

南开大学中村实验室招生信息

从 2025 年 9 月起，南开大学中村实验室将招收数名有抱负的研究生（博士和硕士）以及在有机合成和电子显微镜方面有才华的博士后。此招生和招聘信息长期有效。实验室位于津南校区的前沿科学中心大楼六层。课题组学生成果丰硕，如今年在东京大学的博士毕业生 Sakakibara(榊原雅也)发表了一篇 Science,，获得了东大校长奖；本科毕业生 Anzo(安藏美樹子) 获得了学院奖。

申请请联系： nakamura@chem.s.u-tokyo.ac.jp;

课题组主页： <https://moltech.jp/ja/>。



中村教授获得瑞宝中绶章及紫绶褒章

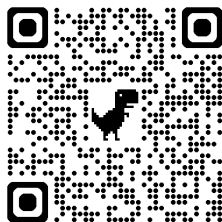
课题组主页：

1

2

3

4



1. 中村荣一教授“Chemical Harmony: A Visual Journey of Eiichi Nakamura”

中村教授于 2024 年制作了一段名为《Chemical Harmony》的短视频，回顾了他职业生涯中的一些重要时刻。视频中的背景音乐由中村教授亲自演奏。这段视频旨在纪念中村教授荣获日本天皇颁发的瑞宝章勋章，并总结了他 50 年来的研究和音乐历程。

https://www.bilibili.com/video/BV1uu9QYTEyA/?vd_source=01b8644892b36f8323e98229e42c597b

2. Video introduction of the Nakamura Laboratory. (2021)

中村课题组于 2021 年制作了一段课题组介绍的短视频，总结了近年来的研究方向，包括了分子合成，材料器件，和原子分子表征等多个方向。

https://www.bilibili.com/video/BV1cx9QYxEeW/?vd_source=01b8644892b36f8323e98229e42c597b

3. Lecture commemorating the 350th anniversary of Robert Hooke's Micrographia

<https://www.bilibili.com/video/BV1Mg9QYiEZd/>

为纪念罗伯特·胡克的《显微镜》出版 350 周年，中村教授受英国皇家化学会邀请，发表了关于课题组电子显微镜研究总结和展望的报告。

4. Capturing the Moment of crystallization

中村课题组于 2021 年发表的食盐于碳纳米管中结晶的视频，在揭示了无机成核生长过程的。

https://www.bilibili.com/video/BV1pW9QYoEcu/?vd_source=01b8644892b36f8323e98229e42c597b

南开大学中村实验室招生信息

2025年



Satoshi Omura教授(NP 2015) visited us

Official Video



Most Recent Publication (Science, January 31, 2025)

RESEARCH

PHASE TRANSITIONS

Nondeterministic dynamics in the η -to- θ phase transition of alumina nanoparticles

Masaya Sakakibara¹, Minoru Hanaya², Takayuki Nakamura^{1*}, Eiichi Nakamura^{1*}

Phase diagrams and crystallography are standard tools for studying structural phase transitions, whereas acquiring kinetic information at the atomistic level has been considered essential but challenging. The η -to- θ phase transition of alumina is unidirectional in bulk and retains the crystal lattice orientation. We report a rare example of a statistical kinetics study showing that for nanoparticles on a bulk Al(OH)₃ surface, this phase transition occurs nondeterministically through an ergodic equilibrium through the molten state, and the memory of the lattice orientation is lost in this process. The rate of the interconversion was found to be insensitive to the electron dose rate, and this process had a small Gibbs free energy of activation. These nondeterministic kinetics should be a key feature of crystal nucleation occurring in high-surface-energy regions of bulk crystals.

Crystal phase transitions are often irreversible and thus deterministic processes. For example, alumina (Al₂O₃) undergoes a series of irreversible first-order phase transitions with increasing temperature as it transforms from hydrated alumina [bayerite, α -Al(OH)₃] into the metastable η phase, the θ phase, and finally the most stable α phase previously reported (Fig. 1A) (1). The transitions in-

ML becomes the most stable only at 2300 K. Here, the η -to- η and θ -to- θ transitions refer to the NP changing its orientation relative to the bulk Al(OH)₃ substrate.

Thus, the η -to- θ phase transition of alumina, which is unidirectional in bulk, occurs nondeterministically through a rapid η/θ equilibrium that occurs through melting and recrystallization of NPs on the bulk Al(OH)₃ surface

represent a rare demonstration of the capability of real-space TEM observation for elucidation of the mechanism of chemical events through statistical mechanical analysis (11, 12).

These kinetics data obtained for NPs grown from Al(OH)₃ crystallites align with the thermodynamics of nanosized alumina polymorphs that Navrotsky *et al.* studied for NPs prepared by gas-phase condensation (13). The Navrotsky data, combined with the data that we present here, suggest that nondeterministic kinetics is a common feature of crystal nucleation in high-surface-energy regions of alumina crystals. The discrepancy between the lattice retention in bulk and the scrambling at the nanoscale suggests that the bulk experiment observations (4) result from an interplay between localized disorder in high-energy nanoregions and the overarching order imposed by the surrounding bulk crystal structure (14). Combined with the atomistic mechanism of bulk crystal ordering (15), this disparity challenges traditional views of phase transitions based on macroscopic analyses and underscores the necessity for caution when extrapolating macroscopic data to comprehend their atomistic mechanism. The observed kinetics and the EDR insensitivity indicate that the surface energy is more influential than has been gen-

Recent Publications

- 560. Non-deterministic Dynamics in η -to- θ Phase Transition of Alumina Nanoparticles. M. Sakakibara, M. Hanaya, T. Nakamura, E. Nakamura, **Science** 387 522-527 (2025).
- 559. Deep-red Emitting Copper(I) Indenediyltrisphosphine Complexes with Minimized Skeletal Vibrations and Configurational Disorder, S. Fukuma, J. Fu, T. Nakamura, R. Shang, E. Nakamura, **Angew. Chem. Int. Ed.** 63, e202416583 (2025).
- 557. Iron-catalysed C(sp²)-H activation for aza-annulation with alkynes on extended π -conjugated systems. Y. Zhang, S. Fukuma, R. Shang, E. Nakamura, **Nat. Synth.** 3, 1349–1359 (2024).
- 553. Melting entropy of crystals determined by electron-beam-induced configurational disordering. D. Liu, O. Elishav, J. Fu, M. Sakakibara, K. Yamanouchi, B. Hirshberg, T. Nakamura, E. Nakamura, **Science** 384, 1212-1219 (2024)
- 546. Iron-catalyzed C-H Activation for Heterocoupling and Copolymerization of Thiophenes with Enamines, T. Doba, R. Shang, E. Nakamura, **J. Am. Chem. Soc.**, 144, ASAP (2022).
- 545. Precision synthesis and atomistic analysis of deep blue cubic quantum dots made via self-organization. O. J. G. L. Chevalier, T. Nakamura, W. Sato, S. Miyashita, T. Chiba, J. Kido, R. Shang, E. Nakamura, **J. Am. Chem. Soc.**, 144, 21146-21156 (2022).
- 538. De Novo Synthesis of Free-Standing Flexible 2D Intercalated Nanofilm Uniform over Tens of cm², P. Ravat, H. Uchida, R. Sekine, K. Kamei, A. Yamamoto, O. Konovalov, M. Tanaka, T. Yamada, K. Harano, E. Nakamura, **Adv. Mater.** 2146465 (2021).
- 537. Iron-Catalysed Regioselective Thieryl C-H/C-H Coupling, T. Doba, L. Ilies, W. Sato, R. Shang, E. Nakamura, **Nat. Catal.**, 4, 631–638 (2021).

Sending student abroad for internship (Nobel Prize)

1988 UC, Berkeley, USA (Prof. Peter Vohlhardt)	山子 茂	2005 RWTH Aachen University, Germany (Prof. Carsten Bolm)	藤本 泰典
1989 University of Cambridge, UK (Prof. Ian Paterson)	伊坂 雅彦	2005 University of Illinois, USA (Prof. Scott E. Denmark)	伊藤 慎庫
1990 Sandoz Co., Basel (現Novartis Co.), Switzerland	徳山 英利	2006 Merck Research Laboratories, USA	真島 慈子
1990 UC Santa Barbara, USA (Prof. Bruce Lioshutz)	荒井 雅之	2006 University of Chicago, USA (Prof. Rustem F. Ismagilov)	Laur Ilies
1991 Sandoz Co., Basel (現Novartis Co.), Switzerland	中村 正治	2007 University of Cambridge, UK (Prof. Ian Paterson)	藤田 健志
1991 Scripps Institute, San Diego, USA (Prof. Dale Boer)	江尻 聡	2007 University of Munich, Germany (Prof. Paul Knochel)	山形 憲一
1992 Sandoz Co., Basel (現Novartis Co.), Switzerland	久保田克巳	2008 MPI for Polymer Research, Germany (Prof. Klaus Müllen)	三津井親彦
1994 Emory University, Atlanta, USA (Prof. Keiji Morokuma)	森 聖治	2008 University of Groningen, Netherland (Prof. Ben L. Feringa)	本間 達也
1995 Princeton University, USA (Prof. Daniel Kahne)	磯部 寛之	2008 Weizmann Institute, Israel (Prof. Milko E. van der Boom)	一木 孝彦
1997 Emory University, USA (Prof. Lanny S. Liebeskind)	平井 敬	2009 MIT, USA (Prof. Mohammad Movassaghi)	中村 優希
1997 SUNY, Stony Brook, USA (Prof. Iwao Ojima)	坂田 剛	2009 University of Ulm, Germany (Prof. Peter Bäuerle)	Yang Zhang
1999 Emory University, Atlanta, USA (Prof. Keiji Morokuma)	山中 正浩	2009 University of Michigan, USA (Prof. Melanie Sanford)	松本 有正
2000 SUNY, Stony Brook, USA (Prof. Iwao Ojima)	原 賢二	2010 Phillips-University Marburg, Germany (Prof. Eric Meggers)	南 皓輔
2000 Emory University, USA (Prof. Frank McDonald)	戸叶 基樹	2011 Northwestern University, USA (Prof. Michael R. Wasielewski)	助川潤平
2001 SIOC, Shanghai, China (Prof. L. Wu)	富田 直輝	2011 UPMC, France (Prof. Max Malacria)	浅子 壮美
2002 University of Madrid, Autonoma (Prof. A. Echavarren)	國信洋一郎	2011 University of Groningen, Netherland (Prof. Ben L. Feringa)	小島 達央
2002 University of Munich, Germany (Prof. Paul Knochel)	松尾 敬子	2011 University of Madrid, Autonoma, Spain (Prof. A. Echavarren)	関根 真樹
2002 Stockholm University, Sweden (Prof. Jan Backvall)	吉成 直彦	2012 Eindhoven Univ. of Technology, Netherland (Prof. E. W. Meijer)	新田寛久
2002 Hong Kong University, PRC (Prof. Dan Yang)	嶋山 琢次	2012 University of Melbourne, Australia (Prof. A. Holmes) Ricardo M. Gorgoll	
2003 University of Geneva, Switzerland (Prof. S. /N. Matile)	At-ian Chen	2012 ETH Zürich, Switzerland (Prof. Jeffery W. Bode)	上田 祥之
2003 SUNY, Stony Brook, USA (Prof. Benjamin Chu)	中西 和嘉	2013 RWTH Aachen University, Germany (Prof. Jun Okuda)	松原 立明
2003 University of Dortmund, Germany (Prof. Norbert Krause)	田原一邦	2013 University of Würzburg, Germany (Prof. Frank Würthner)	庄山 和隆
2003 University of Alberta, Canada (Prof. Jeffrey Stryker)	佐藤 宗太	2013 University of Münster, Germany (Prof. Bart Jan Ravoo)	山田 純也
2003 National Taiwan University, Taiwan (Prof. Tien-Yau Luh)	造藤 伍平	2013 ESPCI ParisTech, France (Prof. Ludwik Leibler)	岡田賢
2003 Peking University, PRC (Prof. Zhenfeng Xi)	村松 彩子	2015 University of Münster (Prof. Frank Glorius)	Junfei Xing
2004 Caltech, USA (Prof. Brian M. Stoltz)	岩下 暁彦		
2005 University of Geneva, Switzerland (Prof. Stefan Matile)	田中 隆嗣		

Alumini in Academia Worldwide

[教授]

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 山形大学理学部
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 東京大学理学部
 東京工業大学理工学部
 立教大学理学部
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 物質・材料研究機構

理化学研究所

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 京都大学理学部
 京都大学理学部
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 中国科学院化学研究所
 北京科学技术大学
 四川大学

澤村 正也
 徳山英利
 吉戒直彦
 金井 勝彦
 森 暹治
 藤部寛之
 佐藤宗太
 Rui Shang
 岡本 敏宏
 山中正浩
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 田原幸治
 原野幸治
 中西和嘉

Lauean Ilies

松尾 豊
 山子茂
 中村正治
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 嶋山琢次
 鈴木一博
 原 真二
 辻 勇人
 國信洋一郎
 Sung Gyeong LEE
 Sang Gyeong LEE
 Shou-Fei ZHU
 Xiaozhang ZHU
 Yu-Wu ZHONG
 Yunlong GUO
 Yonggang ZHEN
 Xiaoming ZENG

浙江大学化学科
 青島科学技術大学

杭州師範大学
 Biotech, Thailand
 University of Zurich
 [准教授]
 東京大学工学部
 東京大学理学部
 東京大学総合文化研究科
 東京理科大学理学部
 京都造形芸術大学環境デザイン学科
 奈良女子大学理学部
 理化学研究所
 Nanyang Technological University
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 甘肅農工大学
 Mahidol University
 Linköping University
 Polish Acad. of Sci.
 Visva-Bharati University
 [助教]
 東北大学WP I
 東京大学物性研究所
 東京農工大学応用物理
 埼玉大学理工学部
 千葉大学工学部
 京都大学工学部

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Chang-Zhi Li
 Zhongming Zhou

Hua Lu
 伊坂雅彦
 Cristina NEVADO

伊藤 喜光
 中室 貴幸
 小島 達央
 遠藤 恒平
 望月 公紀
 松本 有正
 浅子 壮美
 伊藤 慎康
 成田 明光

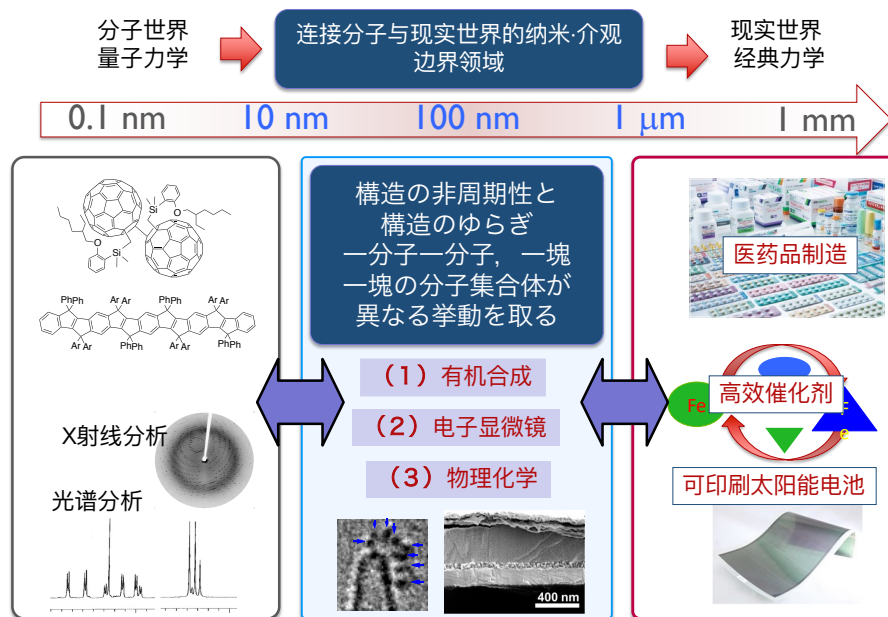
Loic LEMIEGRE

Prince Ravat
 Dom Lungerich
 Zuo XIAO
 Baolin LI
 Qifan YAN
 山川 剛
 Nopporn RUANGSUPACHAT
 Niclas SOLIN
 Adam Mieczkowski
 Alakananda HAJRA

Junfei Xing

藤野智子
 清水俊樹
 古川 俊輔
 花山 博紀
 道場 貴大

我们所开拓的新领域

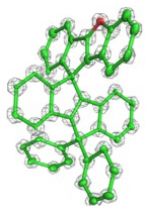
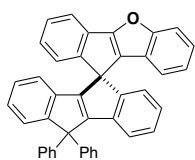


20世纪是“影像的世纪”



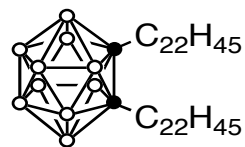
L'Arrivée d'un train en gare de La Ciotat (1895)

20世纪的化学是“分子式与静止图像”

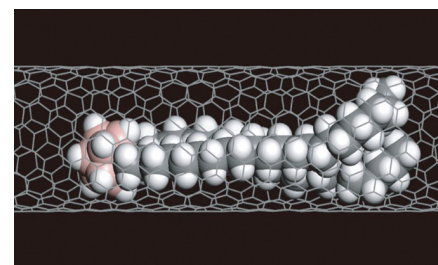
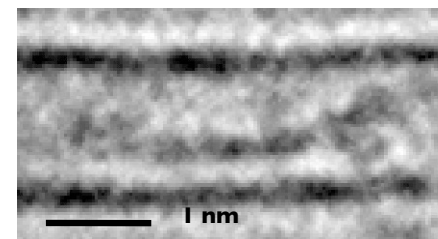


而21世纪的化学已成为“影像分子科学”

2007年，全球首次拍摄到了有机分子构象转换的影像

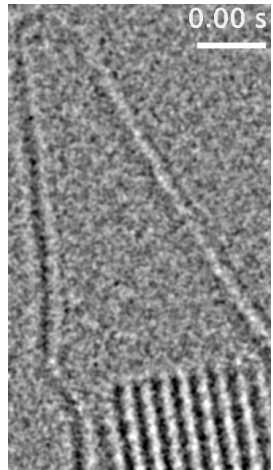


Alkylcarborane



Science **2007**, 316, 853

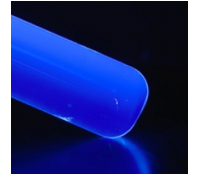
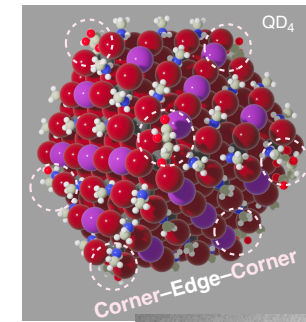
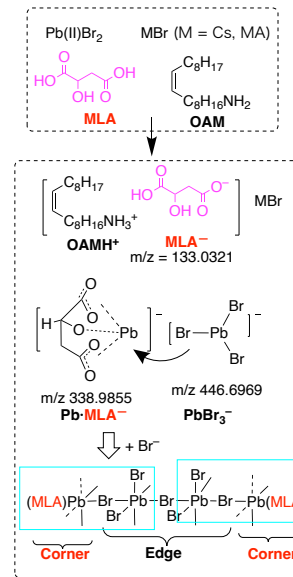
而21世纪的化学已成为“影像分子科学”



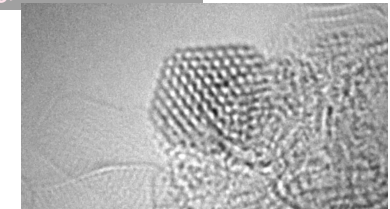
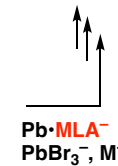
Capturing the Moment of Emergence of Crystal Nucleus from Disorder
J. Am. Chem. Soc., 143, 1763-1767 (2021).

9

量子点的模板诱导成核



MLA·Cs·QD₄



545. Precision synthesis and atomistic analysis of deep blue cubic quantum dots made via self-organization. O. J. G. L. Chevalier, T. Nakamuro, W. Sato, S. Miyashita, T. Chiba, J. Kido, R. Shang, E. Nakamura, *J. Am. Chem. Soc.*, 144, 21146-21156 (2022).

以高速高分辨率透射电镜开拓“影像分子科学”的新世界

化学领域中对电子显微镜不太熟悉的世界



电子显微镜领域中对有机分子不太熟悉的世界

单分子原子分辨率实时电镜法 (SMART-EM法)



催化剂、太阳能电池、生命科学相关的基础科学革新

11

commentary

Nakamura and Sato, *Nature Materials*, March Issue, 2011.

Managing the scarcity of chemical elements

The issues associated with the supply of rare-earth metals are a vivid reminder to all of us that natural resources are limited.

Eiichi Nakamura and K...

For chemists and materials scientists, the period from the 1960s to the 1980s was an era when pioneers were racing through the unexplored and fertile wilderness of the periodic table, searching for treasure suitable for technical applications. Indeed, a number of new materials...

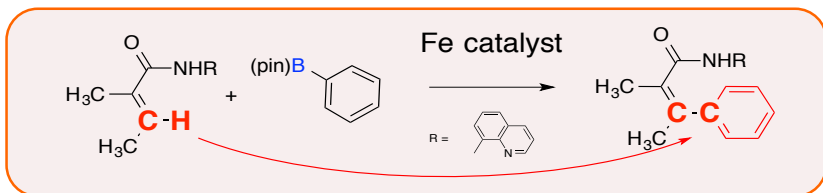
For chemists and materials scientists, the period from the 1960s to the 1980s was an era when pioneers were racing through the unexplored and fertile wilderness of the periodic table, searching for treasure suitable for technical applications.

"Element Strategy Initiative" (元素戦略)
Proposed in 2004 for the Japanese Government

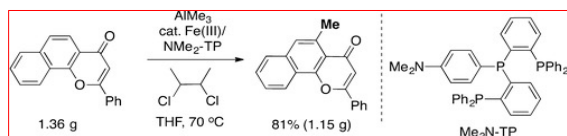
12

铁和铬超越了贵金属 (Pd) !

发现使用铁催化剂可以将碳-氢键自由自在地一步转化为碳-碳键!



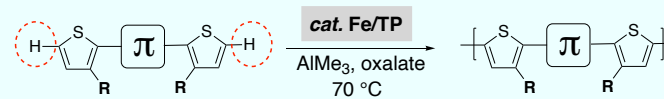
用Pd和Rh催化剂无法合成的化合物正不断涌现!



557. Iron-catalysed C(sp²)-H activation for aza-annulation with alkynes on extended π -conjugated systems. Y. Zhang, S. Fukuma, R. Shang, E. Nakamura, *Nat. Synth.* 3, 1349–1359 (2024).

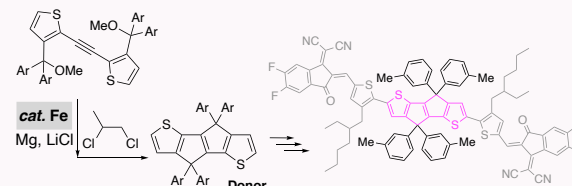
铁催化合成高HOMO有机材料

1. C-H Activation Route to Multi-functionalized Polymers



537. Iron-Catalysed Regioselective Thienyl C-H/C-H Coupling, T. Doba, L. Ilies, W. Sato, R. Shang, E. Nakamura, *Nat. Catal.*, 4, 631–638 (2021).

2. Short-step Synthesis of Narrow Band Gap Materials



534. Iron-Catalyzed Tandem Cyclization of Diarylacetylene to a Strained 1,4-Dihydropentalene Framework for Narrow-Band-Gap Materials, M. Chen, W. Sato, R. Shang, E. Nakamura, *J. Am. Chem. Soc.*, 143, 6823–6828 (2021).

目标: 培养让世界都能看到他们面孔的科学家

希望在从本科研究到研究生阶段期间能掌握的内容: 令世界引以为傲的教育与研究

能够用英语交流、阅读、书写、生活, 并了解世界

- * 外国人学生, 博士研究员, 短期留学生との研究生活
- * 英語文献の英語講読(毎週木曜で年に2回担当)
- * 自分自身の研究の英語発表と英語資料作成(毎週木曜で4週ごとに回る)
- * 外国研究室での短期研究留学(D1学生全員: 欧米・中国)
- * 外国人講演者との昼食会(大学院生)
- * Academic English in Chemistry (D1, COE講義)

能够流利表达, 并使人信服

- * 4年生全員が3月の日本化学会で発表を目標
- * サブグループセミナー(非公式討論会; 毎週木曜夕方, 通年・4グループで一順), グループセミナー(公式発表会; 春秋2回, 持ち時間10分で全員発表)
- * 研究室内での様々なレベルでの議論(大学研究室とERATO研究室)
- * 国内外研究室との共同研究

能够明白什么是非模仿的研究

为此必备的条件:

吃得好, 喝得好, 玩得好

- * 公式: お花見・新人歓迎会, 春季参科セミナー・ハイキング・パーベキュー, 理学部園遊会打ち上げ, 春季研究室運動会, ソフトボール祝勝会, 短期留学歓迎会, 夏の大掃除, 院試合格祝い, 秋季研究室運動会, 秋季参科セミナー・ハイキング・パーベキュー, 研究室同窓会, 忘年会, 学位審査通過祝賀会
- * 非公式: 各グループ毎の懇親会, スキー旅行

首先是IC: 好奇心(探求心)



Gilbert Stork 教授

好奇心 (curiosity) を大切にして, 勇氣 (courage) を持って困難な問題に挑戦すること (challenge), 必ずできるという自信 (confidence) を持って, 全精力を集中 (concentration) し, そして諦めずに継続すること (continuation), その中でも最も重要なのは, curiosity, challenge, continuation の3Cである。これが凡人でも優れた独創的と言われる研究を仕上げるための要素であると私は考える。(本庶佑京大医学部教授)

Our challenges may be new... But those values upon which our success depends - hard work and honesty, courage and fair play, tolerance and curiosity, loyalty and patriotism - these things are old. These things are true.

Roald Hoffmann教授



希望掌握的内容: 物(分子)制造技术 + 概念构建的思维方式

包括反应机理与电子显微镜

- *1 Chemical Kinetics Study through Observation of Individual Reaction Events with Atomic-Resolution Electron Microscopy, E. Nakamura, K. Harano, *Proc. Jpn. Acad., Ser. B*, 94, 428–440 (2018)
- *2 Atomistic Structures and Dynamics of Poreclustering Clusters in MOF-2 and MOF-5 Syntheses, J. Xing, L. Schweighauser, S. Okada, K. Harano, E. Nakamura, *Nat. Commun.*, 10, 3608 (2019)

全体成员必须掌握: 有机与无机合成

- *3 Axially Chiral Spiro-conjugated Carbon-bridged *p*-Phenylenevinylene Congeners: Synthetic Design and Materials Properties H. Hamada, Y. Itabashi, R. Shang, and E. Nakamura, *JACS* 2020
- *4 Homocoupling-free Iron-catalysed Twofold C-H Activation/Cross-couplings of Aromatics via Transient Connection of Reactants, T. Doba, T. Matsubara, L. Ilies, R. Shang, E. Nakamura, *Nat. Catal.* 2, 400–406 (2019)

新反应、新分子

- *5 Air- and Heat-Stable Planar Tri-*p*-quindimethane with Distinct Iron-Catalyzed C-H Bond Activation, R. Shang, L. Ilies, E. Nakamura, *Chem. Rev.* 117, 9086–9139 (2017)
- *6 Interfacial Chemistry of Conical Fullerene Amphiphiles in Water, K. Harano, E. Nakamura, *Acc. Chem. Res.* 52, 2090–2100 (2019)

新功能

- *7 Design and Functions of Semiconducting Fused Polycyclic Furans for Optoelectronic Applications, H. Tsuji, E. Nakamura, *Acc. Chem. Res.* 50, 396–406 (2017)
- *8 Axially Chiral Spiro-conjugated Carbon-bridged *p*-Phenylenevinylene Congeners: Synthetic Design and Materials Properties H. Hamada, Y. Itabashi, R. Shang, and E. Nakamura, *JACS* 2020

以拯救人类的未来(太阳能电池、元素战略、医疗)

- 9 Chemical Formation and Multiple Applications of Organic-Inorganic Hybrid Perovskite Materials, K. Liu, Y. Jiang, Y. Jiang, Y. Guo, Y. Liu, E. Nakamura, *J. Am. Chem. Soc.* 141, 1406–1414 (2019). 10 In vivo gene delivery by cationic tetraamino fullerene, R. Maeda-Mamiya, E. Noiri, H. Isobe, W. Nakanishi, K. Doi, T. Sugaya, T. Homma, and E. Nakamura, *Proc. Nat. Acad. Sci., U.S.A.*, (2010)

Figure showing various chemical structures and materials, including a spiro-conjugated carbon-bridged *p*-phenylenevinylene molecule, a high-stability perovskite, and a thin-film solar cell.