2023 UNISOKU NEWSLETTER

Title：Blue Floating (青い浮遊)　Artwork：Naho Ito (イトウナホ)　@nahoito_at.y

She is an artist based in Kyoto, see back cover for the author details. / 京都を拠点にご活躍されているアーティストです、作者詳細は裏表紙をご覧ください。

Greetings from CEO

Our NewsLetter started since 2016 is now the 8th issue.
We were motivated by one of our customers in oversea who expressed curiosity to know what kind of activities UNISOKU was currently engaged in.
The purpose of NewsLetter is to provide regular updates on UNISOKU activities, as well as a mix of content unrelated to business reports, reflecting the intention of the editorial board, which is made up of UNISOKU employees.
We hope you enjoy the slightly different content in each issue.

2016年から制作を開始したこのNewsLetterは、今回で8号目を迎えます。
海外のとあるお客様から「ユニソクが今、どんな活動をしているのかを知りたい」という声をいただいたことが制作のきっかけでした。
NewsLetterは弊社の活動を定期的にお知らせすることを目的としてスタートしましたが、弊社社員により構成された編集委員の遊び心で、事業報告に留まらない内容も織り交ぜながら制作されています。毎号少しずつ異なる内容をお楽しみいただければ幸いです。

In 2022, though many of the shipments had been stagnant due to the global spread of COVID-19, they have progressed and reached a record-high. On the other hand, we sincerely apologize for the inconvenience caused to our customers, who have been waiting for delivery due to the global shortage of electronic components.
As for overseas visits, we and SPECS-TII Technology (Beijing) are continuously providing technical support in China, but we apologize for the inconvenience caused by the limited number of employees and the quarantine restrictions. We will continue to work on improving the situation by increasing our employees. We have resumed overseas visits, except for China, from the end of 2021, deliveries and repairs that had been delayed for two years. Currently, our priority is to provide technical support. Although we are suspending to attend to exhibitions, we plan to resume them as needed.

2022年はCOVID-19の世界的蔓延によって停滞していた出荷が進み、過去最高の出荷量となりました。しかしながら、一部の製品の入荷の遅れや想定外の部品の入手不足が発生し、いまだに納品をお待たせしているお客様にはご迷惑をおかけし、誠に申し訳ございません。
海外への訪問対応につきましては、中国では弊社やSPECS-TII Technology(Beijing)による技術サポートを継続していますが、人員に限りがあるなか検疫により活動が制限されており、ご不便をおかけしております。今後人員の増強等を進めて改善に取り組んでまいります。
中国を除く海外への訪問は2021年末からすこしずつ再開し、2年間滞ってきた納品や修理を再開しはじめております。現在は納品や修理訪問などの技術サポートを優先しておこなっており、展示会への訪問参加は見合わせてきました。2023年には技術サポートのための海外訪問を本格的に再開させ、展示会への参加も随時再開する予定です。

In the past few years, we have released several new systems into the market, including cryogen-free SPM, time-resolved STM, and transient absorption spectrometers with fluorescence lifetime function. In addition to these, we have also developed customized products, convenient functions for our systems, and fully automated helium liquefaction systems.
We have introduced some of them through the NewsLetters, but those are not all.
If you have any questions about modifications to your systems, measurements you are considering, or any other problems you may have, please contact us. We will continue to challenge ourselves to achieve your special measurement needs.

新製品としましては、無冷媒SPM装置や時間分解STM装置、蛍光寿命機能付き過渡吸収分光装置などの販売を開始しました。また、お客様のニーズを取り入れることにより既存装置に提案する便利な機能やカスタマイズ品、完全自動化されたヘリウム液化装置といったご紹介したい新技術が生まれてきています。
NewsLetterを通してそれらの一部をご紹介しておりますが、すべてではありません。
お使いの装置の改造やお客様がお考えの測定について、また、お困りのことがあれば是非ご相談ください。
私たちはお客様の特別な計測の実現のために挑戦を続けます。

Corporate Philosophy 経営理念

UNISOKU contributes to the development of science and technology by providing customers with measurement systems that meet their exploration needs.
お客様の探究心に応える計測を提供し、
お客様の成果を通じて、科学技術の発展に貢献する。

President and CEO Yutaka Miyatake
代表取締役社長　宮武　優
Yutaka Miyatake

Stories of UNISOKU in 2022

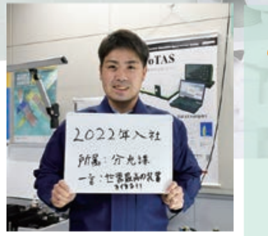
Feb.

The USM1800 (Cryogen-Free Low Temperature UHV SPM) delivered for the first time to China (Shanghai Jiao Tong University).
新製品 USM1800 ヘリウムフリー低温超高真空走査型プローブ顕微鏡の初出荷 (上海交通大学)

Apr.

A research paper on the USM1800 prototype system was published in Review of Scientific Instruments.
USM1800プロトタイプ機論文が
Review of Scientific Instruments誌に掲載

A new employee joined the Optical Instruments department.
分光課に新入社員入社



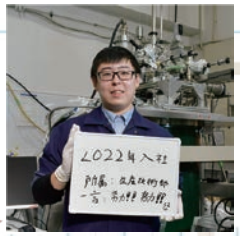
May

We started accepting demonstration experiments of the microwave heating Raman spectrometer, which was jointly developed with MOTOYAMA Co., Ltd.
株式会社モトヤマと共同開発した
マイクロ波加熱ラマン分光装置の
デモ実験受付開始

Jun.

The USM1600 was delivered for the first time to Singopore (Nanyang Technological University).
シンガポールへのUSM1600システムの初出荷
(南洋理工大)

A new employee joined the SPM department.
生産技術グループに
新入社員入社



Aug.

The USM1600 was delivered for the first time to the USA (Oak Ridge National Laboratory).
米国エリアにUSM1600システムの初出荷
(オークリッジ国立研究所)

Sept.

Dr.Iwaya presented a poster on the time-resolved STM system at the 92nd IUVSTS & APSSS-4.
岩谷が国際会議The 92nd IUVSTS & APSSS-4
において時間分解STM装置についてポスター発表

The Photochemistry Discussion Meeting 2022 (Corporate Exhibition) was held as an on-site event for the first time in nearly three years.
対面開催として約3年振りの
2022年光化学討論会で企業展示を実施

Research results using picoTAS/CoolSpeK (by Osaka University - Dr. Aizawa) were published in Nature.
picoTAS/CoolSpeKを使用した研究成果
(大阪大学-相澤博士)がNatureに掲載

Oct.

The USM1600 was delivered for the first time to Europe (University of Stuttgart).
欧州エリアにUSM1600システムの初出荷
(シュトットガルド大学)

Nov.

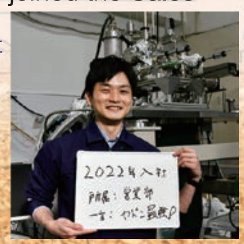
We exhibited in person at the 10th AsBIC, the first international conference attended in 4 years.
第10回 AsBIC にて、国際会議としては４年ぶりに対面での出展を実施

PCT application was filed for the "AFM holder with anti-vibration and vibration-isolation mechanism".
「防振除振機構付きAFMホルダー」PCT出願

Dec.

Our "Time- and Spin-Resolved Scanning Multi-Probe Microscopy" was certified by JST A-STEP.
JST A-STEP「時間・スピン分解
走査マルチプローブ顕微鏡」完了認定

A new employee joined the Sales department.
営業部に新入社員入社



社員の活動風景 (Scenes of UNISOKU activities)

Announcement of the Start of On-Site SPM Experimental Service
来社SPM実験サービス開始のお知らせ

Service Description

We offer high-end measurement systems that customers can use as a paid service. Our systems are permanently set up and ready for use, whether in-person or online. We strive to provide the best measurement environment to ensure optimal performance.

Our service is intended for:

- Researchers who wish to evaluate their samples by conducting measurements with our systems.
- Those who need to perform measurements that cannot be done with their own equipment.
- Customers who face challenges in installing our systems due to limitations in their facilities or location.
- Those who are exploring the possibility of installing our systems in their lab.

Features and Benefits

- Our engineers perform maintenance, which results in optimized systems and fast initial measurements.
- You do not need to worry about arranging refrigerants and other supplies necessary for operation; we take care of everything.
- Some systems are available for online measurement 24hours a day.
- We provide measurement assistance, including sample exchange.
- We quickly respond to necessary arrangements and improvements that are identified during use.
- You can bring your own instruments for sample preparation with prior consultation.
- This is not a joint research project, and 100% of the results belong to the user. We do not provide analysis methods or services.

サービス内容

弊社製品のハイエンド機を社内に常設し、有償でご利用いただき、来社やOnline接続での計測環境をご提供します。

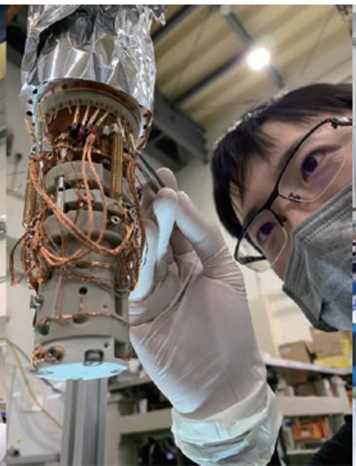
ご利用対象

- ご研究対象の試料の評価に弊社装置による計測を加えてみたい方
- お手持ちの装置ではできない測定をされたい方
- 設置場所や設備の事情により弊社装置の導入が困難な方
- 装置の導入を検討されている方

特徴および利点

- 装置保守点検は弊社技術者が行い、最適化された装置で早期の成果を期待できます。
- 冷媒などの運用に必要な物資手配のご心配は不要です。
- 一部の機器での計測はOnlineで24時間利用に対応させる予定です。
- 試料交換等の計測補助はお引き受けいたします。
- ご利用中に判明する必要なアレンジ、改良に素早く対応いたします。
- 試料準備に必要な機器はお持ち込みいただけます（要事前相談）。

*本サービスで得られたデータはお客様に帰属されます。
計測器ご利用サービスの為、弊社によるデータ解析サービスは原則として行いません。

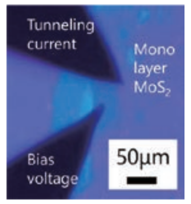



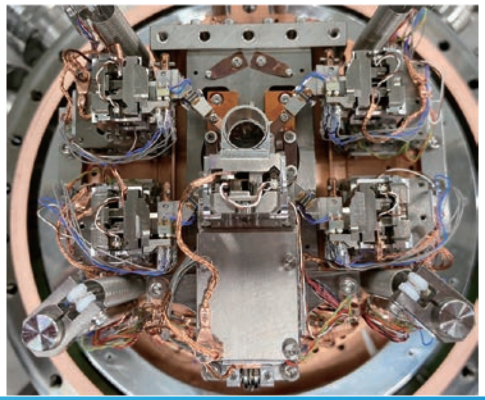

Available Systems
ご利用いただける装置

UHV Time-Resolved Multi-Probe Microscopy
超高真空時間分解マルチプローブ顕微鏡

Available now

Carrier dynamics measurement of micro samples on insulating substrate





Demo measurement conditions

- Temperature: 77 K or 300 K
- Pressure: $\sim 10^{-8}$ Pa
- Laser wavelength: 488, 532 nm
- Temporal resolution: ~80 ps (532 nm), ~10 ns (488 nm)

利用受入れ中

絶縁基板上の微小サンプルのキャリアダイナミクスを測定可能

デモ実験条件

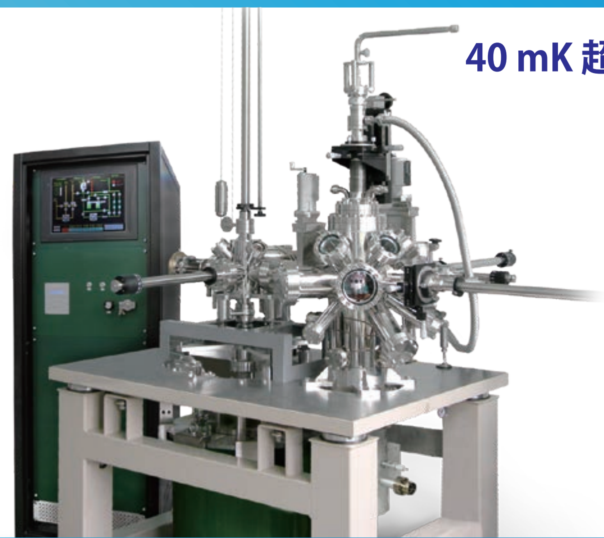
温度: 77 K 又は 300 K
真空度: $\sim 10^{-8}$ Pa
レーザー波長: 488, 532 nm
時間分解能: ~80 ps (532 nm), ~10 ns (488 nm)

40 mK UHV STM
40 mK 超高真空強磁場STM

1.75 T-1.75 T-7 T vector magnet

Scheduled to start in November 2023

2023年11月開始予定



USM1600

Specifications

- $T_{STM\ Head}$ = 40 mK
- Vector Magnet operation
- RF-STM
- Long-term dI/dV measurement

装置仕様

40 mK以下
ベクターマグネット操作
高周波STM測定
長時間dI/dV測定

1.5 K UHV SPM with Optical Access
1.5 K超高真空光学アクセスSPM

Scheduled to start in November 2023

2023年11月開始予定

USM1200 JT

Specifications

- $T_{STM\ Head}$ = 1.5 K (when optical shutters close)
- Compatible with AFM measurement
- Optical access capabilities by inertial-driven lens stages
- Time resolved STM with high spatial resolution
- Shot noise measurement by integrated RydeenAmp

装置仕様

試料温度1.5 K以下（光学アクセス閉鎖時）
AFM対応　内部レンズ付き光学アクセス
高空間分解能時間分解STM
Rydeen Amp（内蔵高周波アンプ）によるショットノイズ測定

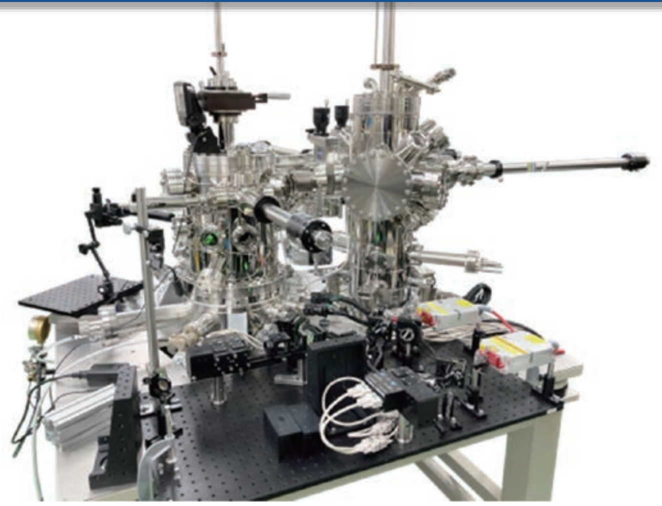
Product Development News in 2022

2022年 製品開発 ニュース

ご興味のある方は、info@unisoku.co.jp にご連絡下さい。 If you're interested, please contact us at info@unisoku.co.jp

Time-Resolved Scanning Tunneling Microscope

時間分解STM **New product!**



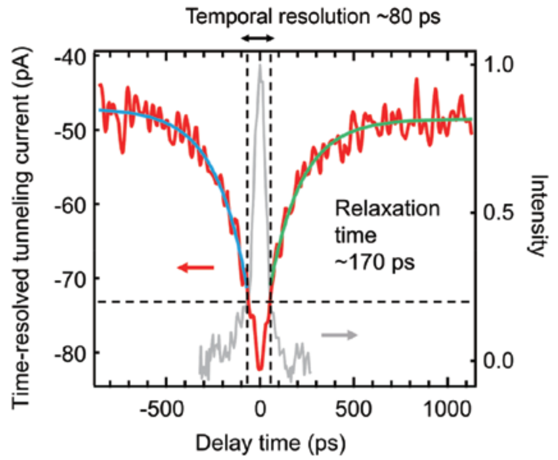
Scientific Reports

"Externally-triggerable optical pump-probe scanning tunneling microscopy with a time resolution of tens-picosecond"

Sci. Rep. **13**, 818 (2023).

Katsuya Iwaya*, Munenori Yokota, Hiroaki Hanada, Hiroyuki Mogi, Shoji Yoshida, Osamu Takeuchi, Yutaka Miyatake, Hidemi Shigekawa**

Time-resolved tunneling current of low-temperature grown GaAs



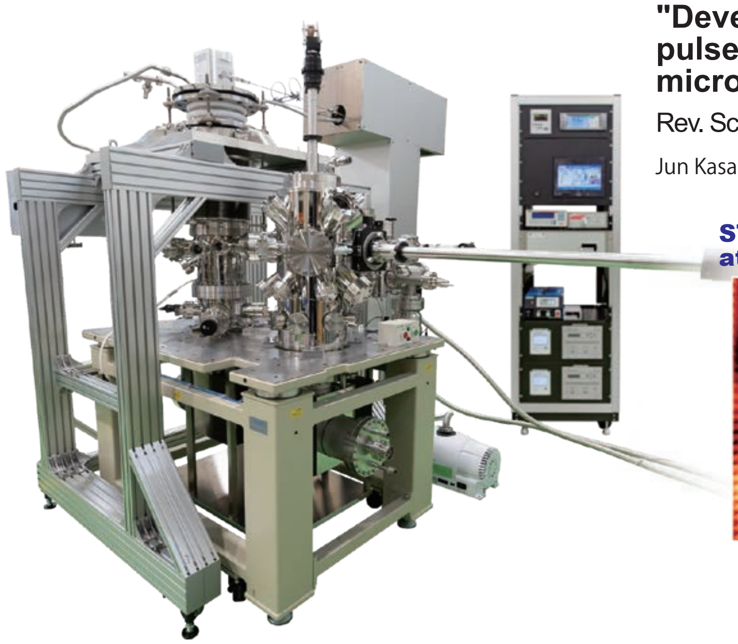
Collaboration with Prof. Shigekawa group (Univ. of Tsukuba) and financially supported by JST

- **Nano-scale carrier dynamics measurements with time resolution of 80 ps**
- **Compact table-top optical system (Integration into an existing STM system is possible)**
- **The design and performance of the prototype system published in Sci. Rep.**

Cryogen-Free SPM (USM1800)

液体ヘリウムフリー低温SPM

The design and performance of the prototype system published in Rev. Sci. Instrum.



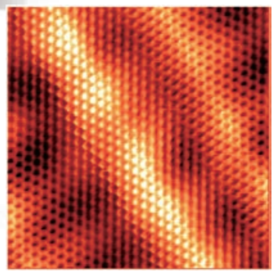
Review of Scientific Instruments

"Development of a near-5-Kelvin, cryogen-free, pulse-tube refrigerator-based scanning probe microscope"

Rev. Sci. Instrum. **93**, 043711 (2022).

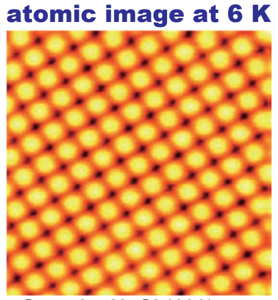
Jun Kasai*, Tomoki Koyama, Munenori Yokota, and Katsuya Iwaya**

STM Au(111) atomic image at 5.6 K



Scan size 7 nm x 7 nm
Bias voltage: +5 mV
Tunnel current: 1 nA

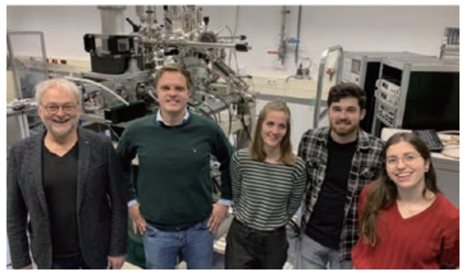
Nc-AFM NaCl atomic image at 6 K

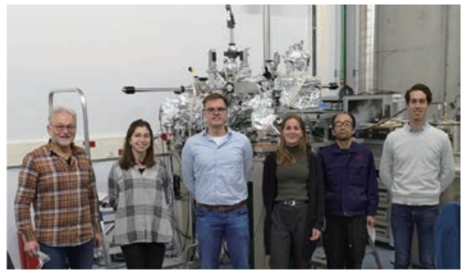


Sample: NaCl (100)
AFM sensor: qPlus
amplitude: 200 pm
Frequency shift: -13 Hz

RydeenAmp

雷電アンプ

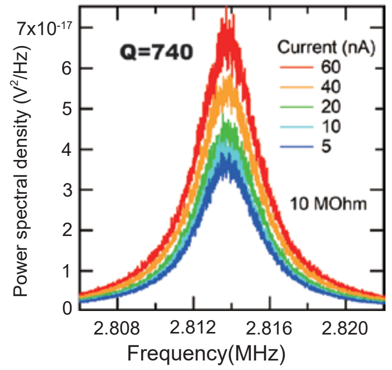


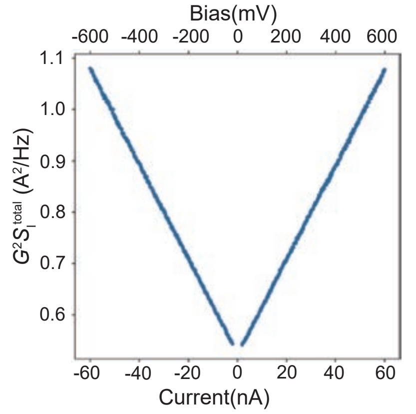


First RydeenAmp integrated with USM1300 operating in Prof. Ingmar Swart group (Utrecht Univ.)

Q factor ~740 @T = 0.3 K

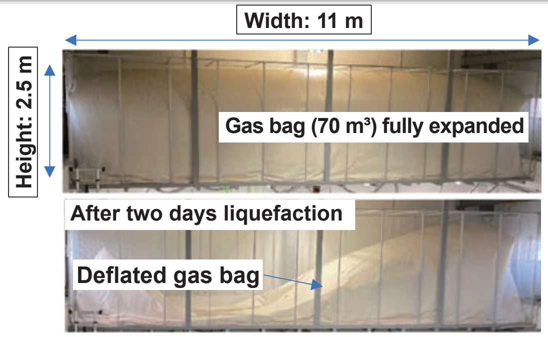
Shot noise measurement on Au(111) at T = 0.3 K

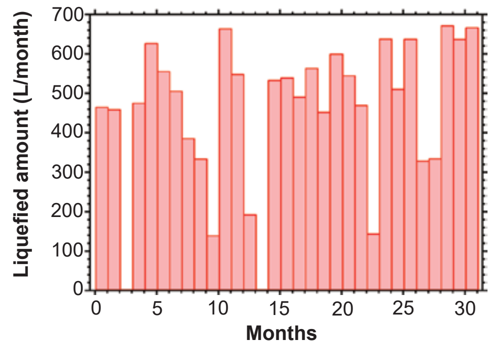


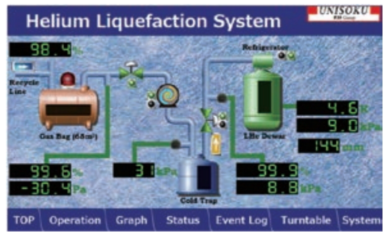


Helium Re-Liquefaction System Operated in UNISOKU

社内ヘリウム液化システム







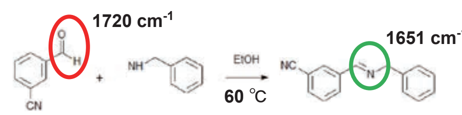
- Maximum production > 25 L/day!
- Total liquefied amount since May 2020: ~15,000 liters.
- Gas-purifier using liquid nitrogen enables long-time operation.
- Automatic control of the purifier reduces maintenance work.

Microwave Heating Raman Spectrometer

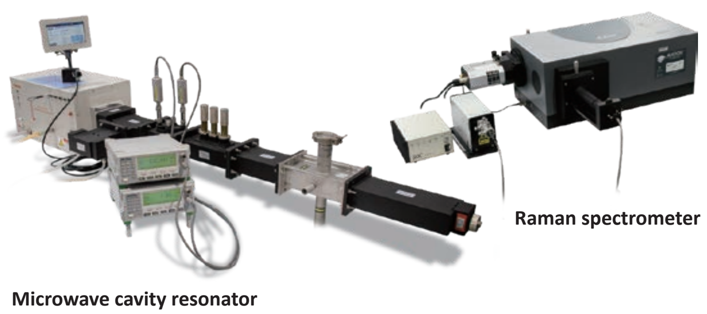
マイクロ波加熱ラマン分光装置

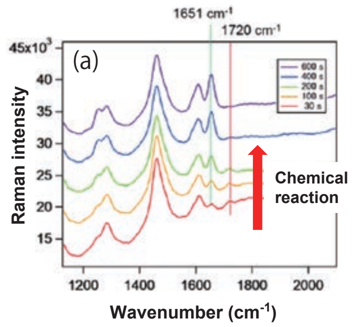
- **In-situ observation of chemical reactions by selective microwave heating**
- **Collaboration with MOTOYAMA Co., Ltd.**

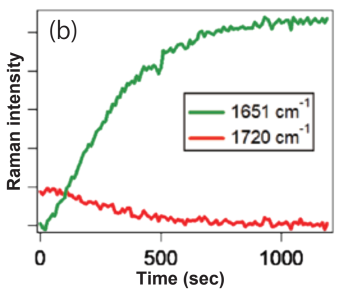
Ex. Imine-synthesis reaction measurement



Demo measurements currently available







(a) In situ Raman spectra of Imine synthesis reaction.
(b) Time-resolved Raman intensity of each peak (10 second intervals).

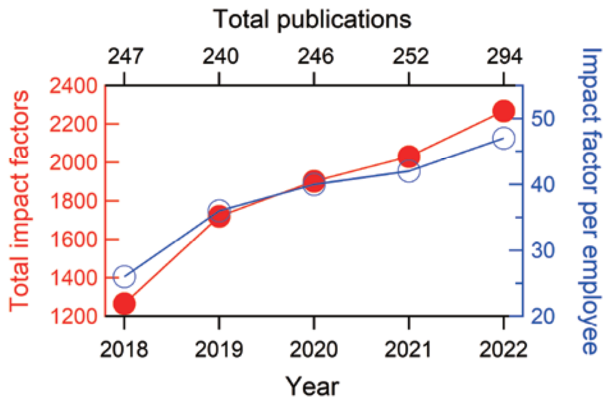
Introduction of Publications

論文の紹介

Publication Stats in 2022

- Total number of publications using UNISOKU systems = 294 (252 in 2021)
- Total impact factors ~2268 (2030 in 2021)
  Corresponding to 45 Nature papers (41 in 2021)
- Impact factor per employee ~ 47 (~42 in 2021)
  c.f. impact factor of Nature ~50

Popular Research Fields	Num. of Publications	Average Impact Factor
Thin Films Excluding TMDs (Nanowire, 2D Superconductivity, 2D vdW, etc)	35	7.99
Transition Metal Dichalcogenides (TMDs)	29	12.63
Molecules	28	9.76
Topological Materials (Majorana, Weyl)	27	12.92
Graphene (Twisted Bilayer Graphene)	22	13.64
Kagome Materials	14	15.63



Evidence for Unconventional Superconductivity in Twisted Trilayer Graphene

Kim *et al.*, Nature **606**, 494 (2022).

Product used: USM1300

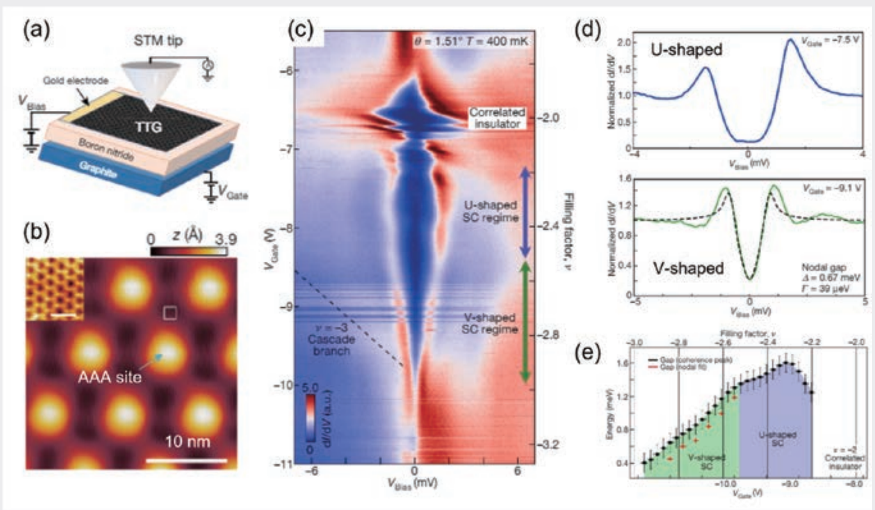


Figure
(a) Configuration of the STM experiment. (b) STM image of MATTG showing moiré lattices. (c) dI/dV spectra taken near AAA site as a function of the gate voltage. (d) U-shaped superconducting gap at V_{Gate} = -7.5 V (top) and V-shaped superconducting gap at V_{Gate} = -9.1 V (bottom). (e) Superconducting gap size Δ as a function of V_{Gate}.

Magic-angle twisted trilayer graphene (MATTG) is a moiré material that exhibits strong electron correlations and unconventional superconductivity. However, local spectroscopic studies of this system have remained elusive. Kim *et al.* (Nadj-Perge group, California Institute of Technology) reported spectroscopic signatures of two distinct superconducting states in the doping range spanning from two to three holes per moiré unit cell. The evolution with doping is consistent with a gate-tunable transition from a gapped to a nodal superconductor, which is theoretically compatible with a transition from a BCS superconductor to a BEC superconductor with a nodal order parameter. Their results will provide a further understanding of superconductivity and correlated states in graphene-based moiré structures beyond twisted bilayers.

Publication List in 2022

Nature

1. **Ordered and Tunable Majorana-Zero-Mode Lattice in Naturally Strained LiFeAs**
   M. Li *et al.*, Nature **606**, 890 (2022). USM1300
2. **Evidence for Unconventional Superconductivity in Twisted Trilayer Graphene**
   H. Kim *et al.*, Nature **606**, 494 (2022). USM1300
3. **Discovery of Charge Density Wave in a Kagome Lattice Antiferromagnet**
   X. Teng *et al.*, Nature **609**, 490 (2022). USM1300
4. **Delayed Fluorescence from Inverted Singlet and Triplet Excited States**
   N. Aizawa *et al.*, Nature **609**, 502 (2022). picoTAS

Science

1. **Reconfigurable Perovskite Nickelate Electronics for Artificial Intelligence**
   H. Zhang *et al.*, Science **375**, 533 (2022). USM1400
2. **Spin-Selective Tunneling from Nanowires of the Candidate Topological Kondo Insulator SmB_6**
   A. Aishwarya *et al.*, Science **377**, 1218 (2022). USM1300

Nature Materials

Evidence of a Room-temperature Quantum Spin Hall Edge State in a Higher-Order Topological Insulator
N. Shumiya *et al.*, Nat. Mater. **21**, 1111 (2022). USM1300

Nature Nanotechnology

Wavelike Electronic Energy Transfer in Donor- Acceptor Molecular Systems through Quantum Coherence
F. Kong *et al.*, Nat. Nanotechnol. **17**, 729 (2022). USM1400

Advanced Materials

1. **Harnessing the Quantum Behavior of Spins on Surfaces**
   Y. Chen *et al.*, Adv. Mater.DOI: 10.1002/adma.202107534 USM1300
2. **Nontrivial Doping Evolution of Electronic Properties in Ising-Superconducting Alloys**
   W. Wan *et al.*, Adv. Mater. **34**, 2200492 (2022). USM1300
3. **Catalytic Growth of Ultralong Graphene Nanoribbons on Insulating Substrates**
   B. Lyu *et al.*, Adv. Mater. **34**, 2200956 (2022). JT-SPM
4. **Observation of Superconducting Collective Modes from Competing Pairing Instabilities in Single-Layer $NbSe_2$**
   W. Wan *et al.*, Adv. Mater. **34**, 2206078 (2022). USM1300

Nature Sustainability

Harnessing Infrared Solar Energy with Plasmonic Energy Upconversion
Z. Lian *et al.*, Nat. Sustain. **5**, 1092 (2022). PK120

Nature Chemistry

Quantum Nanomagnets in on-Surface Metal-Free Porphyrin Chains
Y. Zhao *et al.*, Nat. Chem. DOI: 10.1038/s41557-022-01061-5 JT-SPM

Nature Physics

1. **Rotation Symmetry Breaking in the Normal State of a Kagome Superconductor KV_3Sb_5**
   H. Li *et al.*, Nat. Phys. **18**, 265 (2022). USM1300
2. **Charge Order and Superconductivity in Kagome Materials**
   T. Neupert *et al.*, Nat. Phys. **18**, 137 (2022). USM1300
3. **Manipulation of Dirac Band Curvature and Momentum-Dependent G-factor in a Kagome Magnet YMn_6Sn_6**
   H. Li *et al.*, Nat. Phys. **18**, 644 (2022). USM1300
4. **Correlated Hofstadter Spectrum and Flavour Phase Diagram in Magic-Angle Twisted Bilayer Graphene**
   J. Yu *et al.*, Nat. Phys. **18**, 825 (2022). USM1300

Publication List in 2022

Advanced Functional Materials

1. **Bimetallic Synergy in Ultrafine Cocatalyst Alloy Nanoparticles for Efficient Photocatalytic Water Splitting**
   C. Pelicano *et al.*, Adv. Func. Mater. **32**, 2202987 (2022). CoolSpeK
2. **Eliminating the Reverse ISC Bottleneck of TADF through Excited State Engineering and Environment-Tuning Toward State Resonance Leading to Mono-Exponential Sub-μs Decay. High OLED External Quantum Efficiency Confirms Efficient Exciton Harvesting**
   H. Yersin *et al.*, Adv. Func. Mater. **32**, 2201772 (2022). USP-PSMM-NP
3. **Selective Triplet–Singlet Förster-Resonance Energy Transfer for Bright Red Afterglow Emission**
   B. Sk *et al.*, Adv. Func. Mater. DOI: 10.1002/adfm.202211604 picoTAS

ACS Nano 1/2

1. **Manipulating the Electronic and Magnetic Properties of Coordinated Nickel Atoms in Metal-Organic Frameworks by Hydrogenation**
   B. Liu *et al.*, ACS Nano **16**, 2147 (2022). USM1300
2. **Large-Gap Quantum Spin Hall State and Temperature-Induced Lifshitz Transition in Bi_4Br_4**
   M. Yang *et al.*, ACS Nano **16**, 3036 (2022). USM1400
3. **Planar Heterojunction of Ultrathin $CrTe_3$ and $CrTe_2$ van der Waals Magnet**
   R. Li *et al.*, ACS Nano **16**, 4348 (2022). USM1500
4. **Two-Dimensional Superconductivity of Ca-Intercalated Graphene on SiC: Vital Role of the Interface Between Monolayer Graphene and the Substrate**
   H. Toyama *et al.*, ACS Nano **16**, 3582 (2022). USM1300
5. **Observation of Yu-Shiba-Rusinov States and Inelastic Tunneling Spectroscopy for Intramolecule Magnetic Exchange Interaction Energy of Terbium Phthalocyanine (TbPc) Species Adsorbed on Superconductor $NbSe_2$**
   S. Shahed et al., ACS Nano **16**, 7651 (2022). USM1300
6. **Observation of Magnetism-Induced Topological Edge State in Antiferromagnetic Topological Insulator $MnBi_4Te_7$**
   H. Xu *et al.*, ACS Nano **16**, 9810 (2022). USM1600
7. **Manipulation of Spin Polarization in Boron-Substituted Graphene Nanoribbons**
   K. Sun *et al.*, ACS Nano **16**, 11244 (2022). USM1300
8. **On-Site Synthesis and Characterizations of Atomically-Thin Nickel Tellurides with Versatile Stoichiometric Phases through Self-Intercalation**
   S. Pan *et al.*, ACS Nano **16**, 11444 (2022). USM1400
9. **Confined Vacuum Resonances as Artificial Atoms with Tunable Lifetime**
   R. Rejali *et al.*, ACS Nano **16**, 11251 (2022). USM1300
10. **Femtosecond Thermal and Nonthermal Hot Electron Tunneling inside a Photoexcited Tunnel Junction**
    N. Sabanes *et al.*, ACS Nano **16**, 14479 (2022). USM1400
11. **Joule Heating in Single-Molecule Point Contacts Studied by Tip-Enhanced Raman Spectroscopy**
    B. Cirera *et al.*, ACS Nano **16**, 16443 (2022). USM1400

Spin-Selective Tunneling from Nanowires of the Candidate Topological Kondo Insulator SmB_6

Aishwarya *et al.*, Science, **377**, 1218 (2022). Product used: USM1300

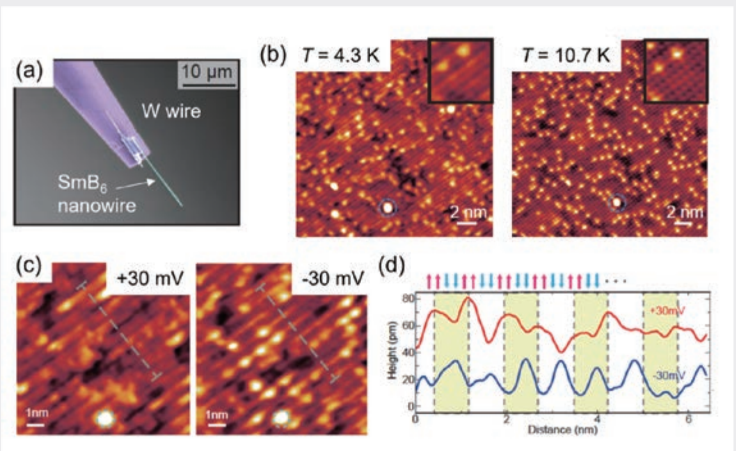


Figure
(a) A SEM image of the SmB_6 nanowire tip.
(b) Temperature-dependent STM image showing the disappearance of antiferromagnetic stripes in $Fe_{1.03}Te$.
(c) Contrast reversal of the antiferromagnetic stripes at opposite bias voltages originating from the helical tunneling with SmB_6 nanowire tip. T = 4.3 K.
(d) Line profile along dashed lines in (c).

Topological Kondo insulators (TKIs) are known to be ideal topological systems where surface Dirac fermions naturally dominate the density of states near the Fermi level due to the hybridization gap originating from localized f electrons and conduction electrons together with the strong spin-orbit coupling. Aishwarya *et al.* (Madhavan group, University of Illinois Urbana-Champaign) utilized a nanowire of the TKI candidate SmB_6 as an STM tip to image the stripe spin order in the antiferromagnet $Fe_{1.03}Te$ (Néel temperature of ~50 K). They showed the antiferromagnetic stripes become invisible above 10 K, indicating the suppression of the topological surface states of SmB_6. They also demonstrated a contrast reversal of the antiferromagnetic stripes at opposite bias voltages, which is not observed using Cr tips, indicating the selection of the opposite spin channel in the tunneling current. These results suggest that the SmB_6 nanowires host the topological surface states (TSS) near the Fermi level and may be utilized for manipulating spin currents in spintronics. Their technique of mounting functionalized nanowires on the STM tip opens new avenues for studying various nanoscale properties such as magnetism, superconductivity, and other emergent excitations.

ACS Nano 2/2

12. **Atomistic Insight into the Epitaxial Growth Mechanism of Single-Crystal Two-Dimensional Transition-Metal Dichalcogenides on Au(111) Substrate**
    D. Ding *et al.*, ACS Nano **16**, 17356 (2022). USM1500
13. **Arsenic Monolayers Formed by Zero-Dimensional Tetrahedral Clusters and One-Dimensional Armchair Nanochains**
    G. Liu *et al.*, ACS Nano **16**, 17087 (2022). USM1300
14. **Spatially Dependent Electronic Structures and Excitons in a Marginally Twisted Moiré Superlattice of Spiral WS_2**
    J. Peng *et al.*, ACS Nano **16**, 21600 (2022). USM1400
15. **Epitaxial Growth of High-Quality Monolayer MoS_2 Single Crystals on Low-Symmetry Vicinal Au(101) Facets with Different Miller Indices**
    J. Hu *et al.*, ACS Nano **17**, 312 (2022). USM1400

Journal of the American Chemical Society

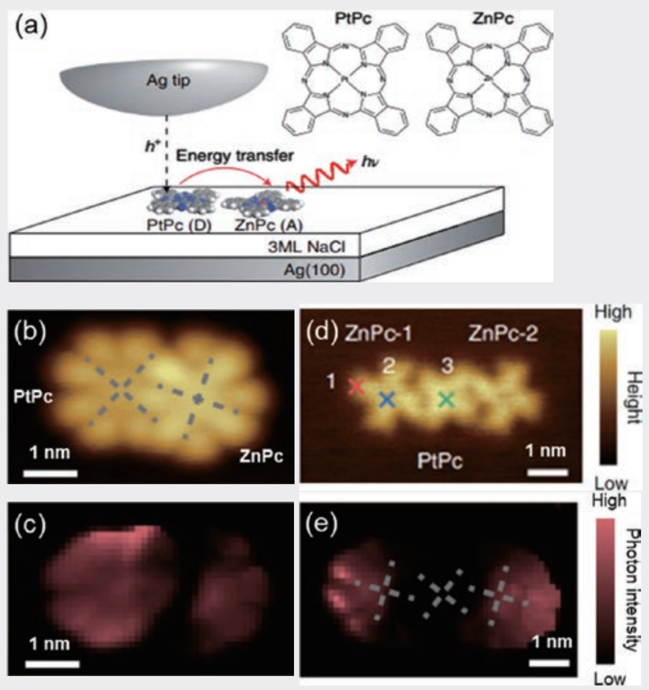
1. **Controlling Localized Plasmons via an Atomistic Approach: Attainment of Site-Selective Activation inside a Single Molecule**
   S. Mahapatra *et al.*, J. Am. Chem. Soc. **144**, 2051 (2022). USM1400
2. **Mimicking the High-Valent Heme-Oxo Mediated Indole Monooxygenation Reaction Landscape of Heme Enzymes**
   P. Mondal *et al.*, J. Am. Chem. Soc. **144**, 3843 (2022). CoolSpeK
3. **Bright, Modular, and Switchable Near-Infrared II Emission from Compact Tetrathiafulvalene-Based Diradicaloid Complexes**
   L. McNamara *et al.*, J. Am. Chem. Soc. **144**, 16447 (2022). CoolSpeK
4. **Controlling Diradical Character of Photogenerated Colored Isomers of Phenoxyl-Imidazolyl Radical Complexes**
   M. Nishijima *et al.*, J. Am. Chem. Soc. **144**, 17186 (2022). picoTAS
5. **Aliphatic and Aromatic C-H Bond Oxidation by High-Valent Manganese(IV)-Hydroxo Species**
   Y. Lee *et al.*, J. Am. Chem. Soc. **144**, 20752 (2022). CoolSpeK
6. **Preparation and Characterization of a Formally NiIV-Oxo Complex with a Triplet Ground State and Application in Oxidation Reactions**
   D. Karmalkar *et al.*, J. Am. Chem. Soc. **144**, 22698 (2022). CoolSpeK, RSP-601

Nature Communications 1/2

1. **Spin Mapping of Intralayer Antiferromagnetism and Field-Induced Spin Reorientation in Monolayer $CrTe_2$**
   J. Xian *et al.*, Nat. Commun. **13**, 257 (2022). USM1500
2. **Real-space Observation of Incommensurate Spin Density Wave and Coexisting Charge Density Wave on Cr(001) Surface**
   Y. Hu *et al.*, Nat. Commun. **13**, 445 (2022). USM1300
3. **Coexistence of Electron Whispering-Gallery Modes and Atomic Collapse States in Graphene/WSe_2 Heterostructure Quantum Dots**
   Q. Zheng *et al.*, Nat. Commun. **13**, 1597 (2022). USM1300, USM1400
4. **Chemically Identifying Single Adatoms with Single-Bond Sensitivity during Oxidation Reactions of Borophene**
   L. Li *et al.*, Nat. Commun. **13**, 1796 (2022). USM1400

Wavelike Electronic Energy Transfer in Donor–acceptor Molecular Systems Through Quantum Coherence

Kong *et al.*, Nat. Nanotechnol. **17**, 729-736 (2022). Product used: USM1400



Intermolecular energy transfer in a donor-acceptor system is a ubiquitous photo-physical process and important for photosynthesis and photovoltaics. However, direct real-space observation of such quantum-coherent energy transfer has been lacking. Kong *et al.*, (Dong group, Univ. of Science and Technology of China) built a donor-acceptor molecular model system consisting of platinum phthalocyanine (PtPc) as a donor and zinc phthalocyanine (ZnPc) as an acceptor on a silver surface. They precisely controlled intermolecular separation and observed the energy transfer process between molecules by a scanning tunneling luminescence technique. With decreasing intermolecular distance, light emission peaks from the dimer or trimer were found to be spatially delocalized, indicating that exciton can travel coherently through the whole dimer/trimer as a quantum-mechanical wavepacket. The results give a new insight into molecular-level energy transfer mechanisms, which will provide comprehensive guidance to design a controlled artificial device related to energy production or optoelectronics.

Figure
(a) Experimental-setup.(b, c) STM image of PtPc and ZnPc dimer and its spectroscopic image at the emission peak of the dimer.
(d, e) STM image of ZnPc-PtPc-ZnPc trimer and its spectroscopic image at the emission peak of the trimer.

Publication List in 2022

Nature Communications 2/2

5. **Atomic-Scale Visualization of Chiral Charge Density Wave Superlattices and Their Reversible Switching**
   X. Song *et al*., Nat. Commun. **13**, 1843 (2022). USM1300
6. **Inducing and Tuning Kondo Screening in a Narrow-Electronic-Band System**
   S. Shen *et al*., Nat. Commun. **13**, 2156 (2022). USM1600
7. **Chirality Locking Charge Density Waves in a Chiral Crystal**
   G. Li *et al*., Nat. Commun. **13**, 2914 (2022). USM1600
8. **Evolution of Br···Brcontacts in Enantioselective Molecular Recognition during Chiral 2D Crystallization**
   Z. Yi *et al*., Nat. Commun. **13**, 5850 (2022). USM1400
9. **Discovery of Conjoined Charge Density Waves in the Kagome Superconductor CsV_3Sb_5**
   H. Li *et al*., Nat. Commun. **13**, 6348 (2022). USM1300
10. **Spin-Orbital Yu-Shiba-Rusinovstates in Single Kondo Molecular Magnet**
    H. Xia *et al*., Nat. Commun. **13**, 6388 (2022). USM1300

Science Advances

1. **Observation of Robust Zero-Energy State and Enhanced Superconducting Gap in a Trilayer Heterostructure of MnTe/Bi_2Te_3/Fe(Te, Se)**
   S. Ding *et al*., Sci. Adv. **8**, eabq4578 (2022). USM1300
2. **Nanoscale Coherent Phonon Spectroscopy**
   S. Liu *et al*., Sci. Adv. **8**, eabq5682 (2022). USM1400

Nature Protocol

Synthesis of Cyclodextrin Derivatives for Enantiodifferentiating Photocyclodimerization of 2-Anthracenecarboxylate
X. Wei *et al*., Nat. Protoc. **17**, 2494 (2022). CoolSpeK

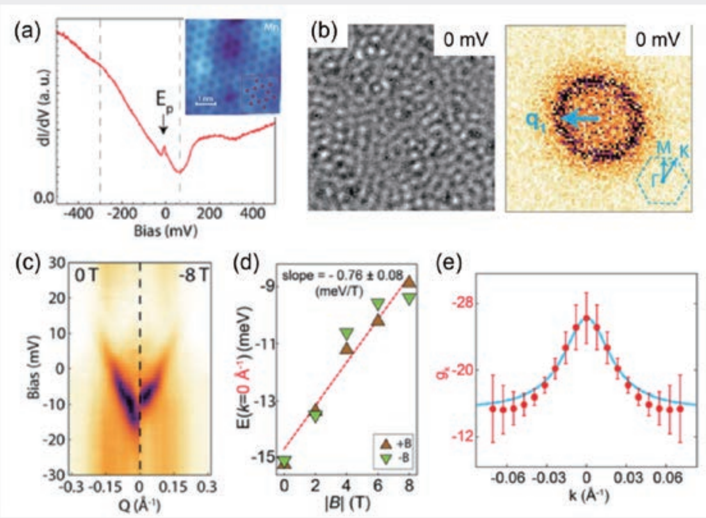
ACS Catalysis

1. **Cobalt-Catalyzed Hydrogenation Reactions Enabled by Ligand-Based Storage of Dihydrogen**
   S. Anferov *et al*., ACS Catal.**12** , 9933 (2022). CoolSpeK
2. **How Do the Axial and Equatorial Ligands Modulate the Reactivity of a Metal-Bound Terminal Oxidant? An Answer from the Hypochlorite Adduct of Iron(III) Porphyrin**
   S. Yokota *et al*., ACS Catal.**12**, 10857 (2022). CoolSpeK

Manipulation of Dirac Band Curvature and Momentum-Dependent g Factor in a Kagome Magnet

Li *et al*., Nat. Phys. **18**, 644 (2022).

Product used: USM1300



The Zeeman effect is the effect of splitting a spectral line into several components in magnetic fields. The magnitude and the direction of this splitting depend on the Landé g-factor, which is theoretically predicted to vary with the crystal momentum. This can lead to field-induced modifications to the electronic band structure in topological and magnetic systems. However, experimental observation of such momentum-dependence of the g-factor has remained challenging. Li *et al*. (Zeljkovic group, Boston College) reported the experimental discovery of a strongly momentum-dependent g-factor in a kagome magnet YMn_6Sn_6 using quasiparticle interference (QPI) imaging in magnetic fields. They found that a massive Dirac dispersion crossing the Fermi level shifts linearly with magnetic fields and by plotting the field-induced shift of the Dirac state at each momentum, the momentum-dependent g-factor is successfully obtained. Their result provides the first momentum-resolved visualization of Dirac band manipulation by the magnetic field, providing the possibility of driving topological phase transitions.

Figure
(a) Averaged dI/dV spectrum on the kagome Mn layer of YMn_6Sn_6. (inset) Atomically-resolved STM image.
(b) dI/dV map at 0 mV (left) and its FFT image (right). (c) Energy dispersion of the QPI pattern at 0 T (left) and -8 T (right).
(d) Dispersion of the quantum state at k = 0 with magnetic field. (e) Measured g-factor in momentum space.

Nano Letters

1. **Moiré-Enabled Topological Superconductivity**
   S. Kezilebieke *et al*., Nano Lett. **22**, 328 (2022). USM1300
2. **Semiconductor–Metal Phase Transition and Emergent Charge Density Waves in 1T-ZrX_2 (X = Se, Te) at the Two-Dimensional Limit**
   M. Ren *et al*., Nano Lett. **22**, 476 (2022). USM1500
3. **Nanoscale Control of One-Dimensional Confined States in Strongly Correlated Homojunctions**
   Q. Zhang *et al*., Nano Lett. **22**, 1190 (2022). USM1300
4. **Evolution of Electronic Structure in Pristine and Rb-Reconstructed Surfaces of Kagome Metal RbV_3Sb_5**
   J. Yu *et al*., Nano Lett. **22**, 918 (2022). USM1300
5. **Confinement-Engineered Superconductor to Correlated-Insulator Transition in a Van Der Waals Monolayer**
   S. Ganguli *et al*., Nano Lett. **22**, 1845 (2022). USM1300
6. **Charge Transfer-Mediated Dramatic Enhancement of Raman Scattering upon Molecular Point Contact Formation**
   B. Cirera *et al*., Nano Lett. **22**, 2170 (2022). USM1400
7. **Fully Two-Dimensional Incommensurate Charge Modulation on the Pd-Terminated Polar Surface of $PdCoO_2$**
   P. Kong *et al*., Nano Lett. **22**, 5635 (2022). USM1200
8. **Tuning of the Valley Structures in Monolayer In_2Se_3/WSe_2 Heterostructures via Ferroelectricity**
   D. Huo *et al*., Nano Lett. **22**, 7261 (2022). USM1400
9. **Strong Coupling Superconductivity in Ca-Intercalated Bilayer Graphene on SiC**
   X. Wang *et al*., Nano Lett. **22**, 7651 (2022). USM1300
10. **Fabrication and Imaging Monatomic Ni Kagome Lattice on Superconducting Pb(111)**
    Y. Lin *et al*., Nano Lett. **22**, 8475 (2022). USM1300
11. **Experimental Determination of a Single Atom Ground State Orbital through Hyperfine Anisotropy**
    L. Farinacci *et al*., Nano Lett. **22**, 8470 (2022). USM1300
12. **Visualizing Large Facet-Dependent Electronic Tuning in Monolayer WSe_2 on Au Surfaces**
    B. Zhu *et al*., Nano Lett. **22**, 9630 (2022). USM1400

Proc. Natl. Acad. Sci. USA

1. **Long-lifetime Spin Excitations Near Domain Walls in 1T-TaS_2**
   A. Aishwarya *et al*., PNAS **119**, e2121740119 (2022). USM1300
2. **Discrete Scale Invariance of the Quasi-Bound States at Atomic Vacancies in a Topological Material**
   Z. Shao *et al*., PNAS **119**, e2204804119 (2022). USM1300
3. **Correlation-Driven Electronic Nematicity in the Dirac Semimetal $BaNiS_2$**
   C. Butler *et al*., PNAS **119**, e2212730119 (2022). USM1300

Chemically Identifying Single Adatoms with Single-Bond Sensitivity During Oxidation Reactions of Borophene

Li *et al*., Nat. Commun. **13**, 1796 (2022).

Product used: USM1400

Investigating individual atomic adsorbates on a surface is critically important to understand the atomic-scale processes associated with on-surface chemical reactions but remains highly challenging. Utilizing the combination of STM and tip-enhanced Raman spectroscopy (TERS) measurements, Li et al.(Nan Jiang group, University of Illinois Chicago) observed the oxidation of a boron monolayer (borophene) with ~0.5 nm chemical spatial resolution and single bond (B-O) sensitivity. It was found that the oxygen molecule dissociates on a borophene sheet in a thermally reversible manner, revealing the reactive nature of borophene for oxygen molecule activation. Their experimental technique represents the potential capabilities of investigating site-resolved structural and chemical properties of surface species at the atomic level in the field of catalysis, on-surface molecular engineering, and low-dimensional materials.

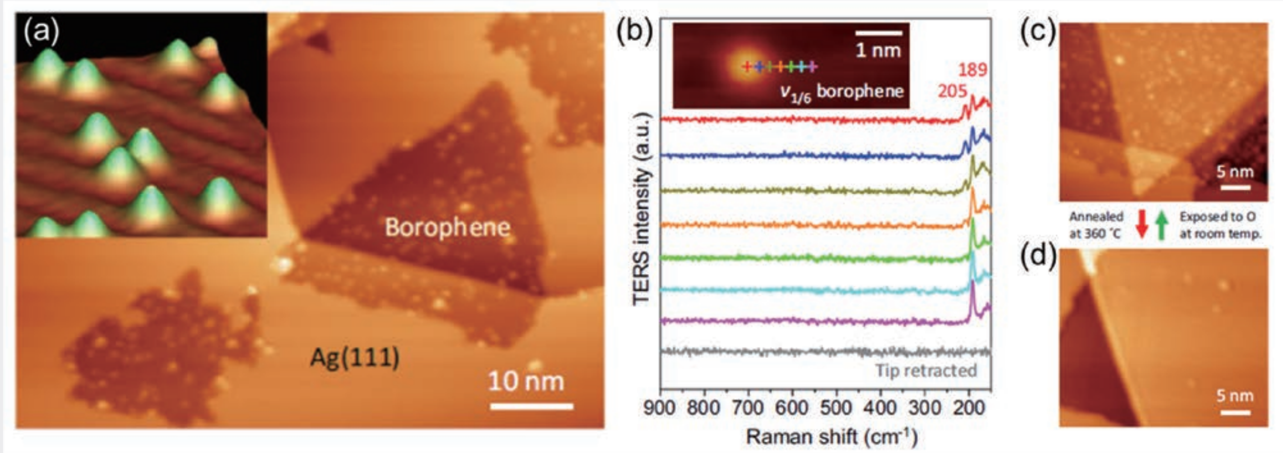


Figure
(a) STM image of borophene/Ag(111). Inset: three-dimensional rendered STM image of oxygen adatoms on borophene.
(b) TERS line scan across the interface of an oxygen adatom on $v_{1/6}$ borophene in the inset STM image.
(c,d) STM images of oxidized borophene before and after annealed at 360 ℃.

Publication List in 2022

NPJ 2D Materials and Applications

1. **Visualization of Defect Induced In-Gap States in Monolayer MoS_2**
   D. Trainer *et al*., NPJ2D Mater. Appl. **6**, 13 (2022). USM1300
2. **Ultrafast Nanoscale Exciton Dynamics via Laser-Combined Scanning Tunneling Microscopy in Atomically Thin Materials**
   H. Mogi *et al*., NPJ2D Mater. Appl. **6**, 72 (2022). USM1400-4P

Physical Review Letters

1. **Nanoscale Heating of an Ultrathin Oxide Film Studied by Tip-Enhanced Raman Spectroscopy**
   S. Liu *et al*., Phys. Rev. Lett.**128**, 206803 (2022). USM1400
2. **Realizing Valley-Polarized Energy Spectra in Bilayer Graphene Quantum Dots via Continuously Tunable Berry Phases**
   Y. Ren *et al*., Phys. Rev. Lett.**128**, 206805 (2022). USM1300
3. **Coexistence of Robust Edge States and Superconductivity in Few-Layer Stanene**
   C. Zhao *et al*., Phys. Rev. Lett.**128**, 206802 (2022). USM1300-4P
4. **Observation of Biradical Spin Coupling Through Hydrogen Bonds**
   Y. He *et al*., Phys. Rev. Lett.**128**, 236401 (2022). USM1300
5. **Magnetic Moment Preservation and Emergent Kondo Resonance of Co-Phthalocyanine on Semimetallic Sb(111)**
   L. She *et al*., Phys. Rev. Lett.**129**, 026802 (2022). USM1300
6. **Realizing One-Dimensional Electronic States in Graphene via Coupled Zeroth Pseudo-Landau Levels**
   Y. Liu *et al*., Phys. Rev. Lett.**129**, 056803 (2022). USM1500
7. **Tunable Sample-wide Electronic Kagome Lattice in Low-angle Twisted Bilayer Graphene**
   Q. Zheng *et al*., Phys. Rev. Lett.**129**, 076803 (2022). USM1400
8. **Magnetic-Field-Tunable Valley-Contrasting Pseudomagnetic Confinement in Graphene**
   Y. Ren *et al*., Phys. Rev. Lett.**129**, 076802 (2022). USM1300
9. **Characterization and Manipulation of Intervalley Scattering Induced by an Individual Monovacancy in Graphene**
   Y. Zhang *et al*., Phys. Rev. Lett.**129**, 096402 (2022). USM1300
11. **Discovery of Charge Order and Corre sponding Edge State in Kagome Magnet FeGe**
   J. Yin *et al*., Phys. Rev. Lett.**129**, 166401 (2022). USM1300
12. **Visualization of Chiral Electronic Structure and Anomalous Optical Response in a Material with Chiral Charge Density Waves**
   H. Yang *et al*., Phys. Rev. Lett.**129**, 156401 (2022). USM1200
13. **Berry-Phase Switch in Electrostatically Confined Topological Surface States**
   J. Zhang *et al*., Phys. Rev. Lett.**128**, 126402 (2022). USM1300

Nanoscale Coherent Phonon Spectroscopy

Liu *et al*., Sci. Adv. **8**, eabq5682 (2022).

Product used: USM1400

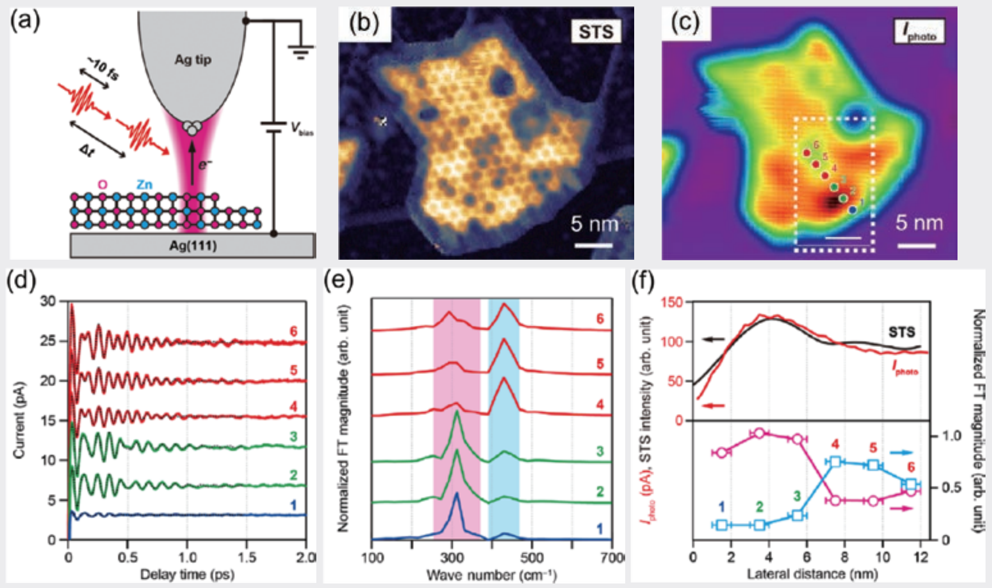


Figure
(a) Schematic of the experiment. (b) dI/dV map at +1.5 V of 3ML ZnO.
(c) Photocurrent Iphoto map taken at the same location as (b). (d) Interferometric autocorrelation traces of I_{photo} at different positions marked in (c). (e) Fourier-transformed (FT) spectra of (d).
(f) Lateral distance dependence of dI/dV, I_{photo} and the FT peak magnitude.

The time evolution of coherent lattice vibrations provides valuable insight into the interaction between electronic and structural degrees of freedom in condensed matter. However, real-space observation of such coherent phonons with nanoscale resolution has remained challenging. Liu *et al*. (Kumagai group, Fritz Haber Institute, Institute for Molecular Science) demonstrated nanoscale coherent phonon spectroscopy measurements on ultrathin ZnO films using ultrafast laser-induced STM (temporal resolution of ~10 fs) combined with scanning tunneling spectroscopy (STS) and tip-enhanced Raman spectroscopy (TERS). Their real-time and real-space observation of ultrafast coherent lattice dynamics will pave the way for studying the coupling of lattice, charge, orbital, and spin degrees of freedom in solids on the atomic scale.

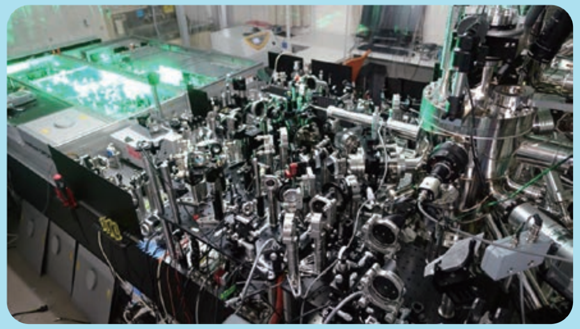
Hidemi Shigekawa

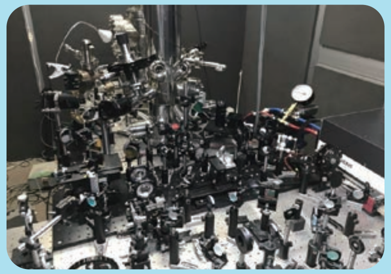
Institute of Pure
and Applied Sciences,
University of Tsukuba, Japan

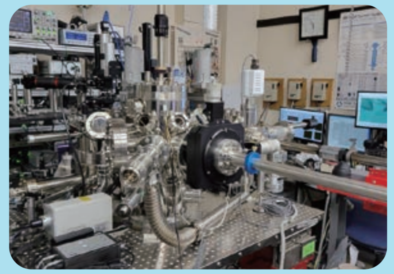
Research Interests

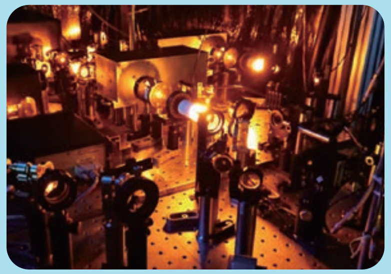
- Time-Resolved SPM
- Quantum Dynamics
- Low Dimensional Materials
- Organic Solar Cells
- Molecular Science
- Biology

SPM Facilities in the Team





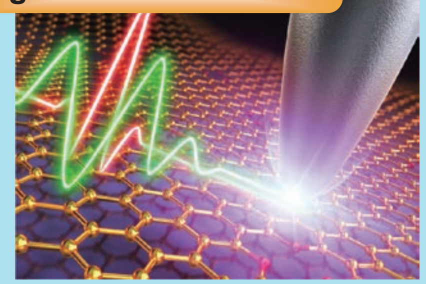




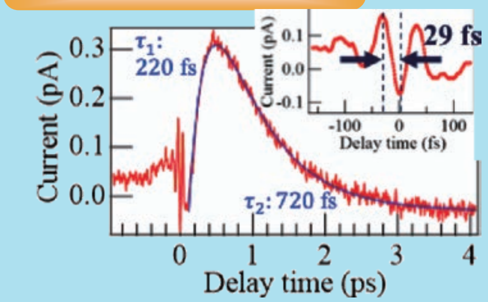
Features:

- Multi THz laser + STM (USM1400)
- USM1400 based four probe STM
- Pump-probe technique (fs to ns)

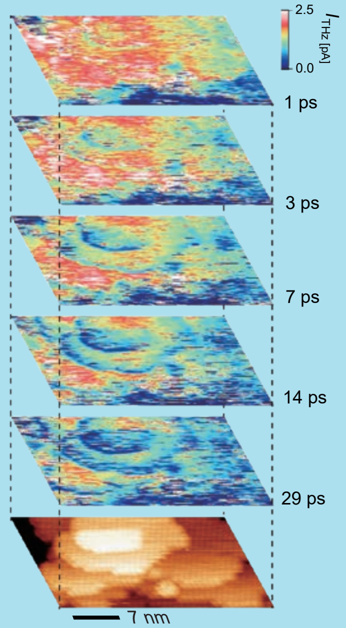
Light-wave Driven STM



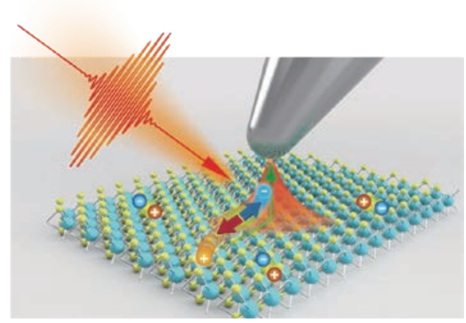
Band Renormalization

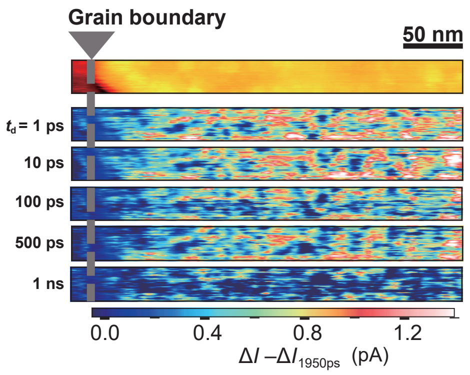


C_{60} Carrier Dynamics



2D Exciton Dynamics



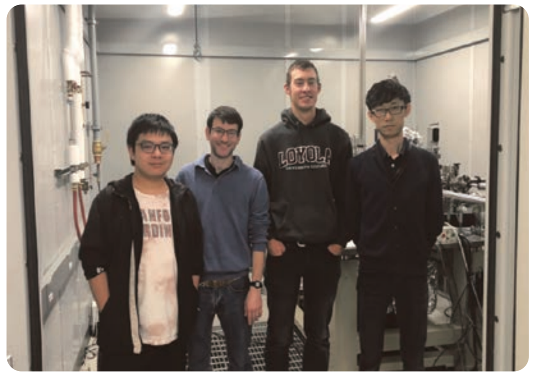


Selected References:

(1) Y. Arashida, *et al*., ACS Photonics, **9**, 3156 (2022).
(2) H. Mogi, *et al*., npj 2D Mater. Appl., **6**, 72 (2022).
(3) S. Yoshida, *et al*., ACS Photonics, **8**, 315 (2021).
(4) K. Yoshioka, *et al*., Nature Photonics, **10**, 762 (2016).
(5) S. Yoshida, *et al*., Nature Nanotechnology, **9**, 588 (2014).

Ben Feldman

Stanford University
at California, U.S.A.



Research Interests

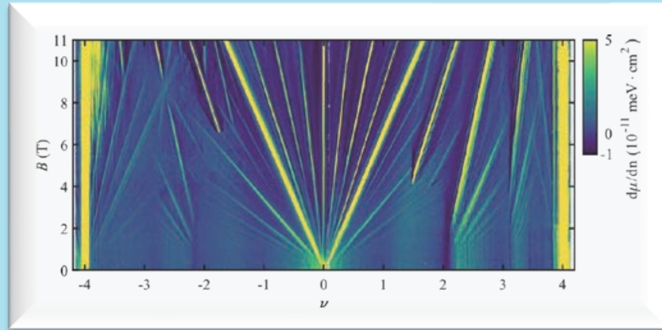
- Scanning probe microscopy
- Electronic interactions and correlated phases
- Topological states
- van der Waals materials and other 2D systems
- Moiré superlattices and emergent ground/excited states
- Electronic compressibility and electronic transport

USM1300

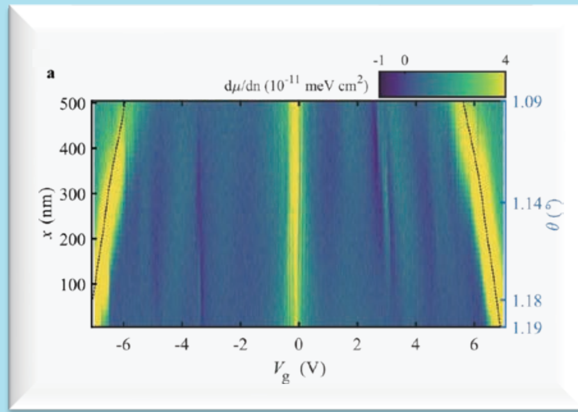
Features:

- STM and single-electron transistor (SET) capability
- Extended (18 x 18 μm^2) XY scan range
- Six independent sample contacts for device experiments
- ^{3}He (330 mK, >90h hold time), 11 T out-of-plane magnet

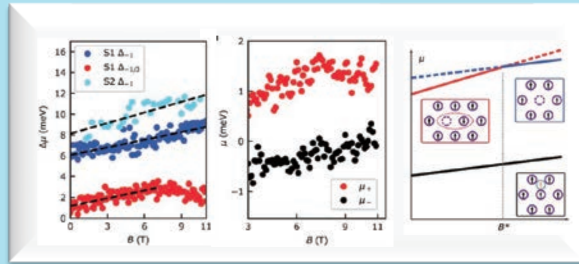
Correlated Chern Insulators in Magic-angle Graphene



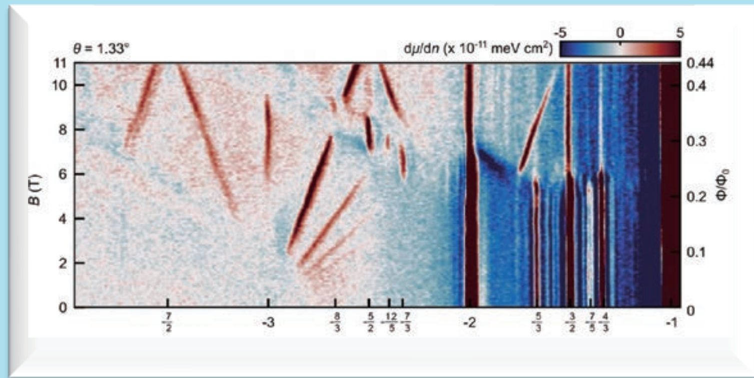
Spatial Dependence of Correlated Insulators in Magic-angle Graphene



Thermodynamic Probe of Spin Polarons in Twisted Double Bilayer WSe₂



Competing Hofstadter States and Charge Order in a Semiconductor Moiré Lattice



Selected References:

(1) J. Yu, *et al.*, Nature Physics, **18** 825 (2022).
(2) B. A. Foutty*, J. Yu*, T. Devakul*, *et al.*, arXiv:2206.10631 (2022).
(3) J. Yu*, B. A. Foutty*, Y. H. Kwan*, *et al.*, arXiv:2206.11304 (2022).
(4) C. R. Kometter*, J. Yu*, T. Devakul*, *et al.*, arXiv:2212.05068 (2022).

Miguel M. Ugeda

Donostia International
Physics Center
at Donostia-San Sebastián, SPAIN

Research Interests

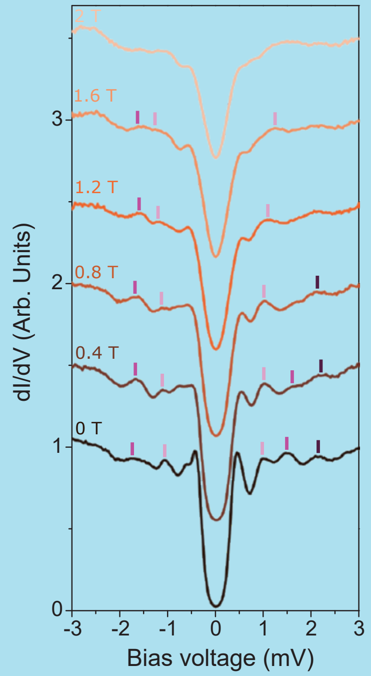
- Electronic/magnetic properties of 2D materials
- Two-dimensional superconductivity
- Strongly correlated materials

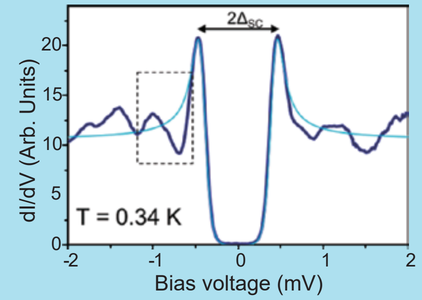
USM1300

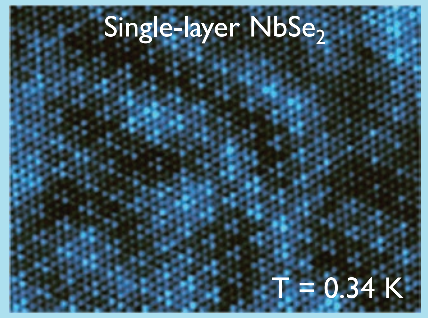
Features:

- 11 T uniaxial z-magnet
- Electron transport capability

Collective Modes in 2D-TMD Superconductors

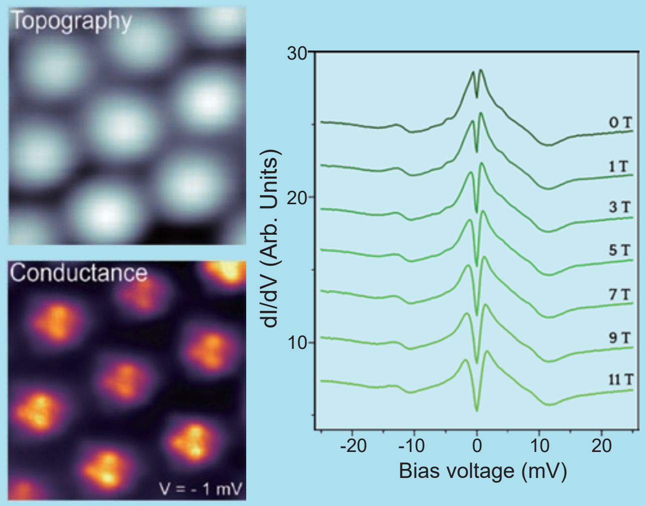






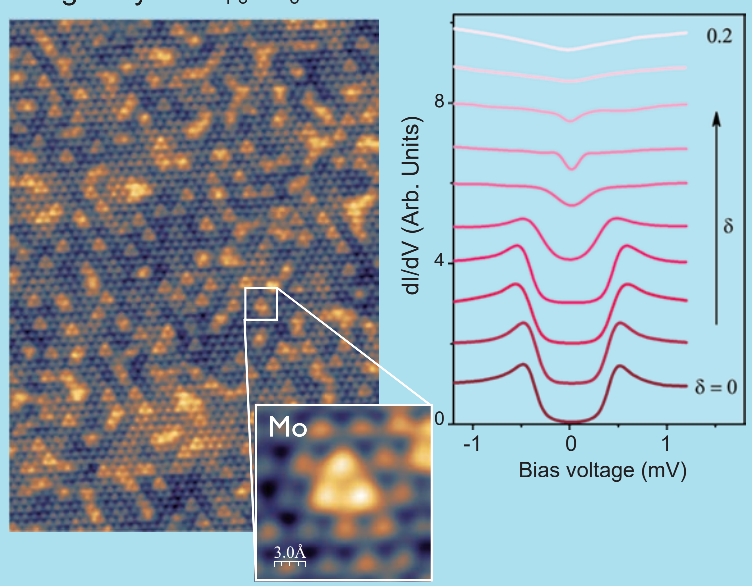
Magnetism in 2D Kondo Lattices

Single-layer 1T-TaSe$_2$ on single-layer 1H-TaSe$_2$



Superconductivity in 2D-TMD Alloys

Single-layer Nb$_{1-\delta}$Mo$_\delta$Se$_2$



Selected References:

(1) W. Wan *et al.*, Advanced Materials, **34,** 2200492 (2022).
(2) W. Wan *et al.*, Advanced Materials, **34,** 2206078 (2022).
(3) W. Wan *et al.*, arXiv:2207.00096 (2022).

User Interview
ユーザーインタビュー

Dr. Naoya Aizawa, Nakayama Lab., Osaka University
大阪大学大学院工学研究科中山研究室　助教 **相澤 直矢** 博士

picoTAS and CoolSpek SLIM contributed to Nature for the first time!

UNISOKU (U) あらためまして、このたびのご研究の Nature への掲載、本当におめでとうございます。弊社のpicoTASを使っていただいたご研究では初のNature/Science論文で、弊社一同大変喜んでおります。反響はいかがですか？

UNISOKU (U): First of all, congratulations on the publication of your research in Nature. We are delighted that our picoTAS was used in your research. How has the response been so far?

相澤博士(A): ありがとうございます。教科書で習うフントの規則を破ったということで、皆様から「おもしろい!」とポジティブな反響を頂いています。2022年のC&EN's molecules of the yearにもノミネートして頂きました。

Dr. Aizawa(A): Thank you. We have received positive feedback. Our heptazine analogue was shortlisted for C&EN's Molecule of the Year for 2022.

U: 論文のタイトルですが、フント則を破るSingletとTripletのエネルギーの逆転の話だけでも十分凄いと思ったのですが、Delayed fluorescence from inverted・・・、となっているのはなぜですか？(研究概要は下記要約参照)

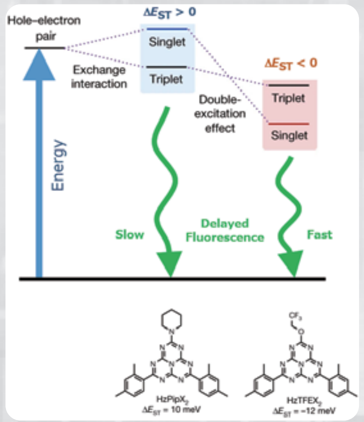
U: The title of your paper, 'Inverted Singlet and Triplet Excited States,' which violates Hund's rule, is already quite impressive. However, I'm curious about the rationale behind including 'Delayed Fluorescence from' in the title. Could you provide some insight into this? (Please refer to the abstract below.)

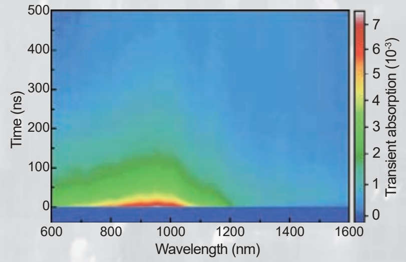
Delayed Fluorescence from Inverted Singlet and Triplet Excited States

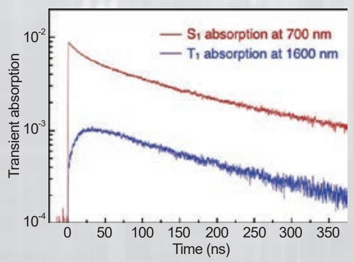
N. Aizawa *et al.*, Nature **609**, 502 (2022).

picoTAS

Recently, numerous photochemists and display manufacturers have focused their efforts on utilizing thermally activated delayed fluorescence (TADF) of organic compounds for OLEDs. This approach is particularly advantageous as it eliminates the need for rare metals. In TADF, luminescence efficiency is enhanced by converting the triplet excited state (T_1) to the singlet excited state (S_1). However, the conversion efficiency is typically limited due to the Hund's rule of maximum multiplicity, which dictates that the energy of T_1 is lower than that of S_1 and thus their energy difference (ΔE_{ST}) is positive. To address this limitation, N. Aizawa at Osaka University and his collaborators conducted computational simulations to screen various heptazine analogues where the ΔE_{ST} could be theoretically negative by violating the Hund's rule. Out of promising candidates, the researchers synthesized two heptazine analogues. They showed that one of these molecules exhibit delayed fluorescence with shorter lifetimes at lower temperatures, and the ΔE_{ST} was experimentally determined to be –11 meV. These findings represent the first instance of the successful creation of a Hund's rule-breaking OLED molecule.







The both data from Extended Data Fig.1

A: SingletとTripletが逆転していることに加えて、遅延蛍光として発光することも強調したかったからです。また、今回の分子が、発光するからこそ、分光学的にSingletとTripletが逆転していると初めて実験で示すことができました。

A: We'd like to emphasize that in addition to the inversion of singlet and triplet states, the molecule also emits delayed fluorescence. Furthermore, we were able to spectroscopically prove the inversion because the molecule is fluorescent.

U: なるほど。ところでセレンディピティ—という言葉がありますが、意外な現象や結果が先に見つかり、理論や目的は後付け、という研究がときどきあると思います。このご研究は、その点についていかがですか？

U: I see. By the way, there's a word called 'serendipity,' which refers to a phenomenon where unexpected discoveries or results are made first, and theories or objectives are added later. I'm curious about how your research relates to this aspect.

A: 今回の研究は理論が先にあり、負のΔE_{ST}を示す材料を狙って設計しました。1980年代からヘプタジン誘導体の理論研究でΔE_{ST}が逆転している可能性が議論されてきましたが、実例がありませんでした。研究の途中では正直半信半疑で、ΔE_{ST}が本当に負だとわかったときはかなり驚きました。

A: We started with theoretically designing candidates having a negative ΔE_{ST}. Since the 1980s, the possibility of negative ΔE_{ST} in heptazine derivatives has been discussed, but no experimental evidence has been reported. I must admit that I was somewhat skeptical, but when we found out that the ΔE_{ST} of the molecule was indeed negative, it was quite surprising.

U:「これはいける」と思ったのはどのタイミングですか？　決定的な証拠はどのような実験でもたらされましたか？

U: At what point did you feel confident about your success, and what kind of experiments provided decisive evidence for your findings?

A: 普通のTADFなら温度を下げると発光寿命は長くなりますが、この分子では寿命が短くなるのを確認したときです。

A: It was when I observed that the fluorescence lifetime of the molecule became shorter as the temperature decreases. For conventional TADF* molecules, the fluorescence lifetimes become longer as the temperature decreases. (*Thermally Activated Delayed Fluorescence)

U: それはもしかして・・・

U: Could it be measured with...

A: はい、ユニソクのクライオスタットCoolSpeKを使って発光寿命の温度依存性を測りました。

A: Yes, We used UNISOKU's CoolSpeK to control the temperature!

U: それは素晴らしい！　着想して結果が出るまで、どのくらいかかりましたか？

U: That's great! How long did it take the inception to outcome?

A: 2020年に着想して、年内にはコアなデータは得られました。むしろ、Natureの査読にすごく時間がかかっています（笑）。

A: We had the idea in 2020, and we obtained the core data within the year. Actually, the review process for the publication in Nature took a long time.

picoTAS CATCHED THE EVIDENCE !　picoTAS が決定的な証拠をとらえた！

U: 査読の過程で、picoTASはどのような役割を果たしましたか？

U: How did picoTAS contribute to the peer-review process?

A: picoTASを用いた過渡吸収測定により、S_1とT_1の間で可逆的な項間交差が起こっている決定的な証拠を得ることができました。過渡蛍光だけでは、T_1が確実に発光に関わっていることを示すことはできません。

また、査読の際に低温下の過渡吸収のデータをレフリーから求められたのですが、picoTAS用の薄型のCoolSpeK-SLIMのおかげで、対応することができました。

A: We were able to obtain decisive evidence of reversible intersystem crossing between the singlet and triplet states by using transient absorption measurements with picoTAS. This evidence was not evident with transient fluorescence alone, and the data from picoTAS provided crucial information about the involvement of triplets in the emission process. During the peer-review process, we were asked to provide low-temperature transient absorption data. Fortunately, we were able to provide the data thanks to the CoolSpeK-SLIM, which was designed for use with picoTAS.

U: これまた素晴らしい！データを拝見すると、発光性の強いサンプル、可視から近赤外に渡る継ぎ目のないデータ、ナノ秒オーダーからサブマイクロ秒オーダーのディケイなど、picoTASの特長が見事に活かされています。レフリーから特にその辺りのコメントもなかったようですが、細かい点で他の市販品では測定が難しいデータであることを、ここで弊社として強調しておきたいと思います！　間違いなくpicoTASにしか取れない凄いデータなんです！

U: That's also wonderful! Looking at your data, we can see seamless spectra spanning from visible to near-infrared, and seamless decays from nanoseconds to microseconds for highly fluorescent samples. Although the referees did not mention these remarkable results, we'd like to emphasize that no other commercial supplier can obtain data of the same quality as picoTAS.

A: そうなんですね（笑）。たしかにYAGレーザーの波長付近の測定は通常難しいですよね。

A: Certainly. There is usually a spectral gap around 1064 nm due to the notch filter for removing the extremely intense Nd:YAG laser fundamental.

U: picoTASでの過渡吸収測定のご検討を始められた目的は、このご研究で実験的証拠を得るためですか？

U: Did you consider purchasing a picoTAS to obtain experimental data for this study?

A: はい、今回の系のようにナノからサブマイクロ秒の発光材料の過渡吸収を測定するためです。

A: Yes, exactly! It's to measure the transient absorption of fluorescent molecules in the nanosecond to sub-microsecond range, as in the case of this study.

U: それまで過渡吸収測定をされたご経験はあったのでしょうか？

U: It's nice! Were you familiar with transient absorption measurements before conducting this study?

A: 経験はまったくなかったです。ユニソクさんにしっかりサポートして頂けたので、大変助かりました。

A: We had no experience at all. Thank you for your kind support.

U: 相澤先生の、応用に対する考え方とかは？

U: By the way, I was wondering what your thoughts and approaches are towards basic research and applied research?

A: 有機ELの研究は、有機化学・光化学・量子化学・半導体物理といった様々な分野の知識や技術が必要な、まさに応用研究だと思います。おもしろいことに、こういった応用研究からも、基礎科学の知見が得られることは多々あって、今回の負のΔE_{ST}の研究も好例だと思います。

A: I think research on OLEDs is truly an applied research. Interestingly, such applied research often provides insights into fundamental science, and this research on negative ΔE_{ST} is one of the good examples.

What do you expect UNISOKU ?　ユニソクに対してご希望は？

U: 今回のNatureのご研究のためにpicoTASを買われたということでしたが、今後も過渡吸収は使われていきますか？

U: Do you plan to continue using the transient absorption setup in your future work?

A: はい、これからの研究でも大いに活用すると思います。

A: Yes, I think we will make great use of it in our future work.

U: 弊社では2021年にデモルームを整備し、picoTASなどの有償の来社実験サービスを行っています。デモルームのpicoTASでは、励起波長を変えることができ、また時間分解能も標準モデルより少し高いです。先生は picoTAS のユーザー様ですので、年２日まで無償でご実験に来ていただくことができますので、是非ご利用いただきたいのですが、３日目からは有償となり、アカデミック価格は通常料金の半額で１日４万円となります。

U: In 2021, we established a Demo Room where we offer paid experimental services using our products. The Demo Room is equipped with the picoTAS, which offers tunable excitation wavelengths and higher temporal resolution than the standard model. The cost for using the Demo Room is 80,000 yen per day, but we offer a 50% academic discount, making it 40,000 yen per day.

A: 良心的な価格ですね。研究室の装置は、励起光波長が355 nmしかなく、高次のS_nを励起しているので、450nmでS_1だけを直接励起した場合にどうなるか興味があります。

A: That's reasonable, I think. Our setup only has an excitation wavelength of 355 nm, which generates higher-lying singlet states. I'd like to use 450 nm to directly generate S_1.

U: 是非お越しください。最後に、装置に足らないところ、またユニソクに対して希望されることはありますか？

U: You are always welcome to visit our Demo Room. Finally, we would like to ask if you have any feedback or suggestions for improvements to our products or if you have any specific requests for UNISOKU?

A: picoTASとCoolSpeKを連携させて、自動で過渡吸収の温度依存性を測定できると嬉しいです。また、ユニソクさんの手厚いサポート体制も継続してほしいです。

A: It would be great if the picoTAS and CoolSpeK could be combined to enable automated measurements of the temperature dependence of transient absorption. Additionally, I hope that your excellent support system can continue in the future.

相澤博士はこれからも新進気鋭の若手研究者として研究分野を牽引してゆかれることでしょう。今後の益々のご活躍に期待したいと思います！

Dr. Aizawa is expected to continue leading his research field as one of the rising young stars.　We look forward to his even greater achievements in the future!

※ インタビュー全文はユニソクホームページにて掲載を予定しています。　※ The full interview is scheduled to be posted on the UNISOKU website.

Product Introduction: Accessories for CoolSpeK USP-203

CoolSpeKのオプション紹介

CoolSpeK
USP-203

E-mail: info@unisoku.co.jp

We have various accessories other than listed on the right. Please contact us for more information.
右記以外にも測定に役立つ様々なオプションをご用意しております。詳しくはお問い合わせください。

For optical fiber connection
光ファイバーを使用した測定に

CS-AD-UW-FB
ファイバーホルダー

Attachable fiber holder for CoolSpeK

クールスペック本体に取り付け可能なファイバーホルダーです。

For short path cuvettes
短光路長セルでの測定に

CS-CL-H1 (1 mm path)
1mmセルアダプタ
CS-CL-H2 (2 mm path)
2mmセルアダプタ

For transmittance measurement with short path cuvettes

短光路長セルでの透過/吸収測定時に使用します。

For film or plate samples
薄膜、板状試料の測定に

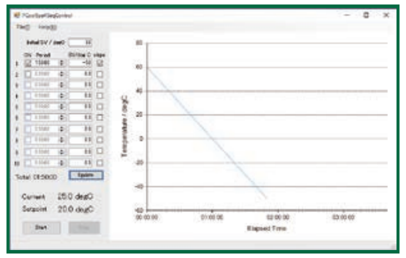
CS-KT-H00-32
CS-KT-H07-42
固体サンプルホルダー
(透過/吸収用)

CS-KF-H00-32
CS-KF-H07-42
固体サンプルホルダー
(蛍光用)

Sample holders for measuring the transmittance or fluorescence of solid samples in the form of films, plates or powders.

薄膜・板状の固体試料、粉体試料の透過・吸光・蛍光測定用のサンプルホルダーです。

For remote measurement
リモート測定に



Measurement software(Under development)
測定ソフトウェア(開発中)

For picoTAS or pump-probe spectroscopies
picoTAS、ポンププローブ装置での低温測定に

Available for only 2mm path cuvettes
光路長 2 mm のセルに対応

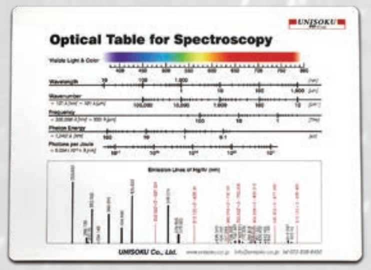
Stirrer built-in
スターラー内蔵

CoolSpeK SLIM
USP-203 ST-BP

Novelties of Optical Products

ノベルティグッズご用意しています

Achievement 500 Units
CoolSpeK USP-203 Series
Commemorative items
for over 500 units sales of USP-203
CoolSpeK販売500台達成を記念したグッズを作成しました



Mousepad with optical table for spectroscopy.
It is useful for optical researchers.

実験に役立つと好評のマウスパッドです。
波長/波数/エネルギーの換算が一目でわかります。

We will give those items at our office and exhibition booth.
ご来社や展示会ブースへお立ち寄りの際にはぜひお持ち帰りください！

Publication List in 2022

Selected picoTAS/CoolSpeK/TSP-2000 related papers

Preparation and Characterization of a Formally Ni^{IV}Oxo Complex with a Triplet Ground State and Application in Oxidation Reactions
D. G. Karmalkar *et al.*, J. Am. Chem. Soc. **144**, 22698 (2022).

Unassisted Uranyl Photoreduction and Separation in a Donor? Acceptor Covalent Organic Framework
Y. Song *et al.*, Chem. Mater. **34**, 2771 (2022).

Controlling Diradical Character of Photogenerated Colored Isomers of Phenoxyl-Imidazolyl Radical Complexes
M. Nishijima *et al.*, J. Am. Chem. Soc. **144**, 17186 (2022).

Results from the Demo Room デモルームによる成果

Fluorescein-Based Type I Supramolecular Photosensitizer via Induction of Charge Separation by Self-Assembly
H. Shigemitsu *et al.*, JACS Au, **2**, 1472 (2022).

On the Origin of Photoluminescence Enhancement in Biicosahedral Ag_xAu_{25-x} Nanoclusters (x = 0–13) and Their Application to Triplet–Triplet Annihilation Photon Upconversion
M. Mitsui *et al.*, Adv. Opt. Mater. **10**, 2200864 (2022).

Please refer to our website for a detailed publication lists/詳細な論文リストはユニソクウェブサイトをご覧ください

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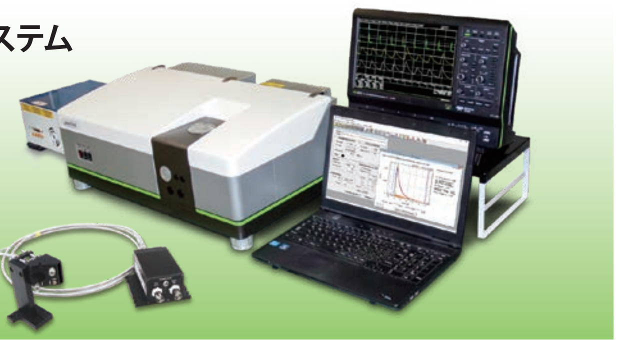
We Now Offer In-House Experimental Demonstrations.

弊社では最新製品のデモルームを開設し、来社実験サービスを行っています。興味を持っていただいた製品について、購入前に実際に性能を確認の上、購入後も満足して使っていただきたいと考えております。また装置をなかなか購入できないお客様にも測定をしていただき、研究の一助となりたいとも願っております。

Because we aim for after-purchase satisfaction, we provide our customers the opportunity to check the product performance before purchase. Further, we also aim to help customers who are not ready to purchase our systems conduct their research. To these ends, we have set up a room showing the newest instruments, both for demonstration purposes and for in-house experiment service.

ピコ秒過渡吸収分光 + 蛍光寿命コンバインシステム
picoTAS + TCSPC

Combined System of Picosecond Transient Absorption and TCSPC Fluorescence Lifetime

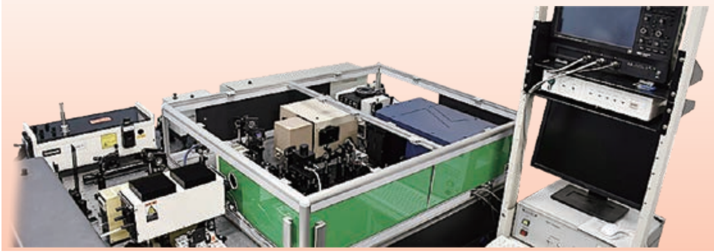


分光用クライオスタット
CoolSpeK※

Cryostat for Spectrophotometer USP-203 Series

近赤外対応ナノ秒時間分解分光測定装置
TSP-2000

Conventional UV/VIS/NIR Flash Photolysis System



※CoolSpeKにつきましてはお客様のラボに伺い、お客様が所有している分光計と組み合わせることによる訪問デモ測定も随時行っております。
We also offer on-site CoolSpek demonstration at your facility. CoolSpek adaptation to your spectrometer for custom demonstration measurements is available

Hydrogen-Sensitive Thermal Desorption Spectroscopy System
HEMTO-TDS
超高感度熱脱離分析装置

デモ測定受付中
※こちらはデモ測定のみの対応です。
Now Accepting Demo Measurements
***This is a demo measurement only.**

試料導入室を備えたスタンドアロンの3室構成のシステムをデモ測定器として準備しています。本計測は大気中での水分吸着に敏感な可能性がありますので、試料の導入方法や測定内容については相談して進めさせていただきます。

【Custom demo measurements】
We organize demonstration measurements of your samples using the HEMTO-TDS at our facility.
Contact us to discuss the details of the samples you are interested in!

UNISOKU Gourmet Map
ユニソク周辺グルメマップ

UNISOKU welcomes you to visit our company. This page features restaurants located near UNISOKU or in Hirakata city. We hope that you will find it helpful when planning your visit to our company.

世界的な規制緩和を受け、弊社はお客様のご来社を歓迎しております。
ユニソク近辺や枚方市近辺のお食事処を取り上げました。
弊社お立ち寄りの際のお食事の参考になれば幸いです。

Here is the complete gourmet map グルメマップ拡大版はコチラ➡

1 Nettai-shokudo 熱帯食堂 (枚方市岡東町12-3)

Nettai-shokudo is located near Hirakata-shi station, where you can enjoy authentic Thai and Balinese cuisine in a casual atmosphere. They offer a wide variety of menus ranging from curry that even children can easily eat to authentic dishes that even locals are satisfied with.

熱帯食堂は枚方市駅すぐ近くにあり、本格的なタイ・バリ料理を気軽な雰囲気で楽しめます。子供でも食べやすいカレーから、現地の人も唸る本格メニューまで豊富なメニューがあり、幅広い人達が楽しめます。

2 Hinemosu ひねもすぱん (枚方市堤町10-24)

VEGAN

Hinemosu is situated inside the Kagiya shop, which is a little further away from Hirakata-shi station. They specialize in selling bread made with completely organic natural yeast. The bread has a chewy and fluffy texture and a delicious taste. Their breads become even more delicious if you let them rest overnight.

枚方市駅より少し離れた鍵屋にあるパン屋です。天然酵母で発酵させたもちもち食感のパンが美味しいです。一晩おくことによってさらに美味しくなる、とのことです。

3 Kojindo 呼人堂 (枚方市岡本町10-3)

This store, founded in 1907, specializes in dorayaki. The moist dough and sweet red bean paste create a consistent and delicious taste, as one would expect from a long-established shop. In addition to regular dorayaki, they also offer other unusual varieties such as rice cake-filled, butter-filled, plum-filled, and kumquat-filled. They also offer a branding service, and this time we had "UNISOKU" branded on the dorayaki. You can also order original branding with your own logo, etc.

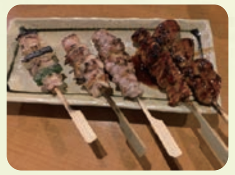
明治40年創業のどら焼き専門店。しっとりした生地と甘さ控えめの餡で安定した美味しさはさすが老舗と思いきや、普通のどら焼きの他にも餅入り、バター入り、梅入り、金柑入りと変わった種類があります。焼印サービスもあり、今回は「ユニソク」と焼印を入れてもらいました。ロゴマーク等のオリジナル焼印も注文できます。

4 Notoya 鰻彩 のとや (枚方市川原町 7-1)

Notoya is an authentic eel restaurant situated in Kawahara-cho near Hirakata-shi station. They use fresh domestic eel and grill it over charcoal from beginning to end, without steaming it (Kansai style). This way, you can enjoy the flavor and crispy texture of the eel. Recommended for those who want to eat authentic eel cuisine.

のとやは枚方市駅近く川原町にある鰻屋です。国産の新鮮な鰻を使い、鰻を蒸さず初めから最後まで炭火で焼き上げる関西ならではの焼き方を採用しています。鰻の味がストレートに出てパリッとした食感が味わえます。本格的な鰻料理を食べたい方にお薦めです。

5 Yamakura 本格炭火焼鳥 山くら (枚方市川原町10-6)



At Yamakura, you can enjoy Japanese-style chicken BBQ called yakitori and local sake selected from several prefectures. Ordering "Kushi Mori" (assorted yakitori) is a great option as it allows you to savor various kinds of yakitori. You can also have a wonderful time with sake and appetizers such as edamame and hirakata-tulip (fried chicken flavored with salty and sweet sauces).

山くらでは全国選りすぐりの日本酒と炭火焼き鳥をいただくことができます。炭火焼き鳥はお任せの串焼き盛り合わせを頼めば間違いないです。居酒屋定番のおつまみの枝豆、特製の甘辛ダレがかかった枚方チューリップなどと共にお酒をお楽しみください。

14 Tensho そば切り 天笑 (枚方市岡南町10-30)

Sobakiri Tensho is a famous soba restaurant located near Hirakata-shi station. It was awarded a star in the Michelin Guide in 2011. Open only for lunch, and there is always a long line of customers waiting to enter. The restaurant is also famous for sobagaki (buckwheat mash) and offers a wide selection of sake that goes well with soba.

そば切り天笑は枚方市駅近くにある有名な蕎麦屋です。2011年にミシュランガイド一つ星を獲得しています。昼のみの営業で、いつも行列ができています。蕎麦がきも有名で蕎麦に合うこだわりの日本酒を揃えています。

13 Kamasei 釜盛 (枚方市甲斐田新町1-1)

Popular restaurant with a long line at meal times. You can enjoy your favorite udon from a wide variety of menu items. If you want to enjoy the true taste of udon, try "Zaru Udon" or "Kama-age Udon". The one with tempura is also recommended.

食事時には行列が出来る人気店。種類豊富なメニューから自分好みのうどんを楽しめるお店。うどん本来の味を楽しみたい方は、「ざるうどん」「釜揚げうどん」を。天ぷら付もオススメです。

12 Marugen 丸源ラーメン (枚方市出屋敷元町1-7-1)

The inside of the store is bright and spacious. It's an easy-to-reach place because there is a large parking lot. The signature dish, "Meat Soba," is characterized by thinly sliced pork used as an ingredient. It is topped with grated yuzu citrus, making it light and refreshing. The fried rice is also served in a unique way that you won't find anywhere else, giving it a bit of an attraction.

店内は明るく、ゆったりしています。駐車場も広いので行きやすいお店です。看板メニューの「肉そば」の具に豚の薄切り肉を使っているのが特徴的。ゆずおろしがトッピングされていてあっさりいただけます。炒飯も他では見ない変わった形で提供され、ちょっとしたアトラクション感があります。

11 Pomunoki ポムの樹 (枚方市岡本町7-1)

Authentic Japanese-Western fusion cuisine featuring omelette and rice made with carefully selected ingredients! While ketchup rice is the classic choice for omelette, you can opt for butter rice which has a milder taste. The addition of pink pepper on top creates a great accent to the dish.

素材にこだわった本格派洋食、オムライス!
ケチャップライスが定番なオムライスですがバターライスに変更もでき、口当たりのいいマイルドな味。ピンクペッパーのアクセントが効いていました。

10 Kazenomachi 風の街 (枚方市出屋敷元町1-46-1)

You can enjoy Okonomiyaki (Japanese pancake) or Yakisoba (pan-fried noodle with savory pancake sauce) at Kazeno-machi. They offer special Okonomiyaki made with seasonal ingredients. It's also a good idea to try the "Kazeno-machi special" which includes a mix of seafood, beef, and pork. Additionally, you can try cooking Okonomiyaki by yourself with the option to have a waiter cook it for you.

風の街では関西名物のお好み焼き、焼きそばを中心に召し上がっていただくことができます。旬の素材を生かした期間限定のお好み焼きや、たくさんのシーフードや牛肉が一緒になった"風の街スペシャル"が絶品です。セルフで焼くスタイルですので、ぜひお好み焼きづくりにもトライしてください!(焼いてもらうことも可能です)

9 Menroku 麺麓 (枚方市大峰元町1-6-30)

Menroku is a 10-minute walk from UNISOKU and offers a variety of noodle dishes with strongly flavored, duck-based soup (both Tsukemen and the basic soup). For Tsukemen, you can change the flavor by mixing it with balsamic sauce. You can also choose between roasted duck fillet options, including thigh or loin! Note that Tsukemen is a dipping-style ramen dish shown in the photo.

会社から徒歩10分でいける麺麓では、濃厚な鴨出汁の効いた中華そばやつけ麺をいただくことができます。
つけ麺は、バルサミコソースを絡めながら味の変化を楽しむことができます。もも、ロースどちらかの鴨チャーシューをお選びください。

6 Chibita ちびた (枚方市春日西町2-1-4)

Chibita looks like an old-fashioned café and offers a variety of set meals, as well as curry and rice, coffee, and more. The owner's hospitality is great, as each set meal comes with bonus appetizers that might even fill you up.

純喫茶風な佇まいのちびたでは、珈琲やカレーをはじめとする定食をいただけます。
サービス精神あふれる店主さんの計らいで、定食にはたくさんのおまけがつくのでボリュームがあります。

7 Tsunezune 恒づね (枚方市津田山手1-8-1)

The restaurant has an upscale atmosphere and offers course menus for dining in, but they also provide take-out box lunches. The steak meat is tender and flavorful even when cold. The bento boxes are visually appealing as well. Reservations are required for both in-restaurant dining and take-out orders.

高級感があり、雰囲気のいいお店です。店内でコースメニューをいただけますが、テイクアウトのお弁当もあります。ステーキ肉は柔らかく、冷めてもとても美味しい。見た目も豪華なお弁当です。店内、テイクアウトともご利用の際には予約が必要です。

8 Daikokuya 大黒屋 (枚方市大峰元町2-8-5)

This long-established Japanese confectionery has been in business for 180 years. Popular items include "Oimomaki" and "Cheese Souffle". Products change with the seasons, and many Japanese and Western sweets are available, such as "Strawberry Daifuku" from winter to spring, "Wakaayu" and "Kuzu-Zakura" in early summer, and "Ultra-soft Chestnut Soufflé during autumn" for seasonal soufflé. There are also famous sweets associated with Hirakata, making them ideal for souvenirs.

創業180年の老舗和菓子処。「おいも巻き」や「チーズスフレ」が人気です。季節ごとに商品が入れ替わり、冬から春にかけては「いちご大福」、初夏には「若鮎」「くず桜」、秋になると季節のスフレに「極軟栗のスフレ」など、たくさんの和洋菓子を扱っています。枚方にちなんだ銘菓もあるので手土産に最適です。

Where to Contact in Your Area

UNISOKU has great distributors to take care of your inquiries in your area.

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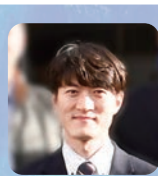

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Events 学会・展示会情報

日本語　English

Meet the Artists 作家紹介

Please find the artist introduction for the cover artwork here.
(A classmate of the editorial committee member)
表紙・作品のアーティスト紹介はこちら
（編集委員の同級生）

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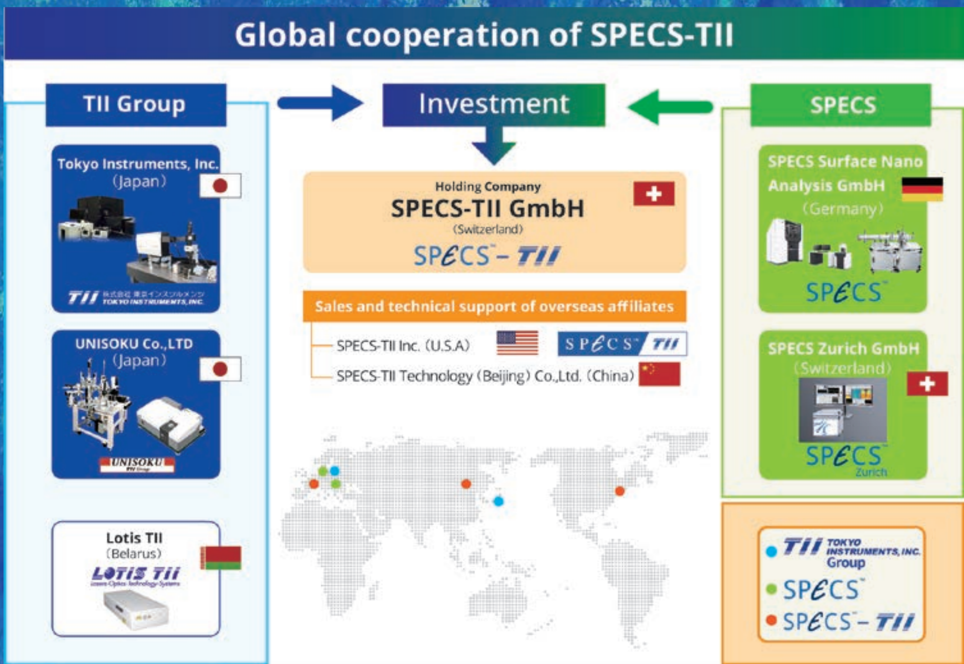

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