Indo-Japan virtual workshop on Cluster science by interdisciplinary approach: Emerging materials and phenomena

September 3rd, 4th & 5th

Venue :

Auditorium (Virtual), IIT Madras

Links :

- September 3
- September 4
- September 5

Organized by :

Centre of Excellence on Molecular Materials and Functions, IIT Madras

Supported by :

सत्यमेव जयते
Department of Science & Technology
Govt. of India

JSPS

Organizing committee :

Prof. T. Pradeep (IIT Madras)

Prof. T. Tsukuda (The University of Tokyo)

Coordinators :

Dr. K S Sugi

Mr. Amoghavarsha Kini

Programme

IST	JST	Day 1: Sep. 3, 2021
09:00–09:10	**12:30–12:40**	Welcome Address
Session I **Session chair: T. Pradeep**		
09:10–09:40	**12:40–13:10**	Chemically modified gold superatoms **Tatsuya Tsukuda** The University of Tokyo
09:40–10:10	**13:10–13:40**	Dichalcogenide Stabilize Coinage Nanoclusters: Synthesis, Characterization, and HER Study **Rajendra Singh Dhayal** Central University of Punjab
10:10–10:40	**13:40–14:10**	Application of atomically precise metal clusters in energy and environmental field **Yuichi Negishi** Tokyo University of Science
10:40–11:10	**14:10–14:40**	Fluorescent Atomic Clusters: From Biomarkers to Energy Materials **Pradipta Purkayastha** IISER Kolkata
11:10–11:25	**14:40–14:55**	Discussion & Break (15 min)
Session II **Session chair: Y. Negishi**		
11:25–11:55	**14:55–15:25**	Atom hybridization: synthesis of multimetallic clusters using a dendrimer reactor **Kimihisa Yamamoto** Tokyo Institute of Technology
11:55–12:25	**15:25–15:55**	Ligand-protected gold clusters: From molecules to assemblies **Katsuaki Konishi** Hokkaido University
12:25–12:55	**15:55–16:25**	Breaking conventions in nanocluster catalysis by tuning atomicity specific properties **Biswarup Pathak** IIT Indore
12:55–13:40	**16:25–17:10**	Lunch/Refreshments break (45 min)

Session III **Session chair: K. Konishi**		
13:40–14:10	**17:10–17:40**	Superatom chemistry apart from ligand protection **Atsushi Nakajima** Keio University
14:10–14:40	**17:40–18:10**	Biological Applications of Metal Nanoclusters **Venkatesh V** IIT Roorkee
14:40–15:10	**18:10–18:40**	Low-temperature catalysis with high durability gained by uni-sized Pt clusters supported on silicon carbide surface **Hisato Yasumatsu** Toyota Technological Institute
15:10–15:40	**18:40–19:10**	Role of Ligands in Luminescent Metal Nanoclusters **Saptarshi Mukherjee** IISER Bhopal
15:40–15:55	**19:10–19:25**	Molecular interactions-driven multifunctional bioprobes: deciphering the supramolecular self-assembly **Abhijit Patra** IISER Bhopal
15:55–16:10	**19:25–19:40**	Structure and Oxidation Catalysis of PVP-Stabilized Au_{24} Cluster **Shingo Hasegawa** (student speaker) The University of Tokyo
16:10–16:20	**19:40–19:50**	Closing remark
IST	**JST**	**Day 2: Sep. 4, 2021**
09:00–09:10	**12:30–12:40**	Welcome Address
Session IV **Session chair: T. Tsukuda**		
09:10–09:40	**12:40–13:10**	Nanoparticles are molecules **T. Pradeep** IIT Madras
09:40–10:10	**13:10–13:40**	Copper fine particles/nanoparticles for electroconductive materials **Tetsu Yonezawa** Hokkaido University
10:10–10:40	**13:40–14:10**	Cluster and Cluster-Assemblies: Transformation Chemistry and Opto-Electrical Properties **Sukhendu Mandal** IISER Thiruvananthapuram

10:40–11:10	**14:10–14:40**	Gold, Silver and Copper Nanoclusters: From synthesis to applications **Arindam Banerjee** IACS Kolkata
11:10–11:25	**14:40–14:55**	**Discussion & Break (15 min)**
Session V **Session chair: S. Mandal**		
11:25–11:55	**14:55–15:25**	Singlet oxygen photo/sono-catalytic activity with thiolated gold nanoclusters **Hideya Kawasaki** Kansai University
11:55–12:25	**15:25–15:55**	The role of clusters and their solvent compatibility on digestive ripening process **B L V Prasad** National Chemical Laboratory
12:25–12:55	**15:55–16:25**	NHC-protected CAu_6 clusters; syntheses, structure and photophysical properties **Hitoshi Ube** The University of Tokyo
12:55–13:40	**16:25–17:10**	Lunch/Refreshments break (45 min)
Session VI **Session chair: B L V Prasad**		
13:40–14:10	**17:10–17:40**	Protein protected luminescent metal nanoclusters and its biomedical applications **Kuruvilla Joseph** IIST Thiruvananthapuram
14:10–14:40	**17:40–18:10**	XAFS study on ligand-protected metal clusters–Electronic, structural, and thermal properties **Seiji Yamazoe** Tokyo Metropolitan University
14:40–15:10	**18:10–18:40**	Plasmonic colloidosomes of black nano gold for solar energy harvesting and hot electron mediated catalysis **Vivek Polshettiwar** TIFR Mumbai
15:10–15:40	**18:40–19:10**	Clustering (assembling) of metal-halide perovskites in energy devices **Sayan Bhattcharya** IISER Kolkata
15:40–15:55	**19:10–19:25**	Exploring catalytic properties and active sites of phosphine-based gold nanoclusters **Sayani Mukherjee** (student speaker) IISER Thiruvananthapuram

15:55–16:10	**19:25–19:40**	Controlled Dimerization & Boding Scheme of Icosahedral M@Au_{12} (M = Pd, Pt) Superatoms **Emi Ito** (student speaker) The University of Tokyo
16:10–16:25	**19:40–19:55**	Light-triggered interconversion of carborane thiol-protected silver nanoclusters **Arijit Jana** (student speaker) IIT Madras
16:25–16:35	**19:55–20:05**	Closing remarks
IST	**JST**	Day 3: Sep. 5, 2021
09:30–11:30	**13:00–15:00**	Virtual lab tour/Research Park tour/Discussion

Meeting links:

Day 1 (Sept 3, 2021)

https://us02web.zoom.us/j/81529315609?pwd=WHp1MmdBOXZreSs3TDEvcWNSejNWdz09

Day 2 (Sept 4, 2021)
https://us02web.zoom.us/j/84347197783?pwd=aFN1ZyszakFMNVFpNytIWGpQZVF4UT09

Day 3 (Sept 5, 2021)

https://us02web.zoom.us/j/86892244126?pwd=VDMyeDFQSUFmbnJqSy9TQ0RZSlBRUT09

Our speakers

Tatsuya Tsukuda

Professor

Department of Chemistry

The University of Tokyo

Tokyo 113-0033, Japan

Phone: +81-3-5841-4363

e-mail: tsukuda@chem.s.u-tokyo.ac.jp

URL: http://www.chem.s.u-tokyo.ac.jp/users/chemreact/index.html

- **Academic Records**

  1989: The University of Tokyo (B.S.)

  1991: The University of Tokyo (M.S.)

  1994: The university of Tokyo (Ph.D)

- **Professional Career**

  1994: Special Postdoctoral Researcher, RIKEN

  1994 – 1999: Research Associate, The university of Tokyo

  2000 – 2007: Associate Professor, Institute for Molecular Science

  2007 – 2011: Professor, Catalysis Research Center, Hokkaido University

  2011 – Present: Professor, The University of Tokyo

- **Research Interests**

  1. Atomically precise synthesis and structure determination of protected metal clusters
  2. Gas-phase photoelectron spectroscopy of protected metal clusters
  3. Catalytic application of metal clusters stabilized by polymers or supported on solids

- **Publications**

  1. H. Hirai, S. Ito, S. Takano, K. Koyasu, T. Tsukuda, ***Chem. Sci.*** **2020**, *11*, 12233.(Perspective)
  2. S. Hasegawa, S. Takano, K. Harano, T. Tsukuda, ***JACS Au***, **2021**, *1*, 660.
  3. K. Koyasu, T. Tsukuda, ***J. Chem. Phys.*** **2021**, *154*, 140901. (Perspective)
  4. S. Takano, T. Tsukuda, ***J. Am. Chem. Soc.*** **2021**, *143*, 1683. (Perspective)
  5. T. Omoda, S. Takano, T. Tsukuda, ***Small*** **2021**, *17*, 2001439. (Review)

- **Awards**

  1995 Inoue Research Aid for Young Scientists (Inoue Foundation for Science)

  2006 Best Presentation Award (GOLD2006)

  2009 The CSJ Award for Creative Work (Chemical Society of Japan)

Rajendra Singh Dhayal

Assistant Professor

Department of Chemistry

Central University of Punjab

Bathinda 151401, India, Phone: +91 9781517027

e-mail: rajendra.dhayal@cup.edu.in

URL: http://www.cup.edu.in/dept_chemistry.php

- **Academic Records**

  2001; The University of Rajasthan, Jaipur (B.Sc.)

  2004; The University of Rajasthan, Jaipur (M.Sc.)

  2011; The Dept. of Chemistry, IIT Madras (Ph.D)

- **Professional Career**

  2005 – 2006: Researcher, CSMCRI Institute (CSIR-Lab), Gujarat, India

  2011 – 2014: Research Associate, National Dong Hwa University, Taiwan

  2014 – 2015: Assistant Professor, Thapar University, Punjab, India

  2015 – present: Assistant Professor, Central University of Punjab, India.

- **Research Interests**

  1. Synthesis and characterizations of dichalcogen ligated metal hydrides, and nanoclusters and their applications.
  2. Metallaboranes and chalcogen contain metallaheterobornaes isolation and characterizations.

- **Publications**

  1. Dhayal, R. S.; Liao, P.−K.; Lin, Y.-R.; Kahlal, S.; Saillard, J.-Y.; Liu, C. W. J. Am. Chem. Soc. 2013, 135, 4704−4707
  2. Dhayal, R. S.; Liao, P.−K.; Lin, Y.-R.; Kahlal, S.; Saillard, J.-Y.; Liu, C. W. Angew. Chem. Int. Ed. 2014, 53, 7214 –7218
  3. Dhayal, R. S.; Liao, J.−H.; Wang, X.; Liu, Y.-C.; Kahlal, S.; Saillard, J.-Y.; Liu, C. W. *Angew. Chem. Int. Ed*., **2015**, *54*, 13604.
  4. Dhayal, R. S.; Liao, J.−H.; Wang, X.; Liu, Y.-C.; Kahlal, S.; Saillard, J.-Y.; Liu, C. W. Angew. Chem. Int. Ed. 2015, 54, 3702.
  5. Dhayal, R. S.; Zyl, van W. E.; Liu, C. W. *Acc. Chem., Res.* **2016**, *49*, 86.
  6. Dhayal, R. S.; Liao, J.−H.; Chiang, M.-H.; Kahlal, S.; Saillard, J.-Y., Liu, C. W. *ChemistrySelect* ***2018***, *3, 3603-3610*.
  7. Khirid, S.; Biswas, R.; Meena, S.; Patil, R. A.; Ma, Y.-R.; Dhayal, R S.; Haldar, K. K. *ChemistrySelect* **2020**, *5*, 10593.

- **Awards**

  2019 Best teaching award by Central University of Punjab
  2017 Outstanding Research Award by Central University of Punjab
  2017 Best research faculty award by Central University of Punjab
  2016 DST-SERB – Young Scientist Research Award
  2011 – 2014 MOST Post-Doctoral Fellowship, NDHU, Taiwan.

Yuichi Negishi

Department of Applied Chemistry

Tokyo University of Science

Tokyo 162-8601, Japan, Phone: +81-3-5228-9145

e-mail: negishi@rs.tus.ac.jp

URL: https://www.rs.kagu.tus.ac.jp/negishi/negishienglish.html

- **Academic Records**

  1996; Keio University (B.S.)

  1998; Keio University (M.S.)

  2001; Keio University (Ph.D)

- **Professional Career**

  2000 Assistant Professor, Keio University

  2000~2008 Assistant Professor, Institute for Molecular Science

  2008~2013 Junior Associate Professor, Tokyo University of Science

  2013~2017 Associate Professor, Tokyo University of Science

  2017~present Professor, Tokyo University of Science

- **Research Interests**

  1. Creation of stable, functionalized metal clusters
  2. Creation of high-performance heterogeneous catalysts for energy conversion
  3. Establishment of high-resolution separation method for metal clusters

- **Publications**

  1. T. Kawawaki, Y. Kataoka, M. Hirata, Y. Akinaga, R. Takahata, K. Wakamatsu, Y. Fujiki, M. Kataoka, S. Kikkawa, A. S. Alotabi, S. Hossain, D. J. Osborn, T. Teranishi, G. G. Andersson, G. F. Metha, S. Yamazoe, Y. Negishi, ***Angew. Chem. Int. Ed.*** **2021**, in press.
  2. T. Kawawaki, A. Ebina, Y. Hosokawa, S. Ozaki, D. Suzuki, S. Hossain, Y. Negishi, ***Small*** **2021**, 17, 202005328. (a review article)
  3. T. Kawawaki, Y. Kataoka, M. Hirata, Y. Iwamatsu, S. Hossain, Y. Negishi, ***Nanoscale Horiz.*** **2021**, 6, 409. (a review article)
  4. T. Kawawaki, Y. Mori, K. Wakamatsu, S. Ozaki, M. Kawachi, S. Hossain, Y. Negishi, ***J. Mater. Chem. A*** **2020**, 8, 16081. (a review article)
  5. W. Kurashige, Y. Mori, S. Ozaki, M. Kawachi, S. Hossain, T. Kawawaki, C. J. Shearer, A. Iwase, G. F. Metha, S. Yamazoe, A. Kudo, Y. Negishi, ***Angew. Chem., Int. Ed.*** **2020**, 59, 7076.

- **Awards**

  2012 Japan Society for Molecular Science Award for Young Scientists (Japan Society for Molecular Science)

  2017 Yagami Prize (Keio University)

  2018 Distinguished Award 2018 for Novel Materials and Their Synthesis (IUPAC etc.)

  2020 International Investigator Awards of the Japan Society for Molecular Science (Japan Society for Molecular Science)

Pradipta Purkayastha

Professor

Department of Chemical Sciences

Indian Institute of Science Education and Research Kolkata

Mohanpur 741246, India

e-mail: ppurkayastha@iiserkol.ac.in

URL: https://www.iiserkol.ac.in/web/en/people/faculty/dcs/ppurkayastha

www.pradiptapurkayastha.com

- **Academic Records**

  1996: University of Calcutta (B.Sc.)

  1998: University of Calcutta (M.Sc.)

  2002: Jadavpur University (Ph.D)

- **Professional Career**

  2002 – 2004: Postdoctoral Researcher, University of Pennsylvania

  2004 – 2009: Assistant Professor, BITS Pilani

  2009 – 2013: Assistant Professor, IISER Kolkata

  2013 – 2018: Associate Professor, IISER Kolkata

  2018 – Present: Professor, IISER Kolkata

- **Research Interests**

  1. Host-guest interaction and applications in biological environments
  2. Synthesis, spectroscopy and applications of metal nanoparticles and nanoclusters
  3. Excited state energy and electron transfer

- **Publications**

1. T. Das, D. K. Poria, P. Purkayastha, *Nanomedicine* **2016**, *12*, 1105.
2. R. Banerjee, P. Purkayastha, *J. Phys. Chem. B* **2017**, 121, 11449.
3. S. Bhunia, P. Purkayastha, *Mater. Lett.* **2019**, 253, 109.
4. S. Bhunia, K. Gangopadhyay, A. Ghosh, S. K. Seth, R. Das, P. Purkayastha, *ACS Appl. Nanomater.* **2021**, *4*, 305.
5. A. Chatterjee, P. Purkayastha, *Mater. Adv.* **2021**, *2*, 1343 and over **114** peer reviewed articles with H-index of **21** (Total Citation Number**: ~1,600**).

- **Awards**

  2018 Outstanding Faculty in Science Award (Venus International Foundation)

  2019 Fellow of the West Bengal Academy of Science and Technology

  2020 InSc Research Excellence Award (Institute of Scholars, Bengaluru)

Kimihisa Yamamoto

Professor

Institute of Innovative Research,

Tokyo Institute of Technology

Yokohama 226-8503, Japan, Phone: +81-45-924-5260

e-mail: yamamoto@res.titech.ac.jp

URL: http://www.res.titech.ac.jp/~inorg/

- **Academic Records**

  1985; Waseda University (B.S.)

  1987; Waseda University (M.S.)

  1990; Waseda University (Ph.D)

- **Professional Career**

  Research Associate, Department of Polymer Chemistry, Waseda University (1989- 1995)

  Associate Professor, Research Institute for Sci. & Eng., Waseda University (1995- 1997)

  Associate Professor, Department of Chemistry, Keio University (1997- 2002)

  Professor, Department of Chemistry, Keio University (2002- 2010)

  Professor, Institute of Innovative Research, Tokyo Institute of Technology (2010- present)

  Director, Laboratory for Chemistry and Life Science, Tokyo Institute of Technology (2020- present)

- **Research Interests**

  1. Atom-hybridization
  2. Subnano Catalyst
  3. Multimetallic Nanomaterials

- **Publications**

  1. T. Tsukamoto, T. Kambe, T. Imaoka, K. Yamamoto, ***Nature Rev. Chem.*** **2021**, 5, 338- 347.
  2. K. Yamamoto, T. Imaoka, M. Tanabe, T. Kambe, ***Chem. Rev.*** **2020**, 120, 1397.
  3. T. Kambe, A. Watanabe, M. Li, T. Tsukamoto, T. Imaoka, K. Yamamoto, ***Adv. Mater.*** **2020**, 32, 1907167.
  4. T. Tsukamoto, N. Haruta, T. Kambe, A. Kuzume, K. Yamamoto, ***Nature Commun.*** **2019**, 10, 3727.
  5. A. Kuzume, M. Ozawa, Y. Tang, Y. Yamada, N. Haruta, K. Yamamoto, ***Science Advances,*** **2019**, 5, eaax6455.

- **Awards**

  2012 The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology, Awards for Science and Technology, Research Category

  2014 Distinguished Award 2014 for Novel Materials and Synthesis by IUPAC & NMS

  2020 The Award of the Society of Polymer Science, Japan

  2021 53th Ichimura Award

Katsuaki Konishi

Professor

Faculty of Environmental Earth Science

Hokkaido University

Sapporo 060-0810, Japan, Phone: +81-11-706-4538

e-mail: konishi@ees.hokudai.ac.jp

URL: http://www.chem.s.u-tokyo.ac.jp/users/chemreact/index.html

- **Academic Records**

  1987; The University of Tokyo (B.S.)

  1989; The University of Tokyo (M.S.)

  1993; The University of Tokyo (Ph.D)

- **Professional Career**

  1991 JSPS Fellowship for Young Scientists

  1991~2000 Research Associate, The University of Tokyo

  2000 Lecturer, The University of Tokyo

  2000~2003 JST PRESTO project leader

  2000~2008 Associate Professor, Hokkaido University

  2008~present Professor, Hokkaido University

- **Research Interests**

  1. Precise design and modification of molecular clusters
  2. Cluster-organic hybrid materials
  3. Molecular recognition and supramolecular Chemistry
  4. Chemical Sensors and catalysis

- **Publications**

  1. K. Konishi, ***Struct. Bonding*** **2014**, *161*, 49. (a review book chapter)
  2. K. Konishi, M. Iwasaki, M. Sugiuchi, Y. Shichibu, ***J. Phys. Chem. Lett.*** (*Perspectives*), **2016**, *7*, 4267.
  3. K. Konishi, M. Iwasaki, Y. Shichibu, ***Acc. Chem. Res.*** **2018**, *51* 3125
  4. M. Sugiuchi, K. Konishi et al., ***J. Am. Chem. Soc.*** **2017**, *139*, 17731
  5. M. A. Bakar, K. Konishi et al., ***Nature Commun.*** **2017**, *8*, 576.
  6. M. Sugiuchi, Y. Shichibu, K. Konishi, ***Angew. Chem. Int. Ed.*** **2018**, *57*, 7855

- **Awards**

  1993 CSJ (Chemical Society of Japan) Special Lectureship for Young Scientists

  2015 The CSJ (Chemical Society of Japan) Award for Creative Work

Biswarup Pathak

Associate Professor

Department of Chemistry

Indian Institute of Technology Indore

Indore 453552, India

e-mail: biswarup@iiti.ac.in

URL: https://iiti.ac.in/people/~biswarup/index.html

- **Academic Records**

  2000: The University of Burdwan (B.Sc.)

  2002: Banaras Hindu University (M.Sc.)

  2007: Hyderabad Central University (Ph.D)

- **Professional Career**

  2007 : Research Associate, IISc Bangalore, India

  2008 – 2009: Postdoctoral Associate, Jackson State University, USA

  2009 – 2012 : Postdoctoral Associate, Uppsala University, Sweden

  2012 – 2016 : Assistant Professor, IIT Indore, India

  2016 – Present: Associate Professor, IIT Indore, India

- **Research Interests**

  1. Computational Studies of Nanoclusters
  2. Catalytic applications of Nanoclusters

- **Publications**

  1. A. S. Nair, B. Pathak, *Wiley Interdiscip. Rev. Comput. Mol. Sci.* **2021,** *11*, 1-19. (a review article)
  2. A. S. Nair, A. Anoop, R. Ahuja, B. Pathak, *J. Comput. Chem.* **2021**, *1*, 1–15 (2021)
  3. Over **175** peer reviewed articles with H-index of **36** (Total Citation Number**: ~4000**).

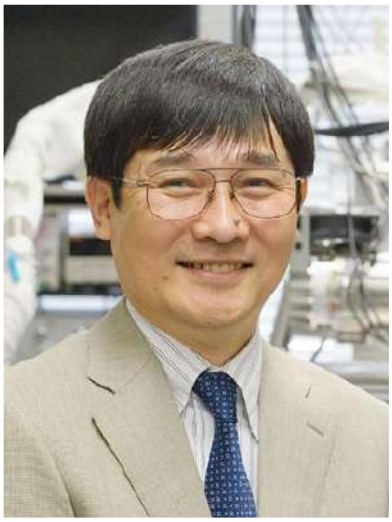
- **Awards**

  2016 Best Research Paper Award from IIT Indore

  2017 Early and Mid-Career Research Award from Indian National Science Academy

  2019 Featured in Journal of Physical Chemistry Young Scientist Special Issue (ACS)

Atsushi Nakajima



Professor
Department of Chemistry, Faculty of Science and Technology
Keio University
Yokohama 2233-8522, Japan, Phone: +81-(0)45-563-1712
e-mail: nakajima@chem.keio.ac.jp
URL: http://chem.keio.ac.jp/nakajima-lab/index.html

- **Academic Records**

  1984; The University of Tokyo (B.S.)
  1986; The University of Tokyo (M.S.)
  1989; The University of Tokyo (Dr. Sc.)

- **Professional Career**

  1989~1994 Research Associate, Keio University
  1994~1997 Assistant Professor, Keio University
  1997~2001 Associate Professor, Keio University
  2001~present Professor, Keio University
  2014~2019 Principal Investigator, Keio Institute of Pure and Applied Sciences

- **Research Interests**

  1. Cluster Science
  2. Nanoscale Material Science

- **Publications**

1. M. Shibuta, N. Hirata, T. Eguchi, A. Nakajima***, ACS Nano,*** **2017**, 11 4307.
2. H. Tsunoyama, M. Shibuta, M. Nakaya, T. Eguchi, A. Nakajima, ***Acc. Chem. Res.*** **2018**, 51, 1735.
3. H. Tsunoyama, A. Ohnuma, K. Takahashi, A. Velloth, M. Ehara, N. Ichikuni, M. Tabuchi, A. Nakajima, ***Chem. Comm.*** **2019**, 55, 12603.
4. K. Yamagiwa, M. Shibuta, A. Nakajima, ACS Nano 2020, 14, 2044.
5. M. Shibuta, K. Yamamoto, T. Ohta, T. Inoue, K. Mizoguchi, M. Nakaya, T. Eguchi, A. Nakajima, ***ACS Nano*** **2021**, 15, 1199.

- **Awards**

  1994 The CSJ Award for Young Chemists (Chemical Society of Japan)
  2008 The CSJ Award for Creative Work (Chemical Society of Japan)
  2018 The Japan Society for Molecular Science Award (Japan Society for Molecular Science)
  2020 The Humboldt Research Award (Alexander von Humboldt Foundation)

Venkatesh V

Assistant Professor

Department of Chemistry

Indian Institute of Technology Roorkee

Roorkee 247667, India

e-mail: venkatesh.v@cy.iitr.ac.in

URL: https://venka71.wixsite.com/dr-venkatesh-iitr

- **Academic Records**

  2006: Gobi Arts and Science College, India (B.Sc.)

  2008: Anna University, Chennai, India (M.Sc.)

  2015: Indian Institute of Technology Kanpur, India (Ph.D)

- **Professional Career**

  2015 – 2017 : Newton International postdoctoral Fellow, The University of Warwick

  2017 – 2019: DST-INSPIRE Faculty, Indian Institute of Science, Bangalore

  2019 – Present: Assistant Professor, Indian Institute of Technology Roorkee, Roorkee

- **Research Interests**

  1. Design and Synthesis of luminescent metal nanoclusters and study their biological applications

- **Publications**

  1. N. Singh, K. P. Raul, A. Poulose, G. Mugesh, and V. Venkatesh, *ACS Appl. Bio Mater*., **2020**, *3*, 7454−7461.
  2. K. T Prakash, N. Singh, and V. Venkatesh, *Chem. Comm*., **2019**, *55*, 322−325
  3. V. Venkatesh, A. Shukla, S. Sivakumar, and S. Verma, *ACS Appl.Mater.Interfaces.* **2014,** *6,* 2185–2191.

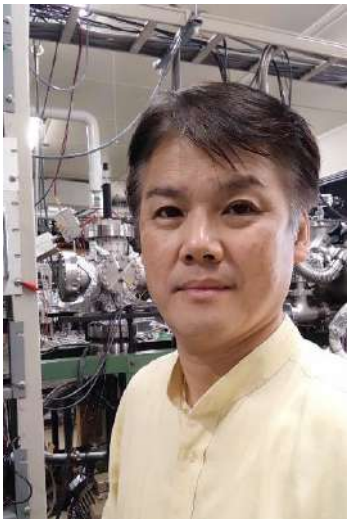
- **Awards**

  2014 Eli Lilly and Company Asia Outstanding Thesis Award

  2015 Newton International Fellowship awarded jointly by The Royal Society and The British Academy

  2017 DST-INSPIRE faculty award from DST, Government of India

Hisato Yasumatsu



Professor
Cluster Research Laboratory, Toyota Technological Institute:
in East Tokyo Laboratory, Genesis Research Institute, Inc.
Chiba 272-0001, Japan, Phone: +81-47-320-5915
e-mail: yasumatsu@clusterlab.jp
URL: https://www.clusterlab.jp/index_e.html

- **Academic Records**

  1990; The University of Tokyo (B.S.)
  1992; The University of Tokyo (M.S.)
  1995; The University of Tokyo (Ph.D)

- **Professional Career**

  1995~1997 Special Postdoctoral Researcher, RIKEN
  1997~2002 Research Associate, Toyota Technological Institute
  2002~2006 Senior Assistant Professor, Toyota Technological Institute
  2006~2014 Associate Professor, Toyota Technological Institute
  2014~present Professor, Toyota Technological Institute

- **Research Interests**

  1. Catalytic activity of uni-sized clusters bound to a solid surface
  2. Chemical, optical and electrochemical functionalities driven by charges accumulated at a sub-nano interface
  3. Novel phenomena and functionalities induced by cluster impact onto a solid surface
  4. Chemical reaction dynamics at molecular levels

- **Publications**

  1. H. Yasumatsu and T. Kondow**, *Rep. Prog. Phys.* 2003**, 66, 1783. (a review article)
  2. H. Yasumatsu, In Encyclopedia of Interfacial Chemistry: Surface Science and Electrochemistry, ***Elsevier*, 2018**; Volume 3.2, pp. 477–489. (an encyclopedia chapter)
  3. H. Yasumatsu, T. Kondow, H. Kitagawa, K. Tabayashi, K. Shobatake, ***J. Chem. Phys.* 1996**, 104, 899.
  4. H. Yasumatsu, T. Hayakawa, S. Koizumi, T. Kondow, ***J. Chem. Phys.* 2005**, 123, 124709.
  5. H. Yasumatsu, ***J. Phys. Chem. C* 2020**, 124, 23724. and over 60 peer reviewed articles with H-index of 18 (Total Citation Number: ~1,000).

- **Awards**

  1998 Inoue Research Aid for Young Scientists (Inoue Foundation for Science)

  2003 Research Award for Encouraging Young Scientists (General Research Meeting on Molecular Science)

Saptarshi Mukherjee

Professor

Department of Chemistry

Indian Institute of Science Education and Research (IISER)

Bhopal

Bhopal 462066, India

e-mail: saptarshi@iiserb.ac.in

URL: https://sites.google.com/a/iiserb.ac.in/ultrafast-and-molecular-spectroscopy-laboratory/home

- **Academic Records**

  1999: Jadavpur University, Kolkata (B.Sc.)

  2001: Jadavpur University, Kolkata (M.Sc.)

  2006: Indian Association for the Cultivation of Science, Kolkata (Ph.D)

- **Professional Career**

  2006 – 2008 : Postdoctoral Research Associate, Bowling Green State University

  2008 – 2013 : Assistant Professor, Department of Chemistry, IISER Bhopal

  2013 – 2018 : Associate Professor, Department of Chemistry, IISER Bhopal

  2018 – Present : Professor, Department of Chemistry, IISER Bhopal

  2018 – 2021 : Deputy Director, IISER Bhopal

- **Research Interests**

  Spectroscopy of Luminescent Metal Nanoclusters, Dynamics of biological assemblies, single nucleotide mismatched DNA, protein unfolding and refolding, surface chemistry, Ultrafast and Single Molecule Spectroscopy

- **Publications**

  1. U. Anand, S. Ghosh, S. Mukherjee, *J. Phys. Chem. Lett*. **2012**, *3*, 3605.
  2. S. Ghosh, N. K. Das, U. Anand, S. Mukherjee, *J. Phys. Chem. Lett*. **2015**, *6*, 1293.
  3. S. Pramanik, A. Nandy, S. Chakraborty, U. Pramanik, S. Nandi, S. Mukherjee, *J. Phys. Chem. Lett*. **2020**, *11*, 2436.
  4. S. Chakraborty, S. Mukherjee, *J. Phys. Chem. Lett*. **2021**, *12*, 3266.
  5. S. Chakraborty, P. Sagarika, S. Rai, C. Sahi, S. Mukherjee, *ACS Appl. Mater. Interfaces* **2021**, *13*, 36938.
  6. K. Bhattacharyya, S. Mukherjee, *Bull. Chem. Soc. Jpn*. **2017**, *91*, 447 (invited review) and **77** peer reviewed articles with H-index of **30** (Total Citation Number**: ~2160**).

- **Awards**

  2012 Indian National Science Academy (INSA) Young Scientist Award in Chemistry

  2018 Chemical Research Society of India (CRSI) Young Scientist Award

  2021 Chemical Research Society of India (CRSI) Bronze Medal

  2020 Senior Editor, Chemical Physics Impact (Elsevier)

  2015 Founding and Core Member, Indian National Young Academy of Sciences

Abhijit Patra

Associate Professor

Department of Chemistry

Indian Institute of Science Education and Research Bhopal (IISERB),

Bhopal 462066, India

e-mail: abhijit@iiserb.ac.in

URL:https://home.iiserb.ac.in/~abhijit/ap.html

- **Academic records**

  2001 : The University of Burdwan (B.Sc.)

  2003 : The University of Burdwan (M.Sc.)

  2009: University of Hyderabad (Ph.D)

- **Professional Career**

  2009 – 2010 : Postdoctoral fellow in PPSM, ENS Paris-Saclay, France

  2010 – 2012 : Alexander von Humboldt dellow, Dept. of Macromolecular Chemistry, University of Wuppertal, Germany

  2012 – 2018 : Assistant Professor, Department of Chemistry, IISER Bhopal

  2018 – present : Associate Professor, Department of Chemistry, IISER Bhopal

- **Research Interests**

  1. Multifunctional porous organic polymers for CO_2 conversion, water purification, and energy storage
  2. Supramolecular self-assembly and molecular bioprobes for intracellular sensing and imaging
  3. Triplet-harvesting organic materials and upconversion nanoparticles

- **Publications**

1. S. Kundu, A. Chowdhury, S. Nandi, K. Bhattacharyya, A. Patra, *Chem. Sci.* **2021**, *12*, 5874.
2. S. Kundu, B. Behera, A. Giri, N. Saha, A. Patra, *Chem. Commun.* **2021**, *57*, 6875.
3. S. Jaiswal, J. Pathak, S. Kundu, A. Patra, *ACS Sustain. Chem. Eng.* **2021**, *9*, 56134.
4. A. Giri, N. N. Patil, A. Patra, *Chem. Commun.* **2021**, *57*, 4404.
5. M. Sarkar, T. K. Dutta, A. Patra, *Chem. Asian J.* **2021**, 10.1002/asia.202100815 (*invited minireview*)
6. M. W. Hussain, V. Bhardwaj, A. Giri, A. Chande, A. Patra, *Chem. Sci.* **2020**, *11*, 7910.
7. S. Kundu, B. Sk, P. Pallavi, A. Giri, A. Patra, *Chem. Eur. J.* **2020**, *26*, 5557.
8. A. Giri, M. W. Hussain, B. Sk, A. Patra, *Chem. Mater.* **2019**, *31*, 8440.

- **Awards**

  2018 Featured in emerging investigator issue of Journal of Materials Chemistry C

  2010 Alexander von Humboldt Fellowship awarded in Materials Science

Shingo Hasegawa

Graduate student

Department of Chemistry

The University of Tokyo

Tokyo 113-0033, Japan

e-mail: shasegawa@chem.s.u-tokyo.ac.jp

URL: https://www.chem.s.u-tokyo.ac.jp/users/chemreact/member/member_hasegawa-e.html

- **Research Interests**
  1. Catalysis of Single Heterometal Atom Doped Gold Clusters Stabilized by PVP

- **Publications**
  1. S. Hasegawa, Shinjiro Takano, Koji Harano and T. Tsukuda* ***JACS Au***, **2021**, *1*, 660.
  2. S. Hasegawa and T. Tsukuda, ***B. C. S. J,*** **2021,** 94, 1036-1044.
  3. S. Hasegawa, S. Takano, S. Yamazoe and T. Tsukuda* ***Chemical Communications,*** **2018,** 54, 5915-5918.

- **Awards**

  2018 Catalysis Society Young Researchers Adopted Overseas Travel Expenses Subsidy.

  2018 Young Excellent Poster Presentation Award, Nano Society 16th Conference, University of Tokyo.

  2018 Student Poster Presentation Award, 121st Catalyst Debate, University of Tokyo.

Thalappil Pradeep

Institute Professor
Deepak Parekh Institute Chair Professor and Professor of Chemistry
Professor in-charge, International Centre for Clean water
Department of Chemistry,
Indian Institute of Technology Madras,
Chennai 600 036, INDIA
Phone : +91-44-2257 4208
Fax : ++91-44-2257 0509/0545
e-mail: pradeep@iitm.ac.in
URL: https://pradeepresearch.org
http://iccwindia.org

- **Academic Records**

  1980, University of Calicut (B.Sc.)

  1983-1985; University of Calicut (M.Sc.)

  1986-1991; IISc (Ph.D.)

- **Professional Career**

  1986-1986, Technical Officer, CWRDM

  1991-1991; Scientific Officer, IISc., Bangalore

  1991-1992; Visiting Faculty, IIT Madras

  1993-1995; Asst. Professor, IIT Madras

  1995-2000; Assoc. Professor, IIT Madras

  2000-present; Professor, IIT Madras

- **Research Interests**

  1. Molecular & nanoscale materials
  2. Nanoscience & nanotechnology
  3. Molecular surfaces
  4. Ion scattering; instrumentation; water purification

- **Publications**

1. A. R. Chowdhuri, B. K. Spoorthi, B. Mondal, P. Bose, S. Bose and T. Pradeep, ***Chem. Sci.,* 2021**, 12 6370–6377.
2. K. S. Sugi, P. Bandyopadhyay, Md. Bodiuzzaman, A. Nag, M. Hridya, W. A. Dar, P. Ghosh and T. Pradeep, ***Chem. Mater.,* 2020**, 32, 7973–7984.
3. J. Ghosh, R. R. J. Methikkalam, R. G. Bhuin, G. Ragupathy, N. Choudhary, R. Kumar, and T. Pradeep, ***Proc. Natl. Acad. Sci. U.S.A.,* 2019**, 116, 1526-1531.
4. P. Bose, P. Chakraborty, J. S. Mohanty, Nonappa, A. R. Chowdhuri, E. Khatun, T. Ahuja, A. Mahendranath and T. Pradeep, ***Nanoscale,* 2020**, 12, 22116-22128.

- **Awards**

  2018 The World Academy of Sciences (TWAS) Prize in Chemistry

  2020 Padma Shri

  2020 Nikkei Asia Prize

  2020 Silver Medal of the Chemical Research Society of India

  2020 National Water Award

Tetsu Yonezawa

Professor

Division of Materials Science and Engineering

Hokkaido University

Sapporo 060-8628, Japan, Phone: +81-11-706-7110

e-mail: tetsu@eng.hokudai.ac.jp

URL: https://nanoparticle.hokkaido.university

- **Academic Records**

  1988 The University of Tokyo (B.Eng.)

  1990 The University of Tokyo (M.Eng.)

  1994; The University of Tokyo (Ph.D)

- **Professional Career**

1994	Post Doc Researcher. Institut sur la Catalyse, CNRS, France
1996~2001	Research Associate, Kyushu University
2001~2002	Associate Professor, Nagoya University
2002~2009	Associate Professor, The University of Tokyo
2009~present	Professor, Hokkaido University

- **Research Interests**

  1. Highly stable copper nanoparticles/fine particles for electronics applications. Atomically precise synthesis, structure determination of protected metal clusters, and the surface reaction.
  2. Catalytic application of alloy/high entropy alloy metal nanoparticles stabilized by polymers or supported on solids

- **Publications**

  1. Y. Ishida, R. D. Corpuz, and T. Yonezawa, ***Acc. Chem. Res.***, **2017**, *50*, 2986-2995. (an account paper)
  2. M. T. Nguyen and T. Yonezawa, ***Sci. Tech. Adv. Mater.***, **2018**, *19*, 883-898. (a review paper)
  3. I. Akita, Y. Ishida, and T. Yonezawa, ***J. Phys. Chem. Lett.***, **2020**, *11*, 3357-3361.
  4. N. Jaikrajang, W. Kao-Ian, T. Muramatsu, R. Chanajaree, T. Yonezawa, Z. Y. Al Balushi, S. Kheawhom, and R. Cheacharoen, ***ACS Appl. Energy Mater.***, **2021**, *4*, 7138-7147.
  5. S. Zhu, M. T. Nguyen, and T. Yonezawa,* ***Nanoscale Adv.***, **2021**, *3*, 4326-4345. (a review paper)
  6. Over **270** peer reviewed articles with H-index of **48** (Total Citation Number**: ~10600**).

- **Awards**

  2016 Fellow, The Royal Society of Chemistry (UK)

  2016 Xingda Lectureship, Peking University (P. R. China)

  2011 SPSJ Hitachi Award (Japan)

  2008 Hot Article Award, Analytical Sciences

  2002 Encouragement Award, Colloid and Surface Science Division, Chem. Soc. Jpn.

Sukhendu Mandal

Associate Professor
School of Chemistry
Indian Institute of Science Education and Research
Thiruvananthapuram
Maruthamala P.O., Vithura, Trivandrum, India
e-mail: sukhendu@iisertvm.ac.in
URL: https://mandalresearchgroup.wixsite.com/home

- **Academic Records**

  1999: University of Calcutta (B.Sc.)
  2001: University of Kalyani (M.Sc.)
  2007: Indian Institute of Science Bangalore (Ph.D)

- **Professional Career**

  2008 – 2012: Postdoctoral Fellow at the Pennsylvania State University (USA)
  2012 – 2017: Assistant Professor, IISER TVM
  2016 – Present: Associate Professor, IISER TVM

- **Research Interests**

  Synthesis and structure determination of ligand protected atom-precise metal nanoclusters; mechanism of ligand exchange and thermally triggered structural transformation; Defect engineering of substrate (CeO_2 and MoS_2, etc.) using atom-precise nanocluster for chemical and electrochemical catalysis reaction; Two-dimensional cluster-assembled materials

- **Publications**

1. A. George, A. Sundar, A. S. Nair, M. P. Maman, B. Ramanan, S. Mandal**,** *J. Phys. Chem. Lett.* **2019**, *10*, 4571-4576.
2. M. P. Maman, A. S. Nair, H. Cheraparambil, B. Pathak, S. Mandal, *J. Phys. Chem. Lett.* **2020**, *11*, 1781-1788.
3. M. P. Maman, A. S. Nair, A. M. Abdul Hakkim Nazeera, B. Pathak, S. Mandal, *J. Phys. Chem. Lett.* **2020**, *11*, 10052-10059.
4. A. K. Das, S. Mukherjee, S. R. Sreehari, A. S. Nair, S. Bhandary, D. Chopra, D. Sanyal, B. Pathal, S. Mandal, *ACS Nano* **2020**, *14*, 16681-16688.
5. S. Mandal, S. Natarajan, P. Mani, A. Pankajakshan, *Adv. Func. Mater.* **2020**, 2006291.

- **Awards**

  2021 CRSI Bronze Medal (Chemical research Society of India)

Arindam Banerjee

Senior Professor

School of Biological Sciences

Indian Association for the Cultivation of Science

Jadavpur, Kolkata - 700032

e-mail: bcab@iacs.res.in

arindamkol1996@iacs.res.in

- **Academic Records**

  1986: Visva-Bharati University, West Bengal (B.Sc.)

  1988: Visva-Bharati University, West Bengal (M.Sc.)

  1997: Indian Institute of Science, Bangalore (Ph.D)

- **Professional Career**

  1998 : Postdoctoral Fellow, Weizmmann Institute of Science, Israel

  1998 – 2001: Lecturer, Indian Association for the Cultivation of Science, Calcutta

  2001 – 2005: Senior Lecturer, Indian Association for the Cultivation of Science, Calcutta

  2005 – 2007: Associate Professor, Indian Association for the Cultivation of Science, Calcutta

  2007 – 2008: Scientist Gr IV (3), Indian Institute of Chemical Biology

  2008 – 2009: Associate Professor, Indian Association for the Cultivation of Science, Calcutta

  2009 – 2014: Professor, Indian Association for the Cultivation of Science, Calcutta

  2014 – present: Senior Professor, Indian Association for the Cultivation of Science, Calcutta

- **Research Interests**

  Bio-Organic Chemistry, Fluorescent nanoclusters, Carbon nanodots and their applications, Peptide and amino acid based functional soft materials in health care (drug delivery and antimicrobials) and waste water management, organic-inorganic nanohybrids, self-assembling peptides and gels.

- **Publications**

Books	Research papers in Journals	General articles
1	**149**	**2**

- **Awards**

2005 B.M. Birla Science Prize in Chemistry

2011 Material research society of India (MRSI) Medal

2014 Young Career award for NanoScience and Technology by Nanomission, DST, Govt. of India

2015 Thomson Reuters Research Excellence India Citation Award

2017 Prof. C.N.R. Rao National Prize in chemical Sciences

Hideya Kawasaki

Professor

Department of Chemistry and Materials Engineering

Kansai University

Osaka 564-8680, Japan, Phone: +81-6-6368-0979

e-mail: hkawa@kansai-u.ac.jp

URL: https://wps.itc.kansai-u.ac.jp/colloid/english

- **Academic Records**

  1993; Mie University (B.S.)

  1995; Mie University (M.S.)

  1998; Kyushu University (Ph.D.)

- **Professional Career**

  1998~1999 JSPS postdoctoral researcher

  1999~2006 Research Associate, Kyushu University

  2006~2013 Associate Professor, Kansai University

  2013~ present Professor, Kansai University

- **Research Interests**

  1. Synthesis of metal nanoclusters and single-nanosized metal nanoparticles
  2. Photo/sono-catalytic applications of metal nanoclusters
  3. Functional Nanoparticles for mass spectrometry
  4. Metal nanoparticle-based inks for electronics

- **Publications**

  1. H Kawasaki, K Hamaguchi, I Osaka, R Arakawa, ***Adv. Funct. Mater.*** **2011**, *21*, 3508.
  2. H Yamamoto, H Yano, H Kouchi, Y Obora, R Arakawa, H Kawasaki, ***Nanoscale*** **2012**, *4*, 4148.
  3. H. Kawasaki, S. Kumar, G. Li, C. Zeng, D. R. Kauffman, J. Yoshimoto, Y. Iwasaki, R. Jin. ***Chem. Mater.*** **2014**, *26*, 2777.
  4. K. Kawamura, D. Hikosou, A. Inui, K. Yamamoto, J. Yagi, S. Saita, H. Kawasaki, ***J. Phys. Chem. C*** **2019**, *123*, 26644.
  5. T. Kawawaki, Y. Negishi, H. Kawasaki, ***Nanoscale Adv.*** **2020**, *2*, 17 (a review article).

- **Awards**

  2003 Younger Researcher Awards (Division of Colloid and Surface Chemistry, Chemical Society of Japan)

  2011 Younger Researcher Awards (Mass Spectrometry Society of Japan)

Bhagavatula L V Prasad

Director

Centre for Nano and Soft Matter Sciences (*CeNS*)

And

Senior Principal Scientist Physical/Materials Chemistry Division,

National Chemical Laboratory (CSIR-NCL)

Dr. Homi Bhabha Road

Pune 411008 India

e-mail: pl.bhagavatula@cens.res.in, pl.bhagavatula@ncl.res.in

URL: https://www.cens.res.in/en/faculty/blv-prasad/profile,

https://academic.ncl.res.in/ncl_1/pl.bhagavatula/home

Bhagavatula L. V. Prasad has recently been appointed as the Director of Centre for Nano and Soft Matter Sciences, Bengaluru. He also holds the position of Senior Principal Scientist in the Physical/Materials Chemistry Division of National Chemical Laboratory (CSIR-NCL), Pune, India. He obtained a Master of Science and PhD degrees in Chemistry from School of Chemistry, University of Hyderabad. After two post-doctoral stints; one at Tokyo Institute of Technology (2 years JSPS fellowship and 1 year Research Associate ship) and second at Kansas State University (KSU; 2.5 years -NASA sponsored project); he joined NCL in 2003. His group is actively working in the general area of material synthesis and in particular nanoparticles and nanoscale materials. He has published more than 125 papers in international peer reviewed journals and has 8 international patents to his credit. He was invited as visiting professor by different universities in many countries, including Japan, USA, UK, France and Germany. 18 students have completed PhD under his supervision and another 6 are pursuing their PhD currently.

Major Awards and Recognitions

MRSI-ICSC Materials Science Annual Prize for 2020; Elected as Fellow of the Andhra Pradesh Akademy of Sciences, 2017; Admitted as Fellow of Royal Society of Chemistry (FRSC), London, 2016; Elected as Fellow of the Indian Academy of Sciences, Bangalore, 2014; Young Career Award-DST Nanomission, 2013; Chemical Research Society of India, Bronze Medal, 2013; CSIR-RAMAN Fellowship 2012; Materials Research Society of India medal 2012; Scientist of the year, NCL Research Foundation January 2009.

Hitoshi Ube

Assistant Professor

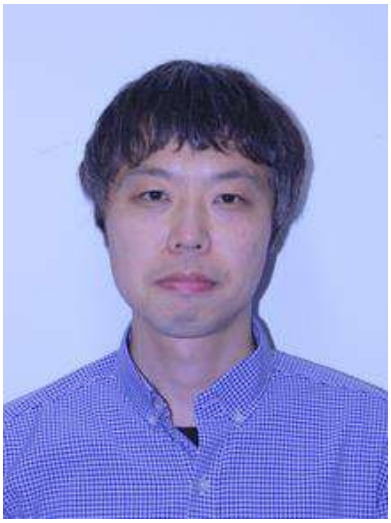
Department of Chemistry

The University of Tokyo

Tokyo 113-0033, Japan, Phone: +81-3-5841-4360

e-mail: ube@chem.s.u-tokyo.ac.jp

URL: http://www.chem.s.u-tokyo.ac.jp/users/bioinorg/index.html



- **Academic Records**

  2003; Tohoku University (B.S.)

  2005; Tohoku University (M.S.)

  2008; Tohoku University (Ph.D)

- **Professional Career**

  2008~Present Assistant Professor, The University of Tokyo

  2007~2008 Research Fellowship for Young Scientist (DC2)

- **Research Interests**

  1. Arrangement of atoms or molecules with well-defined nano-sized scaffolds
  2. NHC-protected, carbon-centered gold clusters
  3. Development of Chira-at-Metal complexes and their catalytic applications
  4. Syntheses of heterometallic supramolecular complexes

- **Publications**

  1. H. Ube, Q. Zhang, M. Shionoya, ***Organometallics*** **2018**, *31*, 2007.
  2. H. Ube, K. Endo, H. Sato, M. Shinoya, ***J. Am. Chem. Soc.*** **2019**, *141*, 19342.
  3. Z. Lei, K. Nagata, H. Ube, M. Shinoya, ***J. Organomet. Chem.*** **2020**, *917*, 121271.
  4. K. Endo, Y. Liu, H. Ube, K. Nagata, M. Shionoya, ***Nat. Commun.*** **2020**, *11*, 6263.
  5. Z. Lei, X.-L. Pei, H. Ube, M. Shionoya, ***Bull. Chem. Soc. Jpn.*** **2021**, *94*, 1324. (Backcover picture)

- **Awards**

  2008 Aoba Society for the Promotion of Science Award (Aoba Society for the Promotion of Science)

Kuruvilla Joseph

Outstanding Professor and Dean (SA, SW and OR)

Department of Chemistry

Indian Institute of Space Science and Technology (IIST)

Valiyamala P.O., Thiruvananthapuram,

Kerala, India 695022

e-mail: kuruvilla@iist.ac.in, kjoseph.iist@gmail.com

URL: www.iist.ac.in

- **Academic records**

  1985: Kerala University, Thiruvananthapuram (B.Sc.)

  1987 : Mahatma Gandhi University, Kottayam (M.Sc.)

  1993: Mahatma Gandhi University, Kottayam (Ph.D)

- **Professional Career**

  1993: Lecturer, St. Berchmans' College Kerala, India

  1994: Faculty Member, St. Berchmans' College, Kerala, India

  1998 - 1999 : Postdoctoral fellow, Federal University of Paraiba, Brazil

  2001 : Postdoctoral fellow, Swedish Institute of Composites (SICOMP), Sweden

  2007 – 2014 : Professor and Head, Department of Chemistry, IIST, TVM

  2014 – 2020 : Senior Professor and Dean (SA, SW and OR), IIST, TVM

  2020 – present: Outstanding Professor and Dean (SA, SW and OR), IIST, TVM

- **Publications**

1. MS Mathew, K Vinod, PS Jayaram, RS Jayasree, K Joseph, Improved bioavailability of curcumin in gliadin-protected gold quantum cluster for targeted delivery, ACS omega 4 (10), 14169-14178, 2019
2. MS Mathew, K Sukumaran, K Joseph, Graphene Carbon Dot Assisted Sustainable Synthesis of Gold Quantum Cluster for Bio-Friendly White Light Emitting Material and Ratiometric Sensing of Mercury (Hg2+), ChemistrySelect 3 (33), 9545-9554, 2018
3. MS Mathew, J Davis, K Joseph, Green synthesis of a plant-derived protein protected copper quantumcluster for intrauterine device application, Analyst 143 (16), 3841-3849, 2018
4. MS Mathew, K Joseph, Green synthesis of gluten-stabilized fluorescent gold quantum clusters: Applicationas turn-on sensing of human blood creatinine, ACS Sustainable Chemistry & Engineering 5 (6), 4837-4845, 2017
5. MS Mathew, A Baksi, T Pradeep, K Joseph, Choline-induced selective fluorescence quenching of acetylcholinesterase conjugated Au@ BSA clusters, Biosensors and Bioelectronics 81, 68-74, 2016

- **Awards**

1993 The Young Scientist Award, Govt of Kerala

1995 The Mathias Award, All India Association of Christian Higher Education

2000 The Young Scientist Award, Indian Science Congress Association, New Delhi

2000 Prof. Sivaprasad Award, Sivaprasad Foundation, Kollam

2019 Fellow of Royal Society of Chemistry (FRSC)

Seiji Yamazoe

Professor

Department of Chemistry

Tokyo Metropolitan University

Tokyo 192-0397, Japan, Phone: +81-42-677-2553

e-mail: yamazoe@tmu.ac.jp

URL: https://www.comp.tmu.ac.jp/yamazoelab/

- **Academic Records**

  2003; Kyoto University (B.S.)

  2005; Kyoto University (M.S.)

  2008; Kyoto University (Ph.D)

- **Professional Career**

  2007 Research Fellowship for Young Scientists of JSPS

  2008~2012 Assistant Professor, Ryukoku University

  2012~2017 Assistant Professor, The University of Tokyo

  2017~present Professor, Tokyo Metropolitan University

- **Research Interests**

  1. Precise synthesis and catalytic application of metal/metal oxide clusters
  2. Development of multi-functional catalysts using complex metal oxides
  3. Electronic and geometric structural studies of functional materials using X-ray absorption spectroscopy

- **Publications**

  1. T. Matsuyama, S. Kikkawa, Y. Fujiki, M. Tsukada, H. Takaya, N. Yasuda, K. Nitta, N. Nakatani, Y. Negishi, S. Yamazoe, ***J. Chem. Phys.***, **155**, 044307 (2021).
  2. T. Matsuyama, J. Hirayama, Y. Fujiki, S. Kikkawa, W. Kurashige, H. Asakura, N. Kawamura, Y. Negishi, N. Nakatani, K. Hatada, F. Ota, S. Yamazoe, ***J. Phys. Chem. C***, **125**, 3143-3149 (2021).
  3. S. Yamazoe, T. Tsukuda, ***Bull. Chem. Soc. Jpn.***, **92**, 193-204 (2019).
  4. S. Yamazoe, T. Yoskamtorn, S. Takano, S. Yadnum, J. Limtrakul, and T. Tsukuda, ***Chem. Rec.***, **16**, 2338-2348 (2016).
  5. S. Yamazoe, S. Takano, W. Kurashige, T. Yokoyama, K. Nitta, Y. Negishi, and T. Tsukuda, ***Nat. Commun.***, **7**, 10414 (2016).

- **Awards**

  2016 Nanoscale Horizons Award (The Society of Nano Science and Technology, RSC)

Vivek Polshettiwar

Associate Professor
Department of Chemical Sciences
Tata Institute of Fundamental Research (TIFR),
Homi Bhabha Road,
Mumbai 400005, India

e-mail: vivekpol@tifr.res.in
URL: http://www.nanocat.co.in

- **Academic records**
  1999 : Amravati University, India (B.Sc.)
  2001 : Amravati University, India (M.Sc.)
  2005: DRDE & Jiwaji University, India (Ph.D)
- **Professional Career**
  2005 – 2006 : Postdoc Researcher, ENSCM, Montpellier (France)
  2006 – 2007 : Research Scientist, Jubilant Chemsys, Noida (India)
  2007 – 2009 : Research Associate, US-EPA, Cincinnati (USA)
  2009 – 2013 : Assistant Professor/Senior Scientist, KAUST (KSA)
  2013 – 2017 : Reader, Tata Institute of Fundamental Research, Mumbai
  2017 – present: Associate Professor, Tata Institute of Fundamental Research, Mumbai
- **Research Interests**

  1. Nanocatalysis for Carbon Capture & Utilization and Solar Energy Harvesting

- **Publications**

  1. Polshettiwar* et al. *Chemical Science* **2021**, *12*, 5744-5786.
  2. Polshettiwar* et al. *Proc. Natl. Acad. Sci. U.S.A* **2020**, *117*, 6383-6390.
  3. Polshettiwar* et al. *Nature Communications*, **2020**, *11*, 3828.
  4. Polshettiwar* et al. *Chemical Science*, **2019**, *10*, 6594-6603.
  5. Polshettiwar* et al. *Nature Protocol*, **2019**, *14*, 2177-2204.

  over **121** peer reviewed articles with H-index of **55** (Total Citation Number**: ~13431**).

- **Awards**

  2021 Elected as a Fellow National Academy of Sciences, India (NASI)

  2020 Young Career Award in Nano Science & Technology by Nano Mission

  2019 Materials Research Society of India (MRSI) Medal

  2017 Chemical Research Society of India (CRSI) Bronze Medal

Sayan Bhattacharyya

Professor

Department of Chemical Sciences

Indian Institute of Science Education & Reseach (IISER),

Kolkata

Mohanpur 741246, India

e-mail: sayanb@iiserkol.ac.in

URL: http://www.iiserkol.ac.in/~sayanb

- **Academic records**

  1996 : University of Calcutta (B.S.)

  1998 : University of Kalyani (M.S.)

  2005: Indian Institute of Technology (IIT) Kanpur (Ph.D)

- **Professional Career**

  2006 – 2008 : Postdoctoral Fellow, Bar-Ilan University, Israel

  2008 – 2010 : Postdoctoral Researcher, Drexel Nanotechnology Institute, USA

  2010 – 2015 : Assistant Professor, IISER Kolkata

  2015 – 2019 : Associate Professor, IISER Kolkata

  2016 – 2020 : Founder Chair, Centre for Adv. Funct. Mater., IISER Kolkata

  2019 – present: Professor, IISER Kolkata

- **Research Interests**

  1. Photovoltaics and optoelectronics with metal-halide perovskite nanostructures;
  2. Electrochemical hydrogen fuel and CO_2 reduction;
  3. Metal-air battery;
  4. Photorechargeable battery

- **Publications**

  1. R. Majee, A. Kumar, T. Das, S. Chakraborty, S. Bhattacharyya, *Angew. Chem. Int. Ed*. **2020**, *59*, 2881-2889.
  2. S. Parvin, A. Kumar, A. Ghosh, S. Bhattacharyya, *Chem. Sci*. **2020**, *11*, 3893-3902.
  3. R. Majee, Q. A. Islam, S. Mondal, S. Bhattacharyya, *Chem. Sci*. **2020**, *11*, 10180-10189.
  4. D. Ghosh, D. K. Chaudhary, Md. Y. Ali, K. K. Chauhan, S. Prodhan, S. Bhattacharya, B. Ghosh, P. K. Datta, S. C. Ray, S. Bhattacharyya, *Chem. Sci*. **2019**, *10*, 9530-9541.
  5. A. Sahasrabudhe, H. Dixit, R. Majee, S. Bhattacharyya, *Nat. Commun*. **2018**, *9*, 2014.

- **Awards**

  2017 Emerging Investigator, J. Mater. Chem. A

  2020 Life Fellow, Indian Chemical Society

Sayani Mukherjee

Senior Research Fellow,

School of Chemistry

Indian Institute of Science Education and Research Thiruvananthapuram

Kerala- 695551, India, Phone: +91-4712778096

e-mail: smukh.chem18@iisertvm.ac.in

- **Academic Records**

  Integrated bachelors and masters: National Institute of Science Education and Research Bhubaneswar, India.

  Current: Indian Institute of Science Education and Research Thiruvananthapuram, India (Fourth year graduate student).

- **Research Interests**

  1. Synthesis of atomically precise gold, copper and alloy nanoclusters
  2. Exploring catalytic activities of metal nanoclusters
  3. Developing of novel ligands for synthesizing diverse nanoclusters

- **Publications**

  1. Das, S. Mukherjee, Sreehari S.R., A. S. Nair, S. Bhandary, D. Chopra, D. Sanyal, B. Pathak, S. Mandal ***ACS Nano.,*** **2020**, *14*, 16681-16688.
  2. S. Mukherjee, D. Jayakumar, S. Mandal, ***J. Phys. Chem. C,*** **2021**, *125*, 12149-12154.

- **Awards**

  2020 Best presentation award, IISER Thiruvananthapuram

Emi Ito

Masters' student

Department of Chemistry

The University of Tokyo

Tokyo 113-0033, Japan

Phone: +81-3-5841-4363

e-mail: e.ito@chem.su-tokyo.ac.jp

URL: https://www.chem.s.u-tokyo.ac.jp/users/chemreact/member/member_e_ito-e.html

- **Research Interests**
  1. Atomically-Precise Synthesis of Thiolate-Protected, Anisotropic Gold Clusters via Inter-Cluster Reactions

- **Publications**
  - Emi Ito, Shinjiro Takano, * Toshikazu Nakamura and Tatsuya Tsukuda *Angew. Chem., Int. Ed., 2021, 60 , 645-649.

Arijit Jana

Ph.D. student

Department of Chemistry

Indian Institute of Technology Madras

Chennai 600036, India, Phone: +91 8392425166

e-mail: arijit1995jana@gmail.com

URL: https://scholar.google.de/citations?user=o1N84moAAAAJ&hl=en

- **Academic Records**

  2015; Ramakrishna Mission Vidyamandira, University of Calcutta (B.Sc.)

  2017; Indian Institute of Technology Madras (M.Sc.)

  2017; Indian Institute of Technology Madras (Ph.D. pursuing)

- **Research Interests**

  1. Synthesis and structural determination of metal clusters protected by carboranes.
  2. Fabrication of cluster assembled nano-film using electrospray deposition.
  3. Boron and carborane based phosphorescence, and X-ray radioluminescence materials

- **Publications**

  1. A. Jana, M. Jash, A. K. Poonia, G. Paramasivam, Md R. Islam, P. Chakraborty, S. Antharjanam, J. Machacek, S. Ghosh, K. V. Adarsh, T. Base, T. Pradeep, ***ACS Nano,* 2021** (under revision).
  2. A. Jana, P. Chakraborty, W. A. Dar, S. Chandra, E. Khatun, M.P. Kannan, R. H.A. Ras, T. Pradeep, ***Chem. Commun.*, 2020**, 56, 12550-12553.
  3. A. Jana, S. K. Jana, D. Sarkar, T. Ahuja, P. Basuri, B. Mondal, S. Bose, J. Ghosh, T. Pradeep, ***J. Mater. Chem. A*, 2019**, 7, 6387–6394.

- **Awards**

  2017 Prof. Ramamurthy Endowment prize for Best M. Sc. Dissertation (IIT Madras).

Available Abstracts

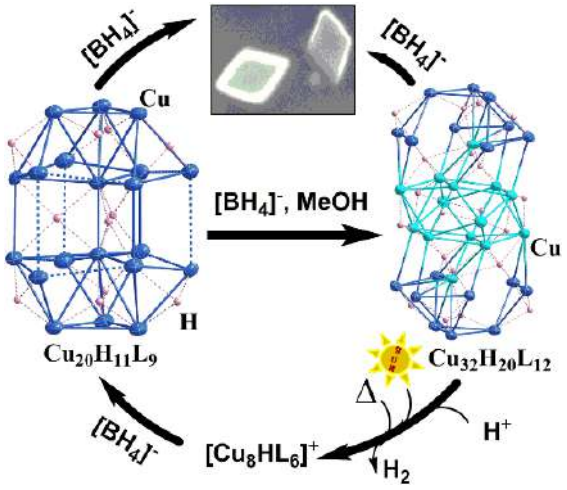
Dichalcogenide Stabilize Coinage Nanoclusters: Synthesis, Characterization, and HER Study

Rajendra Singh Dhayal

Department of Chemistry, School of Basic Sciences,

Central University of Punjab, Bathinda-151001, Punjab

Dichalcogen (S/Se) ligands display an efficient role to isolate polyhydrido copper clusters like $[Cu_{28}H_{11}\{S_2CN^iPr_2\}12]^+$, $[Cu_{20}H_{11}\{S_2P(O^iPr)_2\}_9]$, $[Cu_{20}H_{11}\{Se_2P(O^iPr)_2\}_9]$, $[Cu_{32}H_{20}\{S_2P(O^iPr)_2\}_{12}]$ etc. Exhibits an intrinsically chiral inorganic core of C_3 symmetry was synthesised from achiral $[Cu_{20}H_{11}\{S_2P(O^iPr)_2\}_9]$ of C_{3h} symmetry by a ligand-exchange method. On The other hand, synthesis and structural determination of a silver nanocluster $[Ag_{20}\{S_2P(O^iPr)_2\}_{12}]$, which contains an intrinsic chiral metallic core, is produced by reduction of one silver ion from the eight-electron superatom complex $[Ag_{21}\{S_2P(O^iPr)_2\}_{12}](PF_6)$ by borohydrides. A variety of techniques [^1H, ^2H, ^{31}P NMR, elemental analysis, ESI-MS, EDS and single-crystal X-ray (or neutron) diffraction] were used for investigations and reveals the presence of both capping and interstitial hydrides within copper core. Fascinatingly, copper hydrides were also release H_2 under solar energy, mild thermolysis and acidifications and finally converted into rhombus shaped copper nanoparticles.



References.

1. Dhayal, R. S.; Liao, J.−H.; Wang, X.; Liu, Y.-C.; Kahlal, S.; Saillard, J.-Y.; Liu, C. W. *Angew. Chem. Int. Ed*., **2015**, *54*, 13604.

2 Dhayal, R. S.; Liao, J.−H.; Wang, X.; Liu, Y.-C.; Kahlal, S.; Saillard, J.-Y.; Liu, C. W. Angew. Chem. Int. Ed. 2015, 54, 3702.

3. Dhayal, R. S.; Zyl, van W. E.; Liu, C. W. *Acc. Chem., Res.* **2016**, *49*, 86.

4. Dhayal, R. S.; Liao, J.−H.; Chiang, M.-H.; Kahlal, S.; Saillard, J.-Y., Liu, C. W. *ChemistrySelect* ***2018***, *3, 3603-3610*.

5. Khirid, S.; Biswas, R.; Meena, S.; Patil, R. A.; Ma, Y.-R.; Dhayal, R S.; Haldar, K. K. *ChemistrySelect* **2020**, *5*, 10593.

Fluorescent Atomic Clusters: From Biomarkers to Energy Materials

Pradipta Purkayastha*
Department of Chemical Sciences and Centre for Advanced Functional Materials, Indian Institute of Science Education and Research (IISER) Kolkata, Mohanpur 741246, India
Email address of presenting author: ppurkayastha@iiserkol.ac.in

This talk will elaborate some concepts encompassing biomarking to energy harvesting using fluorescence spectroscopy as a tool. Unique pH-sensitive non-cytotoxic gold nanoclusters (AuNCs) can precisely detect sharp change in biological pH. Dihydrolipoic acid incorporated in γ-cyclodextrins (γ-CDs) coated Au NCs serve the purpose.[1,2] Change in the pH of the microenvironment results into expulsion of the γ-CDs to induce a discrete spectral shift. This method could successfully detect cancer cells with high precision.[1] Suitable logic devices could be designed based on the chemical input and the optical output.[2] In addition to the capability of the metal clusters as biomarkers, these can be very efficiently used as energy materials. Protein-protected red emitting Au NCs enhance the metallic character in single-walled carbon nanotubes (SWCNTs) by PET.[3] Non-functionalized SWCNTs facilitate PET while carboxyl-functionalized ones defer the phenomenon, which, in turn, affects their metallic character. Glutathione-coated AuNCs (GSH-AuNCs) are PET facilitators and used as photosenstizers in photocatalysis, radiotherapy, tomography imaging, etc. It was found that attachment of GSH-AuNCs with lipid vesicles having differently charged head groups is very essential in deciding the extent of PET.[4] Instability of copper nanoclusters (CuNCs) due to aerial oxidation could be substantially reduced by preparing them inside reverse micelles (RMs) which made them useful PET materials.[5] Moreover, PET with the RM-protected CuNCs could be controlled by tuning the aqueous pool of the RMs. To make the metal clusters efficient as energy donors in FRET, the protecting ligands could be rigidified with arginine to substantially enhance the fluorescence quantum yield.[6] Knowing the importance of the metal clusters, hybrid materials could be synthesized with perovskites to broaden their applications. Two-dimensional (2D) perovskite nanosheets could be converted into nanoplatelets by controlling the interaction of ligand or surfactant with three dimensional (3D) $CsPbBr_3$ nanocubes. Surfactant molecules could be grouped together on the surface of AuNCs to bind the 2D nanosheets producing AuNC-embedded massive platelets.[7]

References:

1. T. Das, D. K. Poria, P. Purkayastha, *Nanomedicine* 12, 1105-1112 (2016).
2. A. Mallick, T. Das, P. Purkayastha, *Mater. Lett.* 286, 129262 (2021).
3. T. Das, A. Maity, S. Mondal, P. Purkayastha, *Spectrochim. Acta A* 141, 144-148 (2015).
4. A. Chatterjee, P. Purkayastha, *Mater. Adv.* 2, 1343-1350 (2021).
5. S. Bhunia, M. Mukherjee, P. Purkayastha, *Langmuir* 37, 3500–3507 (2021).
6. S. Bhunia, K. Gangopadhyay, A. Ghosh, S. K. Seth, R. Das, P. Purkayastha, *ACS Appl. Nanomater.* 4, 305-312 (2021).
7. S. Bhunia, P. Purkayastha, *Mater. Lett.* 253, 109-112 (2019).

Breaking conventions in nanocluster catalysis by tuning atomicity specific properties

Biswarup Pathak*

Department of Chemistry, Indian Institute of Technology, Indore, India

Email address of presenting author: biswarup@iiti.ac.in

Nanoclusters feature versatile properties such as high surface area, unique structure activity relationships and reduced material utilization which mark them as important catalyst materials.[1,2] Many of the conventional principles determining the size vs. activity correlation and intermediate binding strength in nanocluster catalysis have been designed based on higher sized nanoclusters.[3] However, recent theoretical studies suggest unexpected catalytic activity trends can be achieved by taking account of atomicity specific properties of subnanometer clusters.[4] A detailed structural scanning revealed significant catalytic activity differences can be achieved by changing a single atom underlining the 'each atom counts' principle of nanoclusters.[5] The high fluxionality associated with nanoclusters can be expected to derive novel symmetry driven guidelines, surface structure activity relationships and unique kinetics.[6] By theoretically exploring the fundamental electronic structure and analysing the external factors, efficient guidelines for understanding and enhancing the nanocluster catalytic activity could be developed. The talk will involve a discussion on some of the recent studies unravelling the role of atomicity, relativistic effects and approaches to regulate the activity of platinum-based nanoclusters for oxygen reduction reaction (ORR) by our research team.

References:

1. E. Roduner, *Chem. Soc. Rev*. 35, 35583–592 (2006).
2. A. Sanchez et al. *J. Phys. Chem. A* 103, 9573–9578 (1999).
3. G. A Tritsaris, J. Greeley, J. Rossmeisl, J. K. Nørskov, *Catal Lett.* 141, 909–913 (2011).
4. A. S. Nair, B. Pathak, *Wiley Interdiscip. Rev. Comput. Mol. Sci.* 1508, 1-19 (2021).
5. A. S. Nair, A. Anoop, R. Ahuja, B. Pathak, *J. Comput. Chem.* 1, 1–15 (2021)
6. Z. Zhang, B. Zandkarimi, A. N. Alexandrova, *Acc. Chem. Res*. 53, 447–458 (2020).

Biological Applications of Metal Nanoclusters

Venkatesh V
Department of Chemistry, Indian Institute of Technology Roorkee, Roorkee – 247667, India
Email: venkatesh.v@cy.iitr.ac.in

Luminescent metal nanoclusters (NCs) have emerged as an interesting class of materials with wide range of applications in materials, catalysis, sensing and biology, to name a few.[1-3] Among the metal nanoclusters, copper nanoclusters (CuNCs) attracted a great deal of interest due to their low cost and the higher earth abundance of the precursor (copper salt). However, the major limitation associated with the design of stable CuNCs is that they undergo facile oxidation because of their low redox potential ($E° = +0.34$ V). Recently, the aggregation induced emission (AIE) CuNCs are reported to exhibit bright luminescent property and high stability. In this context, we have designed highly stable AIE CuNCs and studied the effect of substituent on the ligand in the cluster formation. The substituents on the ligand play critical role in deciding self-assembly, and photophysical properties of CuNCs.[4] The self-assembled CuNCs show good biocompatibility and it has been studied for bioimaging applications. In another study, we have designed biocompatible pyrimidine capped CuNCs and studied their enzyme mimetic activity. They exhibit superoxide dismutase (SOD) mimetic and nitric oxide (NO) releasing capability.[5]

References:

1) K. Kwak and D. Lee, "Electrochemistry of Atomically Precise Metal Nanoclusters" *Acc. Chem. Res*. **2019**, *52*, 12−22.

2) X. Du and R. Jin, "Atomically Precise Metal Nanoclusters for Catalysis" *ACS Nano* **2019**, *13*, 7383−7387.

3) V. Venkatesh, A. Shukla, S. Sivakumar, and S. Verma. "Purine-Stabilized Green Fluorescent Gold Nanoclusters for Cell Nuclei Imaging Applications*." ACS Appl.Mater.Interfaces.* **2014,** *6***,** 2185–2191.

4) K. T Prakash, N. Singh, and V. Venkatesh, "Synthesis of novel luminescent copper nanoclusters with substituent driven self-assembly and aggregation induced emission (AIE)" *Chem. Comm*., **2019**, *55*, 322−325.

5) N. Singh, K. P. Raul, A. Poulose, G. Mugesh, and V. Venkatesh, "Highly Stable Pyrimidine Based Luminescent Copper Nanoclusters with Superoxide Dismutase Mimetic and Nitric Oxide Releasing Activity" *ACS Appl. Bio Mater*., **2020**, *3*, 7454−7461.

Role of Ligands in Luminescent Metal Nanoclusters

Saptarshi Mukherjee

Department of Chemistry, Indian Institute of Science Education and Research Bhopal
Bhopal Bypass Road, Bhauri, Bhopal 462 066, Madhya Pradesh, INDIA

Email: saptarshi@iiserb.ac.in

Owing to their plethora of applications in interdisciplinary research fields, nanoclusters (NCs) formed by noble metals (Ag, Au and Cu) are considered as the next-generation fluorophores.[1-4] There is a huge variety of ligands (from macromolecules to small molecules) that have been used for the preparation of NCs.[4] However, the formation of NCs using small molecules is still a challenging task compared to macromolecules. In my talk, I shall be discussing the role played by ligands in the development of metal NCs. Over the years, we have used various kinds of ligands such as protein (Human Serum Albumin, HSA), tripeptide (Reduced Glutathione, GSH), small molecule (Tyrosine, Tyr) etc.[5-9] AgNCs have been shown to toggle between two different compositions (Ag_9:HSA and Ag_{14}:HSA) using simple redox chemistry and CuNCs can serve as a nanothermomemter.[5,6] We have also prepared CuNCs using GSH as a capping agent.[7] These CuNCs acted as a biomarker for cancerous cells and also selectively detected Fe^{3+} ions.[7] We have established that tyrosine amino acid can serve as a template to prepare NCs outside a protein environment.[8,9] Using experimental as well as theoretical measurements, we have established that Tyr is responsible for the formation of CuNCs along with by rapid formation of fibrillar-like patterns of Tyr followed by time-dependent destruction by CuNCs.[8] We have also reported the formation of silver nanoparticles (AgNPs) and AgNCs mixture system using Tyr as a capping agent.[9] These AgNCs were actually responsible for the luminescence properties whereas AgNPs exhibited excellent antimicrobial properties (against both the fungal and bacterial system including pathogenic strains) through reactive oxygen species (ROS) generation inside the cell lines.[9]

References:

1. I. Chakraborty, T. Pradeep, *Nanoscale* 6, 14190-14194 (2014).
2. K. Zheng, J. Xie, *Trends Chem.* 2, 665-679 (2020).
3. S. Ghosh, U. Anand, S. Mukherjee, *Anal. Chem.* 86, 3188-3194 (2014).
4. K. Bhattacharyya, S. Mukherjee, *Bull. Chem. Soc. Jpn.* 91, 447-454 (2017).
5. U. Anand, S. Ghosh, S. Mukherjee, *J. Phys. Chem. Lett.* 3, 3605-3609 (2012).
6. S. Ghosh, N. K. Das, U. Anand, S. Mukherjee, *J. Phys. Chem. Lett.* 6, 1293-1298 (2015).
7. N. K. Das, S. Ghosh, A. Priya, S. Datta, S. Mukherjee, *J. Phys. Chem. C* 119, 24657-24664 (2015).
8. S. Chakraborty, S. Mukherjee, *J. Phys. Chem. Lett.* 12, 3266-327 (2021).
9. S. Chakraborty, P. Sagarika, S. Rai, C. Sahi, S. Mukherjee, *ACS Appl. Mater. Interfaces* 13, 36938-36947 (2021).

Molecular interactions-driven multifunctional bioprobes: deciphering the supramolecular self-assembly

Subhankar Kundu, Bahadur Sk, A. Patra*

Department of Chemistry, Indian Institute of Science Education and Research Bhopal, Bhopal Bypass Road, Bhauri, Bhopal, India, 462066

abhijit@iiserb.ac.in

The development of new functional molecules and materials with pre-defined properties employing simple chemical methods is significant both from fundamental and application perspectives. In this context, multifunctional sensors capable of selective and sensitive detection of chemicals and biological species in complex environments are of increasing interest.[1] Our earlier study established a biologically important heterocycle, pyrido[1,2-*a*]indole (PI), as a new class of fluorophore with promising applications in intracellular imaging.[2a] To augment the fluorescence properties of PI in the solid-state, we coupled it with tetraphenylethylene (TE), leading to a C-C coupled molecule, PITE2, exhibiting strong emission in the solution, nanoparticle, and solid state. The presence of four propyl groups and multiple phenyl rings make PITE2 substantially hydrophobic and turned out to be a lipid droplet (LD) targeting bioprobe in multiple cell lines (Fig. 1).[2b] A brief appraisal of multifunctional applications of PI-based molecular probes and triaminoguanidinium-based chemosensors,[3] will be presented. In addition, the correlation between the shape and size (solid-state characterization) and the emission behaviour (dispersion-state analysis) of the molecular aggregates will be elucidated through the spectroscopic and microscopic analysis of nanofiber evolution from a true solution of a thiophene-based acceptor-π-donor-π-acceptor molecule (TPAn).[4]

References:

1. J. Mei, N. L. C. Leung, R. T. K. Kwok, J. W. Y. Lam and B. Z. Tang, *Chem. Rev.* 2015, 115, 11718; (b) D. Wu, A. C. Sedgwick, T. Gunnlaugsson, E. U. Akkaya, J. Yoon and T. D. James, *Chem. Soc. Rev.* 2017, 46, 7105.
2. (a) S. Samala et al. *Chem. Eur. J.* 2014, 20, 14344; (b) B. Sk, P. K. Thakre, R. S. Tomar and A. Patra, *Chem. Asian J.* 2017, 12, 2501.
3. (a) V. Kumar, Bahadur, Sk, S. Kundu, A. Patra, *J. Mater. Chem. C* 2018, 6, 12086; (b) P. Pallavi, V. Kumar, M. W. Hussain, A. Patra, *ACS Appl. Mater. Interfaces* 2018, 10, 44696; (c) M. W. Hussain, V. Bhardwaj, A. Giri, A. Chande, A. Patra, *Chem. Sci.* 2020, *11*, 7910.
4. S. Kundu, A. Chowdhury, S. Nandi, K. Bhattacharyya, A. Patra, *Chem. Sci.* 2021,12, 5874.

Nanoparticles are molecules

T. Pradeep

Indian Institute of Technology Madras, Chennai, 600 036, India

E-mail address: pradeep@iitm.ac.in

https://pradeepresearch.org

Research in the recent past has resulted in a large number of nanoparticles whose properties depend on the number and spatial arrangement of their constituent atoms. This distinct atom-dependence of properties is particularly noticeable in ligand protected atomically precise clusters of noble metals. They behave indeed like molecules as revealed most elegantly by mass spectrometry. They show unusual properties such as luminescence in the visible and near-infrared regions. Their molecule-like behavior is shown distinctly by atom and structure conserving chemical reactions between them. Several clusters, which are archetypal nanoparticles, $Ag_{25}(SR)_{18}$ and $Au_{25}(SR)_{18}$ (-SR = alkyl/aryl thiolate) have been used for such reactions. Despite their geometric robustness and electronic stability, reactions between them in solution at room temperature produce alloys $Ag_mAu_n(SR)_{18}$ (m+n = 25), keeping their $M_{25}(SR)_{18}$ composition, structure and topology intact. We captured one of the earliest events of the process, namely the formation of the dianionic adduct, $[Ag_{25}Au_{25}(SR)_{36}]^{2-}$, by electrospray ionization mass spectrometry.

Exploring this science further, we have studied rapid solution state exchange dynamics in nanoscale pieces of matter, taking isotopically pure atomically precise clusters as examples. As two isotopically pure silver clusters made of ^{107}Ag and ^{109}Ag are mixed, an isotopically mixed cluster of the same entity is formed, similar to the formation of HDO, from H_2O and D_2O. This spontaneous process is driven by the entropy of mixing and involves events at multiple timescales. These days, this science has been extended further to make tri- and tetra-atomic alloys. This process happens even with plasmonic nanoparticles.

Key references

K. R. Krishnadas, A. Ghosh, A.Baksi, I. Chakraborty, G. Natarajan and T. Pradeep, *J. Am. Chem. Soc.* **2016**, *138*, 140.

K. R. Krishnadas, A. Baksi, A. Ghosh, G. Natarajan, T. Pradeep, *Nat. Commun.* **2016**, *7,* 13447.

K. R. Krishnadas, A. Baksi, A. Ghosh, G. Natarajan, A. Som, T. Pradeep, *Acc. Chem. Res.* **2017**, *50*, 1988.

P. Chakraborty, A. Nag, G. Natarajan, N. Bandyopadhyay, G. Paramasivam, M. K. Panwar, J. Chakrabarti and T. Pradeep, *Science Advances* **2018**, *5*, aau7555.

P. Chakraborty, A. Nag, A. Chakraborty and T. Pradeep, *Acc. Chem. Res.* **2019**, *52*, 2.

P. Bose, P. Chakraborty, J. Mohanty, Nonappa, A. R. Chowdhuri, E. Khatun, T. Ahuja, A. Mahendranath and T. Pradeep, *Nanoscale* **2020**, *12*, 22116.

E. Khatun, P. Chakraborty, B. Jacob, G. Paramasivam, M. Bodiuzzaman, W. Dar, and T. Pradeep, *Chem. Mater.* **2020**, *32*, 611.

Cluster and Cluster-Assemblies: Transformation Chemistry and Opto-Electrical Properties

Sukhendu Mandal[1]*

[1]*School of Chemistry, Indian Institute of Science Education and Research Thiruvananthapuram, Kerala India*
Email address of presenting author: sukhendu@iisertvm.ac.in

Atom precise nanoclusters are admired by the researchers in nanoscience because of their unique physico-chemical properties caused by quantum confinement effect and specific structural architecture.[1] The physio-chemical properties of these nanoclusters can be modulated by changing the composition, size, morphology and structure, etc. In this circumstances, transformation chemistry has served as a versatile approach for the conversion of one cluster to another that is often triggered by ligand exchange, thermal heating, etc.[2] Gold cluster with 8 valence electrons has been found as a stable kernel in different ligand-protected gold clusters, including $[Au_{23}(SCy)_{16}]^-$ and $[Au_{25}(PET)_{18}]^-$.[3, 4] The cuboctahedron core of Au_{23} can be transformed to icosahedron or other FCC-based core by ligand exchange method. These results suggest that one can transformed one stable cluster to another by ligand exchange.

Cluster-assembled materials provide the concept of producing materials with tailored properties with cluster as building unit. It is interesting to synthesize cluster-assembled materials with Ag nanocluster as building unit that will stabilize the Ag in lower oxidation state and render high efficiency in luminescence and other opto-electronic properties.[5]

The talk will cover the following topics: (1) Mechanism of ligand exchange with different variation of ligands, (2) Two-dimensional Ag_{12} based cluster-assembled material: exfoliation into single later, opto-electronic properties,[6] (3) Ag_{14} based cluster-0assembled material: photoluminescence and photoacoustic imaging.[7]

References:

1. I. Chakraborty and T. Pradeep, *Chem. Rev*., **2017**, *117*, 8208-8271.
2. X. Kang and M. Zhu, *Chem. Mater.*, **2019**, *31*, 9939-9969.
3. M. P. Maman, A. S. Nair, H. Cheraparambil, B. Pathak and S. Mandal, *J. Phys. Chem. Lett.*, **2020**, *11*, 1781-1788.
4. M. P. Maman, A. S. Nair, A. M. Abdul Hakkim Nazeeja, B. Pathak and S. Mandal, J. *Phys. Chem. Lett.*, **2020**, *11*, 10052-10059.
5. A. Ebina, S. Hossain, H. Horihata, S. Ozaki, S. Kato, T. Kawawaki and Y. Negishi, *Nanomater*, **2020**, *10*, 1105.
6. S. Biswas, A. K. Das, S. Mandal, manuscript under preparation.
7. A. K. Das, S. Biswas, A. Das, S. Paul, A. S. Nair, B. Pathak, M. S. Singh, S. Mandal, Manuscript under review.

Gold, Silver and Copper Nanoclusters: From synthesis to applications

Arindam Banerjee*
School of Biological Sciences, Indian Association for the Cultivation of Science, Kolkata-700032, India
E-mail: bcab@iacs.res.in

Gold and silver nanoclusters belong to unique nanomaterials exhibiting molecule-like behaviour and excellent fluorescent property. Gold nanoclusters have been prepared by core-etching method from a gold precursor using a dipeptide L-cysteinyl-L-cysteine and mainly 7 atom Au clusters have been observed. These blue emitting clusters have been successfully used for very selective and ultra-sensitive detection of AsIII ions in the presence of other bivalent and trivalent metal ions in aqueous solution with a lower limit of detection (LOD) is 53.7 nM.[1] Other examples of making a few atoms fluorescent gold clusters include formation of clusters from gold nanorods and the use of these clusters for Fe (III) ions sensing slectively[2], synthesis of various-coloured different sized fluorescent gold clusters from blue to NIR and cancer cell-imaging by the NIR gold cluster [3], preparation of peptide capped different colour emitting gold quantum clusters with tuneable photoswitching behaviour [4]. A recent example includes in situ the formation of fluorescent Au nanoclusters over the graphene sheet to create a novel trihybrid system consisting of rGO , carbon dots and Au clusters from GO , gold salt and carbon dots in presence of a blue light-emitting diode (LED) irradiation [5] and the use of this new nanohybrid system with carbon dots as a good photo-switching material and also as a nanocatalyst. Blue, green and red emitting Ag clusters have been prepared by using a bioactive peptide and the red emitting clusters have been used for selective and sensitive detection of toxic HgII ions in water by using even naked eyes, fluorometric, and calorimetric studies [6]. Different colour emitting Cu nanoclusters have been made by varying reaction conditions and orange-red emitting clusters have been applied for cancer cell imaging [7]. An interesting study includes the bulk scale synthesis of red emitting Cu nanoclusters and their use as a catalyst for the transformation of aromatic nitro to aromatic amino compounds with the reusability for several times [8].

References:

1. S. Roy, G. Palui , A. Banerjee *Nanoscale*, 2012, 4, 2734–2740.
2. A. Baral, K. Basu, S. Roy, A. Banerjee *ACS Sustainable Chem. Eng.* 2017, 5, 1628−1637.
3. S. Roy, A. Baral, R. Bhattacharjee, Batakrishna Jana, A. Datta, S. Ghosh, A. Banerjee *Nanoscale*, 2015, 7, 1912–1920.
4. A. Baral, K. Basu, S. Ghosh, K. Bhattacharyya, S. Roy, A. Datta, A. Banerjee *Nanoscale*, 2017, 9, 4419–4429.
5. S. Paul, N. Hazra, S. Hazra, A. Banerjee *J. Mater. Chem. C*, 2020, 8, 15735—15741.
6. S. Roy, A. Baral, A. Banerjee, *ACS Appl. Mater. Interfaces* , 2014, 6, 4050−4056.
7. K. Basu, K. Gayen, T. Mitra, A. Baral, S. S. Roy, A. Banerjee *ChemNanoMat* , 2017, 3, 808 – 814.
8. K. Basu, S. Paul, R. Jana, A. Datta, A. Banerjee *ACS Sustainable Chem. Eng.* 2019, 7, 1998−2007.

The role of clusters and their solvent compatibility on digestive ripening process

Jayesh Shimpi[1] and B. L. V. Prasad[1,2]

[1]Physical/Materials Chemistry Division
National Chemical Laboratory (CSIR-NCL), Pune 411 008
and
[2]Centre for Nano and Soft Matter Sciences, Bangalore 562162

Digestive ripening (DR) has become a reliable method for the transformation of a polydispersed nanocrystal (NC) dispersion system to the monodispersed one.[1] In this talk we will introduce some of our work which throws some light on the two important parameters that can affect the size and size distribution of the Au NCs during DR process.

In the first one we have studied the efficiency of multidentate ligands, possessing one, two, or three thiol moieties as ligands/DRA. Out of these ligands, monodentate ligand displayed better results in terms of size distribution in the temperature range 60 - 120 °C. In addition, when DR was carried out at lower temperatures (e.g., 60 °C), the NC size increased as the number of thiol groups per ligand increased. However, in the case of ligands possessing two and three thiol moieties, when DR was carried out at higher temperatures (120 or 180 °C), the etching process dominated, which affected the monodispersity of the NCs. We conclude that the temperature-dependent strength of the interaction between the ligand headgroup and the NC surface and the consequent building up of thiolated cluster concentration in the solvent plays a vital role in controlling the final particle sizes.

In another study, with alkanethiol (decanethiol/C10HT) and fluorinated thiol (1H,1H,2H,2H-perfluorodecanethiol/C10FT) as DRA's and toluene and α,α,α-trifluoro-toluene (TFT) and their combination as solvents, we clearly established that alkanethiols result in best-quality NCs in toluene while the fluorinated thiols provide reasonably monodispersed NCs in TFT. Our results also ascertain that even when DR is carried out in a mixture of solvents, as long as the compatible solvent is the major component, the DR process results in reasonably monodisperse NCs. As soon as the amount of uncompatible solvent exceeds a threshold limit, there is perceptible increase in the polydispersity of the NCs. We conclude that the polarity of the solvent, which affects the buildup of ligated atoms/clusters, plays a key role in controlling the size distributions of the NCs.

References:

1) Jayesh R Shimpi, Deepti Sidhaye and B. L. V. Prasad, Langmuir, 2017, 33, 9491-9507.

2) Jayesh R Shimpi, Vijay Choudhari and B. L. V. Prasad, Langmuir, 2018, 34, 13680-13689.

3) Puspanjali Sahu, Jayesh Shimpi, Han Ju Lee, T. Randall Lee and B. L. V. Prasad, Langmuir, 2017, 33, 1943-1950.

Protein Protected Luminescent Metal Nanoclusters and Its Biomedical Applications

Kuruvilla Joseph[1]*, Meegle S Mathew[2]

[1]*Department of Chemistry, Indian Institute of Space Science and Technology, Thiruvananthapuram, Kerala, India*
[2]*School of Energy Materials, Mahatma Gandhi University, Kottayam, Kerala, India*

Email address of presenting author: kjoseph.iist@gmail.com

Fluorescent noble metal quantum clusters (NMQCs) are sub-nanometre core sized materials made up of several tens of atoms. It exhibits interesting functional properties such as well-defined molecular structure, discrete electronic transitions, and strong luminescence, where the size of the particle is comparable to the Fermi wavelength of the conduction electrons. Thus it can act as a bridge between nanoparticles and atoms or molecule. Precise syntheses of the quantum clusters using novel synthetic strategies are an emerging area of recent research. In the past decades, synthesis of gold quantum clusters was achieved using various templates like peptides, amino acids, enzymes, dendrimers, DNA, and proteins. Among these, protein template-based synthesis of the cluster has received much attention in biomedical field due to its simplicity in preparation and, good aqueous, solubility, excellent biocompatibility and versatile surface chemistry. The combination of unique optical, electronic and catalytic properties of the metal quantum cluster with inherent biological properties of protein provide NMQCs as promising candidates for various biomedical applications like imaging, sensing, delivery, and therapeutics.

References:

1. Meegle S. Mathew, Anoop Philip, and Kuruvilla Joseph,ChemistrySelect (2020), 5, 9641–9653.
2. Meegle S. Mathew, Kavya Vinode and Kuruvilla Joseph,ACS omega 4 (10), 14169-14178(2019)
3. Meegle S. Mathew, Kiran. S and Kuruvilla Joseph, Chemistry Select, 3, 9545-9554, (2019).
4. Meegle S. Mathew, Joyal Davis & Kuruvilla Joseph, Analyst, 2018, 143, 3841–3849.
5. Meegle S. Mathew and Kuruvilla Joseph, ACS Sustainable Chem. Eng., 2017, 5 (6), pp 4837–4845.
6. Meegle S. Mathew, K. Sreenivasan and Kuruvilla Joseph, RSC Adv., 5(2015), 100176–100183.
7. Meegle S. Mathew, Ananya Baksi, T. Pradeep and Kuruvilla Joseph, Biosensors and Bioelectronics 81 (2016) 68–74.

Plasmonic Colloidosomes of Black Nano Gold for Solar Energy Harvesting and Hot Electron Mediated Catalysis

Vivek Polshettiwar[1]*

[1]*Department of Chemical Sciences, Tata Institute of Fundamental Research (TIFR), Mumbai,*
Email address of presenting author: vivekpol@tifr.res.in

Climate change due to excessive carbon dioxide (CO_2) is the Most Serious Problem Mankind Has Ever Faced. Capture and then conversion of CO_2 to useful materials and fuels using solar energy are the best ways to tackle these challenges. Recently we have reported range of nanomaterials/ nanocatalysts such as DFNS[1], Black Gold[2], Defective Nanosilica[3], Solid Acids[4] , Lithium Silicate Nanosheets,[5] and Magnesium,[6] to capture CO_2 and then convert to fuels and chemicals using solar energy. In this talk, I will discuss the tuning of catalytic behavior of dendritic plasmonic colloidosomes (DPCs) by plasmonic hotspots.[2] A cycle-by-cycle solution-phase synthetic protocol yielded high-surface-area DPCs by controlled nucleation-growth of gold nanoparticles. These DPCs, which had varying interparticle distances and particle-size distributions, absorb light over the entire visible region as well as in the near-infrared region of the solar spectrum, transforming golden colored gold into black gold. They produced intense hotspots of localized electric fields as well as heat, which were quantified and visualized by Raman thermometry and electron energy loss spectroscopy plasmon mapping. These DPCs can be effectively utilized for the oxidation reaction of cinnamyl alcohol using pure oxygen as the oxidant, hydrosilylation of aldehydes as well as for temperature jump assisted protein unfolding and purification of seawater to drinkable water via steam generation. Black gold DPCs also converts CO_2 to methane (fuel) at atmospheric pressure and temperature, using solar energy.[2]

References:

1. Maity, Polshettiwar et al. *Nature Protocol*, **2019**, *14,2177.*
2. Dhiman, Polshettiwar et al. *Chemical Science* **2019**, *10, 6694.*
3. Mishra, Polshettiwar et al. *Proc. Natl. Acad. Sci. U.S.A* **2020**, *117*, 6383.
4. Maity, Polshettiwar et al. *Nature Comm.* **2020**, 11, 3828.
5. Belgamwar, Polshettiwar et al. *Chemical Science* **2021**, *12, 4825.*
6. Rawool, Polshettiwar et al. *Chemical Science* **2021**, *12, 5774.*

Clustering (Assembling) of Metal-Halide Perovskites in Energy Devices

Sayan Bhattacharyya[1]*

[1]*Department of Chemical Sciences, and Centre for Advanced Functional Materials, Indian Institute of Science Education and Research (IISER) Kolkata, Mohanpur – 741246, India*

Email address of presenting author: sayanb@iiserkol.ac.in

Metal-halide perovskites have emerged as revolutionary optoelectronic materials in the recent years. While lead-based systems have made tremendous progress in photovoltaics, the lead-free counterparts are promising game-changers in optoelectronic devices and photocatalytic reactions. A particular clustering / assembling of the perovskite nanostructures has a tremendous impact on the photoactive films that in turn govern the device performance. The first part of the lecture will discuss the nanocrystal-assisted passivation of pin-holes in $CH_3NH_3PbI_3$ layer of solar cells to achieve photoconversion efficiency up to 20% along with long term ambient stability. The second part will focus on $CsPbX_3$ (X = Br/I) nanosheets, their increased charge separation and facile carrier mobility that enable excellent performances in photodetectors and field-effect transistors. The lecture will conclude with a discussion on the assembly of $Cs_3Bi_2I_9$ nanodiscs and their stabilization.

References:

1. A. Mandal, A. Ghosh, S. P. Senanayak, R. H. Friend, S. Bhattacharyya, *J. Phys. Chem. Lett.* **2021**, *12*, 1560-1566.
2. A. Mandal, A. Ghosh, D. Ghosh, S. Bhattacharyya, *ACS Appl. Mater. Interfaces* **2021**, In print.
3. D. Ghosh, Md. Y. Ali, A. Ghosh, A. Mandal, S. Bhattacharyya, *J. Phys. Chem. C* **2021**, *125*, 5485-5493.
4. D. Samanta, P. Saha, B. Ghosh, S. P. Chaudhary, S. Bhattacharyya, S. Chatterjee, G. D. Mukherjee, *J. Phys. Chem. C* **2021**, *125*, 3432-3440.
5. S. Prodhan, K. K. Chauhan, M. Karmakar, A. Ghosh, S. Bhattacharyya, P. K. Datta, *J. Phys. D: Appl. Phys.* **2021**, In print.
6. A. Ghosh, D. K. Chaudhary, A. Mandal, S. Prodhan, K. K. Chauhan, S. Vihari, G. Gupta, P. K. Datta, S. Bhattacharyya, *J. Phys. Chem. Lett*. **2020**, *11*, 591-600.
7. D. K. Chaudhary, A. Ghosh, M. Y. Ali, S. Bhattacharyya, *J. Phys. Chem. C* **2020,** *124*, 246-255.
8. S. Roy, A. Mandal, A. Raj R., S. Bhattacharyya, B. Pal, *J. Phys. Chem. C* **2020**, 124, 28, 15558–15564.
9. D. Ghosh, D. K. Chaudhary, M. Y. Ali, K. K. Chauhan, S. Prodhan, S. Bhattacharya, B. Ghosh, P. Datta, S. Ray, S. Bhattacharyya, *Chem. Sci*. **2019**, *10*, 9530-9541.
10. D. Ghosh, M. Y. Ali, D. Chaudhary, S. Bhattacharyya, ***Sol. Energy Mater. Sol. Cells*** **2018**, *185*, 28-35.

Exploring Catalytic Properties and Active Sites of Phosphine-based Gold Nanoclusters

Sayani Mukherjee

School of Chemistry, Indian Institute of Science Education and Research Thiruvananthapuram, India

Email address of presenting author: smukh.chem18@iisertvm.ac.in

Nanoclusters are ultrasmall metal clusters (<2 nm) protected by ligands and have attracted significant attention as efficient catalysts for organic and electrochemical reactions lately.[1-3] Their atom-precise structure makes it possible to study the relationship between the structure and properties of the nanoclusters (NCs) as catalysts. Thiolate-based gold NCs are widely studied due to their high stability but have varied staple-motifs which causes drastic changes in structure and hence in properties. In this regard, due to their simple bonding pattern, the phosphine-protected Au-NCs ($Au:PPh_3$) stand to provide better understanding of structure-property relationship in NCs. Even though $Au:PPh_3$ based NCs are not widely used as catalysts due to their low stability, they have been utilized to study the effect of charge on the clusters on their catalytic activity for oxidation reaction and susceptibility towards ligand exchange processes.[4,5] In our recent series of works, we have explored the activity of metal oxide supported $Au:PPh_3$ NCs on C-C coupling reactions, which are among the most important organic transformations.[6] My talk will cover the topics: 1) catalytic activity of $Au:PPh_3$ NCs on C-C coupling reactions 2) effect of single-atom doping on catalytic properties of $Au:PPh_3$ NCs 3) the nature of interaction between $Au:PPh_3$ NCs and metal-oxide support.

References:

1 T. Higaki, Y. Li, S. Zhao, Q. Li, S. Li, X. S. Du, S. Yang, J. Chai and R. Jin, *Angew. Chem. Int. Ed.* 58, 8291–8302 (2019).

2 Y. Du, H. Sheng, D. Astruc and M. Zhu, *Chem. Rev.* 120, 526–622 (2020).

3 T. Kawawaki, Y. Negishi and H. Kawasaki, *Nanoscale Adv.* 2, 17–36 (2020).

4 L. Wang, J. Peng, Z. Tang, X. Kang, M. Fu and S. Chen, *Appl. Catal. A Gen.*, 557, 1–6 (2018).

5 L. C. McKenzie, T. O. Zaikova and J. E. Hutchison, *J. Am. Chem. Soc.* 136, 13426–13435 (2014).

6 A. Das, S. Mukherjee, Sreehari S.R., A. S. Nair, S. Bhandary, D. Chopra, D. Sanyal, B. Pathak and S. Mandal, *ACS Nano*, 14, 16681-16688.

Light-triggered interconversion of carborane thiol-protected silver nanoclusters

Arijit Jana[1]

[1]*DST Unit of Nanoscience and Thematic unit of Excellence, Department of Chemistry, Indian Institute of Technology Madras, Chennai – 600036, India*

Email address of presenting author: arijit1995jana@gmail.com

Atomically precise nanoclusters of noble metals with a core dimension of <3 nm are an emerging class of quantum materials connecting the gap between atoms and nanoparticles.[1-2] Various physicochemical properties, such as narrow energy gap and associated multiple electronic transitions, luminescence, chirality, etc., have been used in numerous fields including optoelectronics, nanosensors, nonlinear optics, circularly polarized luminescence, and nanocluster sensitized solar cells, etc.[3-4] Among these materials, silver nanoclusters protected with carboranes, a twelve-vertex, nearly icosahedral boron-carbon framework system, have received immense attention due to their tunable electronic nature and 3-dimensional aromaticity. We will discuss the synthesis and structural understanding of carborane thiol-protected silver nanoclusters.[5] Various spectroscopic and microscopic studies including single crystal X-ray diffraction manifest their existence.

Based on the inherent light sensitivity of silver, we hypothesized that light may trigger the interconversion of silver nanoclusters. Although these nanoclusters are thermally stable, light irradiation leads to their interconversion to other nanoclusters. Time-dependent UV-vis absorption spectroscopy and mass spectrometric studies confirm the formation of intermediate nanoclusters during this interconversion process. Additionally, femtosecond and nanosecond transient absorption (fs ns-TA) studies proved the formation of kernel-centered stable excited state charge carriers that are responsible for light-activation and subsequent interconversion.

References:

1. Jin, R.; Zeng, C.; Zhou, M.; Chen, Y., *Chem. Rev.* 2016, *116*, 10346–10413.
2. Chakraborty, I.; Pradeep, T. *Chem. Rev.* 2017, *117*, 8208–8271.
3. Kang, X.; Zhu, M. *Chem. Soc. Rev.* 2019, *48*, 2422–2457.
4. Kang, X.; Chong, H.; Zhu, M. *Nanoscale* 2018, *10*, 10758–10834.
5 Arijit Jana, Madhuri Jash, Ajay K. Poonia, Ganesan Paramasivam, Md Rabiul Islam, Papri Chakraborty, Sudhadevi Antharjanam, Jan Machacek, Sundargopal Ghosh, K. V. Adarsh, Tomas Base, Thalappil Pradeep, ACS Nano 2021 (under revision).

Thematic Unit of Excellence