi, Atanu Ghosh, and Jyotirmoy Ghosh, application no. 201841049925, dated December 31, 2018, issued as patent no. 495343, issued on January 5, 2024.
2. A method of detection of low concentration of analytes by superhydrophobic pre – concentration paper spray ionization mass spectrometry (SHPPSI MS), T. Pradeep, Pallab Basuri, Avijit Baidya and Tripti Ahuja, application no. 201741047403, dated December 30, 2017, issued as patent no. 504588, issued on January 31, 2024.
3. A smartphone based fluoride-specific sensor for rapid and affordable colorimetric detection and precise quantification at sub-ppm levels for field applications, Thalappil Pradeep, Sritama Mukerjee, Manav Shaw and Kamalesh Choudhuri, application no. 202041026054, dated June 20, 2020, issued as patent no. 536268, issued on April 30, 2024.
4. A method to transform crystalline minerals to nanoparticles by microdroplets, T. Pradeep, B. K. Spoorthi and Pallab Basuri, application no. 202241038282, dated July 7, 2022, issued as patent no. 539562, issued on May 28, 2024.

PATENTS APPLIED

1. Method of preparing assembled spheroids of copper nanoclusters for ultra-trace arsenic detection, Thalappil Pradeep, Tiju Thomas, Jenifer Shantha Kumar and Arijit Jana, application no. 202441041750, dated May 29, 2024.
2. Method of making nanoparticles from natural minerals in high-pressure water jets, T. Pradeep and B. K. Spoorthi, application no. 202441041814, dated May 29, 2024.
3. Electrospray deposited anisotropic alloy catalysis for efficient nitrate reduction in wastewater, Thalappil Pradeep, Aswathi K. S., Depanjan Sarkar, Keerthana Unni, Sourav Kanti Jana, Anirban Som, Soham Chowdhury, Sinchan Mukhopadhyay, application no. 202441104803, dated December 31, 2024.
4. A method of efficient transformation of crystalline minerals to nanoparticles by salt-containing microdroplets, Thalappil Pradeep, Jamshiya Sulthana P, Anubhav Mahapatra, B. K. Spoorthi, Depanjan Sarkar, application no. 202441104922, dated December 31, 2024.

PCT APPLIED

1. Material and method for sustainable and affordable atmospheric water harvesting, Thalappil Pradeep; Ankit Nagar; Sonali Seth, application no. WO2024047666 A1, dated March 7, 2024.
2. Vertically aligned nanoplates of atomically precise Co6S8 cluster for practical arsenic sensing, T. Pradeep, Anagha Jose, Arijit Jana, Tanvi Gupte, Keerthana Unni, Ankit Nagar, Amoghavarsha R. Kini, B. K. Spoorthi, application no. WO2024142079 A1, dated April 7, 2024.

RESEARCH GRANTS

ONGOING PROJECTS

1. JC Bose Fellowship, DST 2015–2020; renewed 2021, DST, Rs. 90 lakhs.
2. Fingerprinting authenticity of ayurvedic preparations by ambient electrospray deposition Raman spectroscopy, SHRI proposal, DST, Rs. 53.8884 and 41.3656 lakhs for IITM and Manipal Academy of Higher Education respectively. (principal investigator with Santhosh Chidangil, Manipal, Co-PI).
3. Atomically precise naked cluster assemblies from ligand-stabilized clusters: New materials for catalysis, DST/DFG, Rs. 72.028 lakhs. (principal investigator, with Manfred Kappes).
4. National facility of cryo-electron microscopy: Remotely operable, 24x7 for academia and industry, SERB, Rs. 28.6 crores (principal investigator) with IIT Tirupati, IISER Tirupati, IIT Palakkad, RGCB Thiruvananthapuram, Sastra Tanavur, VIT Vellore and MRF Chennai.
5. Carborane-protected metal nanoclusters: A new family of materials with atomic precision - DST/Czech, Rs. 37 lakhs. (principal investigator, with Tomas Base).
6. Centre of Excellence on Molecular Materials and Functions, Ministry of Education, Rs. 16.8 crores. (principal investigator).
7. Atomically precise materials for sustainable water and energy harvesting, SERB, Rs. 75.32 lakhs. (principal investigator).

Others, such as R&D Awards, technology development, CSR grants, and instrument maintenance activities, are also managed as projects.

CONSULTANCY

1. Steel – Rubber adhesion improvement – Phase 2, MRF Ltd., 2019–2021, Rs. 1.2 Cr. (principal investigator).

IMPLEMENTATION PROJECTS

There are several other implementation projects taken through the International Centre for Clean Water.

GRADUATION

Ph.D. GRADUATES

Dr. Vishal Kumar, Dept. of Chemistry and Department of Chem. Engg., IIT Madras, 2024, "Studies on Physical and Chemical Changes by Triboelectricity".

Dr. Paulami Bose, Dept. of Chemistry, IIT Madras, 2024, "Interdimensional Chemistry of Atomically Precise Nanoclusters: A path to Functional Materials".

Dr. B. K. Spoorthi, Dept. of Chemistry, IIT Madras, 2024, "Transformation of Molecules and Materials in Microdroplets".

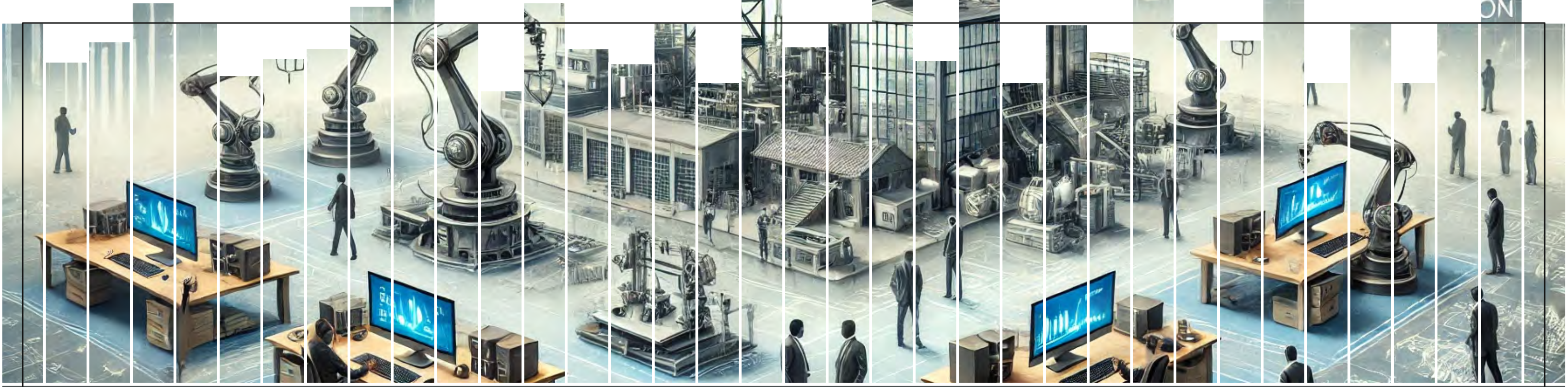
Dr. Anil Kumar Avula, Dept. of Chemistry, IIT Madras, 2024, "Materials for Arsenic and Fluoride: A Study of Affordable and Sustainable Nanocomposites for Clean Water".

Dr. Jayoti Roy, Dept. of Chemistry, IIT Madras, 2024, "Probing Chemical Interactions of Atomically Precise Nanoclusters with Mass Spectrometry".

Dr. S. Jenifer, Dept. of Chemistry and Dept. of Metallurgical and Materials Engg., IIT Madras, 2024, "Studies on Aggregation in Microdroplets and Nanoclusters and Protein Binding for Arsenic Detection in Water".

MS GRADUATES

Ramesh Kumar Soni, Dept. of Chemistry, IIT Madras, 2024, "Fabrication of Pilot Plant and Scale Manufacture of Cellulose-Based Nanomaterial for Arsenic Removal".



INCUBATION

HYDROMATERIALS

Hydromaterials has installed village water treatment units, altogether supplying arsenic and iron-free water to over 1000,000 people. In many places, we have addressed uranium contamination as well. Altogether, there are around 1700 units of this kind operational in our country, supplying clean water to 1.4 million people. This year's highlights include: ongoing execution of 59 village water treatment plants in Uttar Pradesh, ongoing installation of district-wide automation in Himachal Pradesh, successful installation of 2,500 water filters for Anganwadis and ongoing installation of 5,850 automatic water filters for Anganwadis and schools in Andhra Pradesh. For more details, please visit https://hydromaterials.in/

VAYUJAL TECHNOLOGIES

VayuJal Technologies has installed a solar and grid power operated 2000 litres per day (LPD) atmospheric water harvesting unit at Engineers India Limited, Gurugram, Haryana, and at Gram Vikas - Brahmapur, Odisha. They have five variants of atmospheric water generators now with daily drinking water production from 43 to 2800 liters per day. VayuJal now has 130 machines in 29 states in India and Europe & Sri Lanka, catering to more than 4800 people with drinking Water from Air. VayuJal is catering to industry segment leaders such as ITC Chola, ITC Life Science, Toyota Industries, Tata Communications, NASSCOM, IIT Madras, IIT Jammu, DRL-DRDO, IOCL, HPCL, Shell, JCBL, Tata Reality, L&T, Sify, etc. Highlights include: winner of the Climate Smart Innovation Exhibition & Award (CSI) 2024 - Organised by Solar Decathalon India at Infosys-Mysore.; winner of the NASSCOM Foundation Climate Tech Challenge – 2024. For more details, please visit https://vayujal.com/

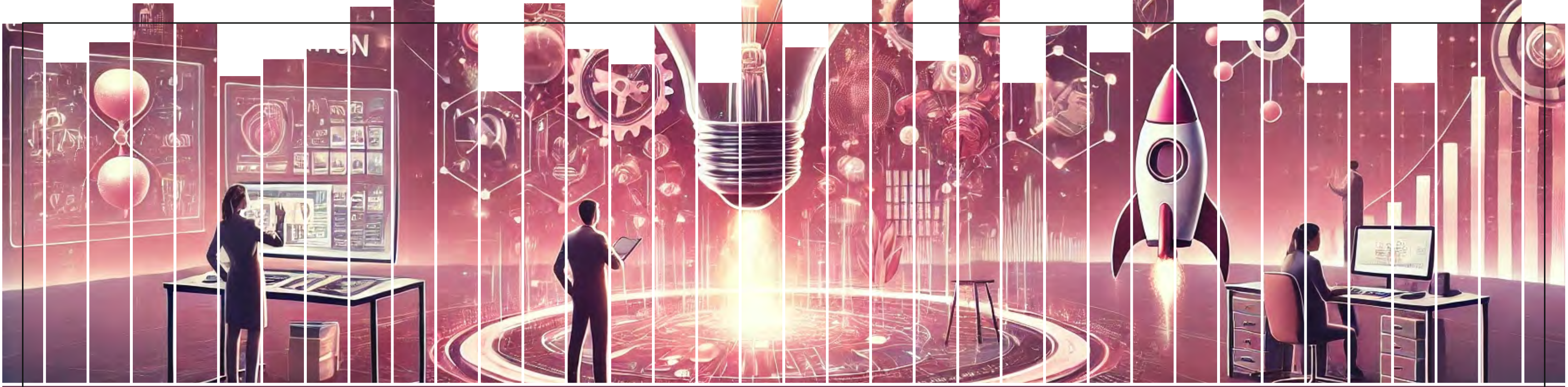
AQUAEASY INNOVATIONS

AquEasy Innovations Private Limited is an Indian company incubated by IIT Madras working in the field of domestic water purification technologies. AquEasy currently develops contaminant specific water purifier bottles, called the 'blue bottle'. Also, the company has developed a rolling water purifier called 'roll pure' that helps in reducing the effort in water transportation and provides clean water, when the water reaches the point of use. For more details, please visit https://www.ynos.in/startup/aqueasy

EYENETAQUA SOLUTIONS

Water quality monitoring unit

EyeNetAqua Solutions Private Limited is a start-up company incubated at ICCW to develop and commercialize IoT-based sensing technologies for water quality monitoring. In the past EyeNetAqua has demonstrated inline measurements of pH, TDS, residual chlorine, nitrate, pressure and volume of flow for source water quality monitoring. For more details, please visit https://www.eyenetaqua.com/



CENTRES

INTERNATIONAL CENTRE FOR CLEAN WATER (ICCW)

The International Centre for Clean Water (ICCW), an initiative of IIT Madras has completed five years of its existence. Located at the IIT Madras Research Park, the Centre has developed and implemented technologies for real-time water quality and flow monitoring to support the Indian government's ambitious plans to implement Drink from Tap facilities across the country. In partnership with the Embassy of Israel, New Delhi, ICCW has initiated capacity-building programs for senior officials of the Ministry of Urban and Housing Affairs.

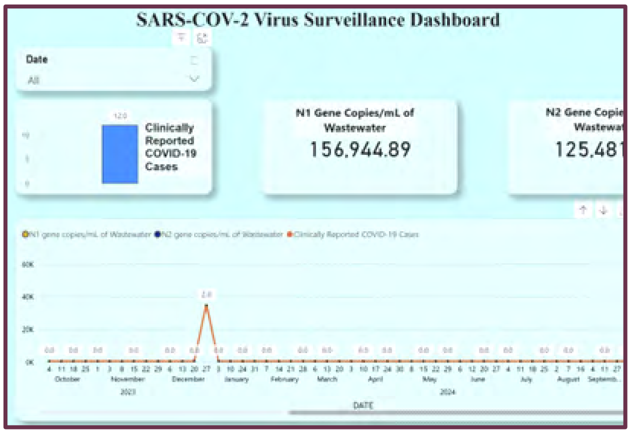
For the industrial sector, ICCW has developed solutions for recovery of materials and clean water from effluents, evaluated water initiatives and conducted water audits and certification programmes to help them in their quest for “Net Zero Water”. ICCW has completed a household water security study for Ramanthapuram district and implemented over 130 safe drinking water solutions for communities, using emerging technologies that save carbon and water footprints, with awareness programmes and behavioural change initiatives. Impact assessment for these projects and projects of other organisations has been added to the portfolio.

ICCW strengthened its support for startups by creating a Waterpreneur Studio – an ecosystem dedicated to startups in the water sector. Over 20 startups are being mentored at various stages of their evolution with a panel of experts. ICCW's international forays include being the India Challenge Owner for the 4th edition of the Atal Innovation Mission -Innovation Centre Denmark Challenge, and an MOU with Feng China University, Taiwan to bring sustainable water solutions to India. For more details, please visit https://iccw.world/

WASTEWATER-BASED EPIDEMIOLOGY (WBE)

We have established a new research centre to test municipal wastewater for pathogens and chemicals and make the data available to the public and other potential stakeholders. This facility acts as an intelligence unit to track and prevent disease outbreaks in its early stages.

The WBE study is performed by analyzing biological and chemical human urinary biomarkers in wastewater. The WBE tool tracks pollutants, pesticides, licit and illicit drugs, and personal care products to which the population is exposed.
We recently created an online dashboard to track SARS-CoV-2 viruses circulating in IIT Madras community. The samples are analysed once a week and the data for the whole year are on the dashboard. An image of the dashboard is shown below. For more details, please visit https://usedwateranalytics.org/



ANRF NATIONAL FACILITY FOR CRYO-ELECTRON MICROSCOPY

DST-ANRF has set up a world-class cryo-electron microscopy facility at IIT Madras to provide a platform for researchers in and around IIT Madras.

We have initiated the setup of a cryo-electron microscopy imaging suite equipped with state-of-the-art infrastructure. We provide high-resolution analysis of a variety of samples, including those from life sciences, materials science, and environmental sciences, to obtain new insights. For more details, please visit https://cryoem.iitm.ac.in/

This year, we organized the 1st International Symposium on Cryo-Electron Microscopy, followed by a hands-on workshop on Microcrystal Electron Diffraction (MicroED) by Prof. Brent L. Nannenga, Associate Professor of Chemical Engineering, Arizona State University. The details of the cryo-EM symposium are available at https://cryoem.iitm.ac.in/conference/

Our mass photometer.

CENTRE OF EXCELLENCE on MOLECULAR MATERIALS & FUNCTIONS

We have built a sustainable centre with global visibility on molecular matter, focusing on atomically precise clusters and gas hydrates, to seed, nurture, and expand cutting-edge science and technology in respective areas, collectively with the best people across the world, with the involvement of the next generation.

As a part of this centre, we organized international winter schools, international conferences, lecture series, technical talks and lab visits. Some of these activities of 2024 are shown in the following pages. For more details, please visit coe-on-molecular-materials-and-functions

ACTIVITIES of the CENTRE

TECHNICAL TALKS

"MDa mass spectrometry for materials science" by **Ms. Anagha Jose**, IIT Madras, January 18, 2024.

LAB VISITS

Visit to the lab of Prof. T. Pradeep, DST Unit of Nanoscience and Technology, Thematic Unit of Excellence, and SERB National Facility of Cryo-Electron Microscopy, Department of Chemistry, IIT Madras, January 25, 2024.

Visit to the lab of Prof. Pijush Ghosh, Department of Mechanical Engineering, IIT Madras, on March 14, 2024.

Visit to the lab of Prof. Thangavelu Palaniselvam, Department of Chemistry, IIT Madras, June 6, 2024.

Visit to the lab of Prof. Rajnish Kumar, Department of Chemical Engineering, IIT Madras, April 18, 2024.

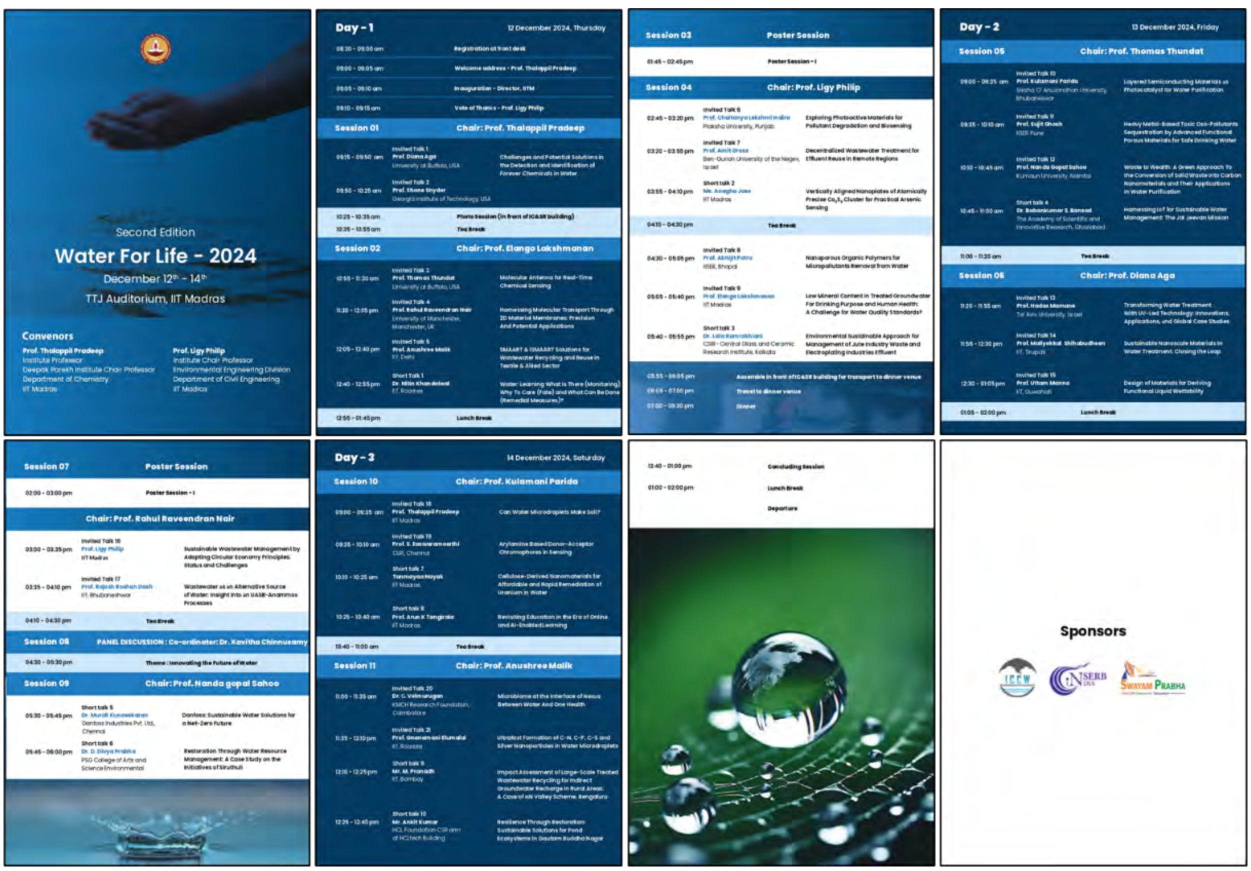
COE WINTER SCHOOL ON MOLECULAR MATERIALS AND FUNCTIONS 2024

The details of winter school are available at https://molmatter.org/coe-winter-school-2024/

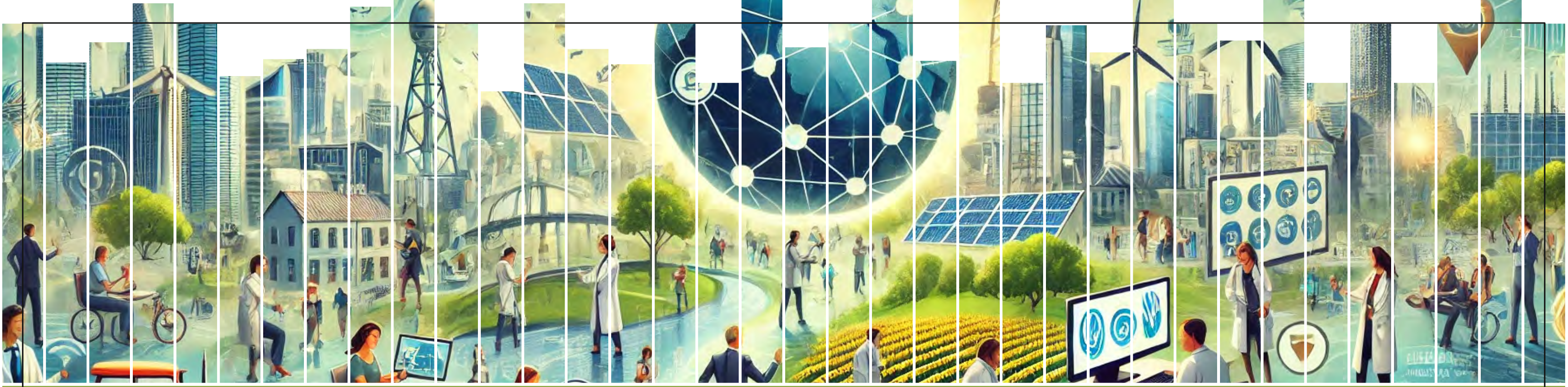
CoE INTERNATIONAL CONFERENCE on MOLECULAR MATERIALS & FUNCTIONS 2024

The conference details are available at https://molmatter.org/conference-2024/

INTERNATIONAL CONFERENCE ON WATER FOR LIFE 2024



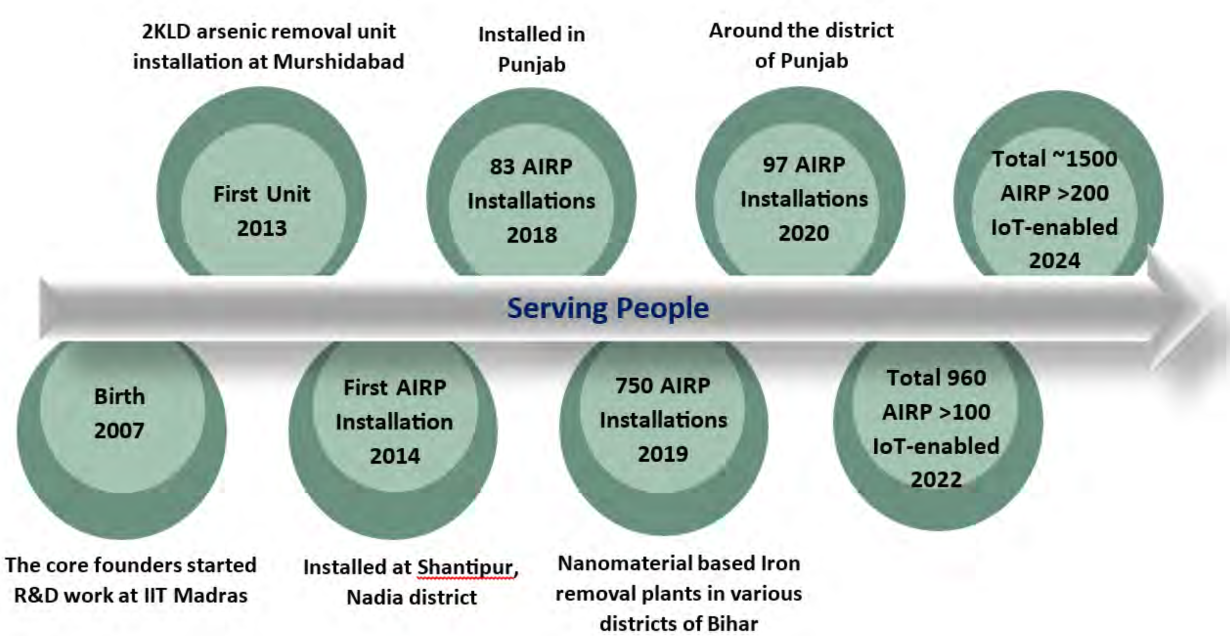
The conference details are available at https://waterforlifeiitm.org/



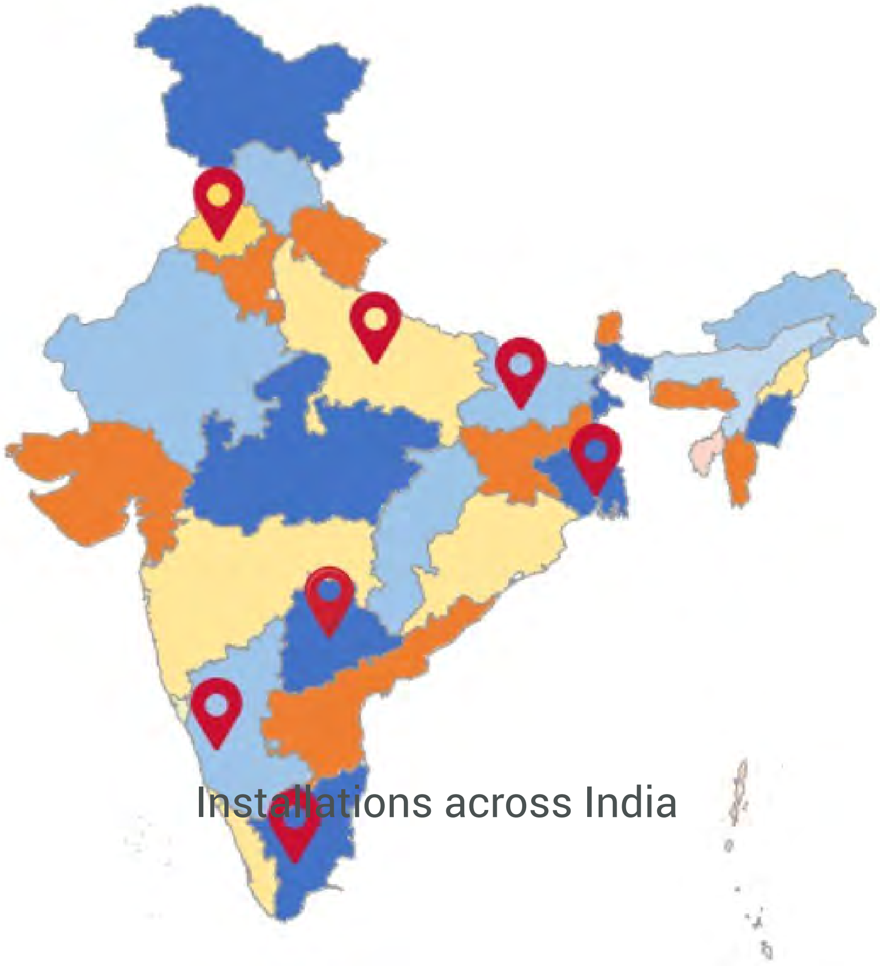
REACH OF OUR TECHNOLOGIES

INTERNATIONAL CENTRE FOR CLEAN WATER (ICCW)

AMRIT- ANION AND METAL REMOVAL BY INDIAN TECHNOLOGY



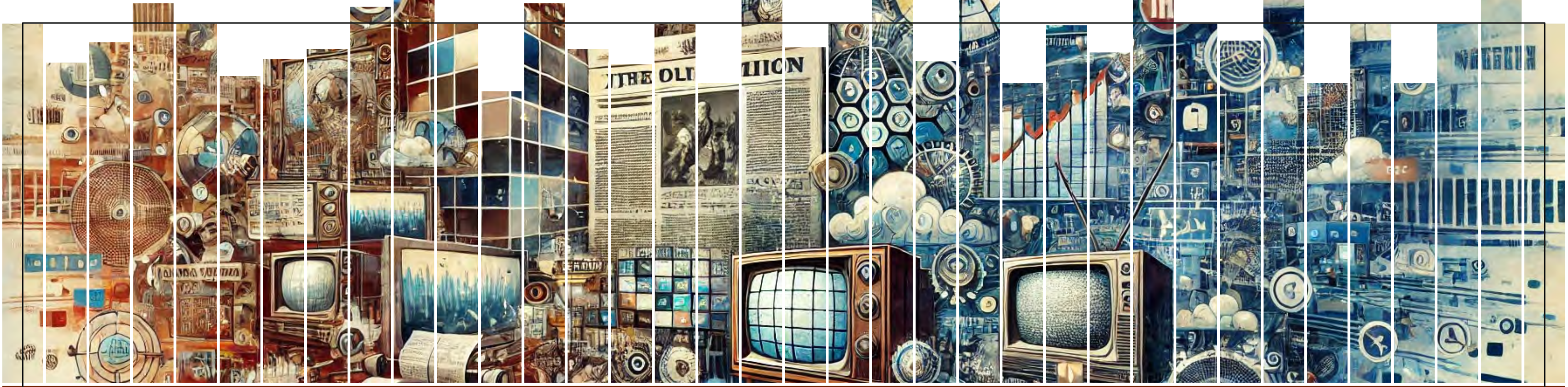
AIRP- ARSENIC AND IRON REMOVAL PLANT



Installations across India

AMRIT continues to expand to different parts of the country.

Our cryo-EM facility houses a Titan Krios G4, a 300 keV top-of-the-line microscope equipped with Falcon 4 direct electron detector.



IN THE MEDIA - A SELECTION

IIT-M unveils hybrid course to increase water literacy

Padmaja.J@timesgroup.com

Chennai: In order to create water-literate citizens, IIT Madras has unveiled a hybrid four-month certificate course — Water Quality — An Approach to People's Water Data.

Apart from teaching students, this course will help create a database of ground, surface and piped water quality, said T Pradeep, chemistry professor with IIT-M and one of the five instructors of the course. The institute has partnered with Tel Aviv University in Israel for the course.

As a pilot project, IIT Madras trained students of Stella Maris College, Madras Christian College and some stu-

WATER QUALITY TESTED IN 300 HOUSEHOLDS

this course to expand the initiative. Theory classes will be conducted online and offline about water quality and its impact on human health. The offline practicals involve each student picking 10 houses and testing water quality inclu-

-ring professor at IIT-M, suggested that the course could involve how different organisms, apart from humans, are affected by water quality.

Students can have a certificate from IIT-M on water quality, which will add to their resumes, and they can apply to water or food testing centres, shared Pradeep.

The course will entail a fee of ₹1,500, which will be refunded after course completion. The fee will also include field test kits. For practicals, the students will be assigned the closest colleges or labs, said Prof Pradeep.

"The course can pick cities like Chennai, Trichy and Coimbatore for offline practi-

INDIA TODAY

Indian professor at IIT Madras elected to National Academy of Engineering, US

...itute of Technology Madras (IIT Madras) faculty Professor ...adeep has become the 23rd foreign member from India to the United States National Academy of Engineering

Good News

Clean-water-for-all crusader Professor Thalappil Pradeep of IIT-Madras elect... international member of US ... Academy of Eng...

Professor Pradeep was bestow... chemistry and the discovery and ... solutions.

IIT Chennai launches groundbreaking wastewater-based epidemiology project

Led by a team of distinguished researchers at IIT Chennai, this pioneering initiative seeks to revolutionize community health through a data-driven preventive healthcare approach using wastewater surveillance.

Written by FE Science

Updated: January 17, 2024 02:49 IST

Follow Us

JUNE 11, 2024 REPORT

Chemists discover sponta... nanoparticle formation in ... microdroplets

by Bob Yirka, Phys.org

A team of chemists at the Indian Institute of Technology Madras, working with a pair of colleagues from the Jawaharlal Nehru Center for Advanced Scientific Research, both in India, has found that particles of minerals sometimes break down spontaneously when immersed in charged microdroplets, leading to the formation of nanoparticles.

In their study, published in the journal *Science*, the group conducted experiments with minerals and an electrospray device. R. Graham Cooks and Dylan T. Holden with Purdue University have published a Perspective piece in the same journal issue outlining the work.

Prior research has shown that natural processes often result in the creation of nanoparticles and that many types of such nanoparticles exist in nature. But not much is known about how they are formed. In this new effort, the research team suspected that some of them may be the result of minerals becoming immersed in charged liquid particles. To find out if that might be the case, they designed an experiment to replicate such natural processes.

...IT-M faculty elected to the National Academy of Engineering

Prof. M.V. Pylee Award for T. Pradeep

Published - March 12, 2024 08:13 pm IST - KOCHI

THE HINDU BUREAU

'Outstanding work': IIT-M team makes mineral nanoparticles with water

THE GIST

PRADEEP RESEARCH GROUP 2024


Ph.D. STUDENTS 2024


Our lab is administered by Ms. K. Priya

For more information:

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