ナノ学会主催

2021 年度　ナノ構造・物性－ナノ機能・応用部会 合同シンポジウム　要旨集

令和3年12月1日～12月2日

松江テルサ（島根県松江市朝日町 478-18）

－ ナノ学会合同部会シンポジウム開催のご案内 －

◇日時 ： 令和3年12月1日 13:25 ～ 12月2日 16:30
◇会場 ： 松江テルサ（島根県松江市朝日町 478-18）
　　　　　JR 松江駅 北口より 徒歩1分
　　　　　　　https://www.matsue-terrsa.jp/
◇注意事項:
【講演される方へ】
1. 会場の感染症防止対策事項を遵守し、ハイブリット(対面,オンライン併用)での開催を準備して
います。講演者が十分な間隔を空けて着席できるように、広い会議室を用意しております。
2. 新型コロナウィルス感染防止のため、会場ではマスクの着用と手の消毒をお願いします。な
お、発熱等の症状がある場合には、オンラインでのご講演をお願い致します。
【参加希望の方へ】
本シンポジウムは、原則、講演者・企画者以外の参加者はオンラインでの参加をお願いしており
ます。
【オンライン(ZOOM)情報】
申請された方に前日までにメールでお知らせいたします。
備考：事前登録必要（11 月 24 日 締切） 先着250名まで。

◇プログラム

講演者（敬称略）		タイトル
12 月 1 日(水)		
13:25-13:30	開会の挨拶：田中 啓文（九州工業大学）	
		座長：清水 智弘（関西大学）
13:30-14:10	牧原 克典 （名古屋大学工学研究科）	【招待講演】 Electroluminescence Study of Si Quantum Dots with Ge Core
14:10-14:50	長島 一樹 （東京大学大学院工学系研究科）	【招待講演】 Odor/Bio-gas Sniffing Sensors from Nanomaterial Design to AI-based Data Analysis
14:50-15:30	治田 充貴 （京都大学化学研究所）	【招待講演】 High spatial resolution electronic state analysis of transition metal oxides using STEM-EELS
15:30-15:40	休 憩	
		座長：田中 啓文（九州工業大学）
15:40-16:40	井村 考平 （早稲田大学先進理工学部）	【基調講演】 Plasmons visualized by near-field optical microscopy
16:40-17:20	田川 美穂 （名古屋大学未来材料・ システム研究所）	【招待講演】 DNA-guided crystallization of nanoparticles: design strategy of high-crystallinity nanoparticle superlattice
17:20-18:00	矢嶋 赳彬 （九州大学システム情報科学研究院）	【招待講演】 Codesign of materials and circuits for neuromorphic edge computing
18:00-18:05	集 合 写 真 撮 影	
18:30-	意 見 交 換 会	

講演者(敬称略)		タイトル
12 月 2 日(木)		
		座長：根岸 雄一（東京理科大学）
9:30-10:10	鎌田 慶吾 （東京工業大学科学技術創成研究院）	【招待講演】 Synthesis and catalytic application of mixed metal oxide nanoparticles
10:10-10:50	三輪 洋平 （岐阜大学工学部）	【招待講演】 Ionomers with Dynamic Crosslinks at Room Temperature
10:50-11:30	廣理 英基 （京都大学理学研究科）	【招待講演】 Extremely nonlinear interaction of strong laser fields with solids
11:30-12:10	永野 修作 （立教大学理学部）	【招待講演】 Surface designs of side-chain liquid-crystalline polymer films by surface segregation
12:10-13:40	昼　　　食	
		座長：鳴瀧 彩絵（名古屋大学）
13:40-14:20	根岸 雄一 （東京理科大学理学部）	【ナノ機能・応用部会長講演】 Precise Synthesis and Application of Thiolate-Protected Gold Clusters
14:20-15:00	笹井 亮 （島根大学自然科学研究科）	【招待講演】 2D Nanospace Characteristic Design for Molecular Detection Material
15:00-15:40	田中 啓文 （九州工業大学生命体工学研究科）	【ナノ構造・物性部会長講演】 In-Materio Computing Devices Consisted of Random Network Nanoparticles for Autonomous robotics
15:40-16:20	田邉 一郎 （大阪大学基礎工学研究科）	【招待講演】 Electrochemical ATR ultraviolet-visible spectroscopy
16:20-16:25	閉会の挨拶：根岸 雄一（東京理科大学）	
16:25-16:30	集 合 写 真 撮 影	

*講演は日本語で行われます。

Abstract

Electroluminescence Study of Si Quantum Dots with Ge Core

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Light emission from Si/Ge based nanostructures has attracted much attention in the field of Si-based photonics because of its potential to combine photonic processing and electronic processing in a single chip. So far, we have demonstrated high density formation of quantum dots (QDs) consisting of Si clad and Ge core by controlling thermal decomposition of SiH_4 and GeH_4, alternately, on thermally-grown SiO_2 and their unique charge storage characteristics associated with type II energy band alignment between the Si clad and the Ge core, that is, holes are store in the Ge core but electrons in the Si clad. And we also reported that, in the case that a single layer of QDs having a 6nm Ge-core and a 3nm-thick Si-clad in average size on SiO_2 was excited by 976nm photons, stable PL signals consisting of four Gaussian components were detected in the energy region from 0.66 to 0.88eV at room temperature, and that the components are attributable to radiative recombination through quantized states in QDs as verified from dot size dependence of PL peak energy and temperature dependence of PL properties. In this work, based on the fundamental study of photoluminescence, we have designed and fabricated stack structure of QDs sandwiched with ~2.0nm-thick SiO2 as a bottom tunnel oxide on p-Si(100) and ~10nm-thick SiO_2 as a control gate oxide and studied electroluminescence through Si substrate in alternate injection of electrons and holes to QDs from the Si substrate under cold light illumination. Capacitance voltage characteristics measured at 1MHz confirm that, under the cold light illumination, photo-generated electrons in the peripheral region of the area masked with metal gate flow into the inversion region formed underneath the gate oxide and respond to the pulsed gate bias even at high frequencies. No EL signals was detectable with zero gate bias while, with application of continuous square-wave bias with peak-to-peak amplitudes of ±1.0V and higher at 500 kHz, EL signals having similar components to PL signals were observed from the backside through the c-Si substrate even at RT. With an increase in the bias amplitude from ±1.0 to ±4.0V, the EL intensity was increased by about one order of magnitude and higher emission energy components become significant with almost no change in the peak energy of each component. Notice that, by applying square-wave bias of -4 to 0V, EL was observable. The result indicates electron charging in QDs at -4V induces hole injection even in 0V half-cycle. From the bias amplitude dependences of the EL intensity, in which positive and negative bias amplitude are changed independently, we have found that hole injection is a rate-limiting factor for EL at ±2V and below because of a smaller tunneling rate of holes than electrons while electron injection becomes a major factor for EL at ±3V and over as a result that electron emission from QDs become significant in positive half cycle.

Odor/Bio-gas Sniffing Sensors
from Nanomaterial Design to AI-based Data Analysis

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An artificial olfaction sensory system, which transduces the volatile molecules to electrical signals, attracts rapidly increasing attentions and it is recently selected as one of the "SEVEN technologies to watch in 2021" (***Nature* 2021**, *589*, 630) due to its applicability to various fields including medical diagnosis, environmental monitoring, food science and agriculture. Since hundreds thousand types of volatile organic compounds (VOCs) exist in nature, the collected huge and multi-directional chemical information will be helpful to understand the complex phenomena such as biological activities and human-environmental interactions. Recent our targets include i) the development of a robust molecular sensing system, which allows the long-term stable collection of chemical information and ii) the exploration of potential of chemical big data analysis. For the former target, we focus on metal oxide nanowires due to its material robustness. Creating the well-defined metal oxide nanowire surfaces via the rational design strategy, we successfully clarified the surface behaviors of dilute VOCs and directed it via manipulating the surface cations, providing a foundation to design the diverse metal oxide based molecular sensors. For the latter target, we analyzed the chromatography-mass spectrometry data and the molecular sensing data of odor/human breath via an artificial intelligence-based technique. The results clearly show the great potential of chemical information for biometrics and health monitoring.
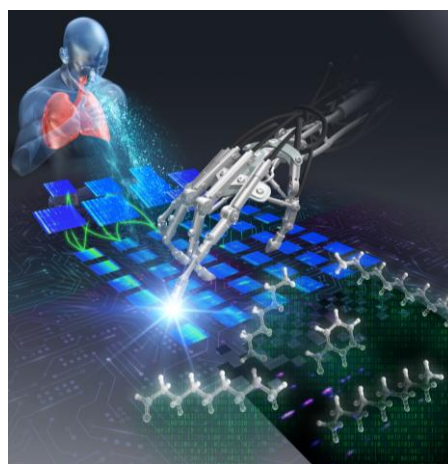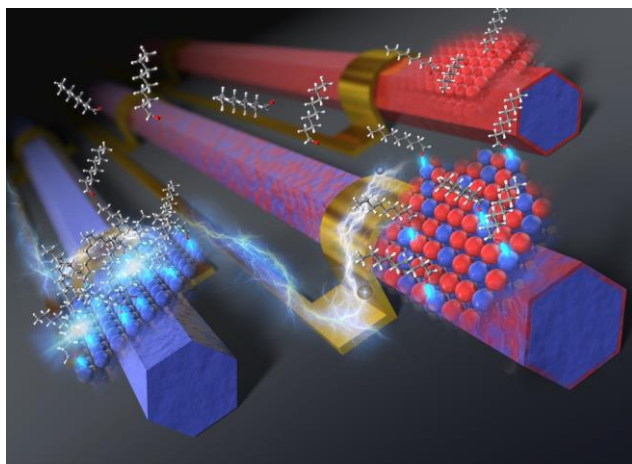
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High spatial resolution electronic state analysis of transition metal oxides using STEM-EELS

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Since transition metal (TM) oxides exhibit a variety of physical properties, such as high temperature (Tc), superconductivity, giant magnetoresistivity, ferroism, etc, which are sensitively related to their complex crystal structures and constituent elements, many experimental and theoretical studies have been conducted for not only bulk but also thin film. In particular, the relationship between localized TM *d*-band and oxygen $2p$ band is one of the key factors to control of the property. For further understanding, it is important to examine not only atomic structure but also individual electronic structure with atomic resolution. This is because it has often some nonequivalent atomic sites in a unit cell even a single crystal, and they have different electronic structure for the same element.

In the field of high spatial resolution analysis, state of the art scanning transmission electron microscopy (STEM) can visualize all atoms (including hydrogen) in crystals with sub-Å resolution. In addition, electron energy-loss spectroscopy (EELS) in STEM can investigate not only elemental information but also electronic structure with atomic resolution. In addition, recent development of a monochromated electron source realizes very high energy resolution. Thus, we can experimentally measure different spectral shape at individual atomic site at last.

In this contribution, I will explain the basis of STEM-EELS and present recent results on atomic resolution electronic state analysis using core-loss spectra, e.g. real space hole mapping (Fig.1) of high-Tc super conductor [1], local electronic structure of octahedron in TM oxides [2] and vibration effects in core-loss spectra etc.
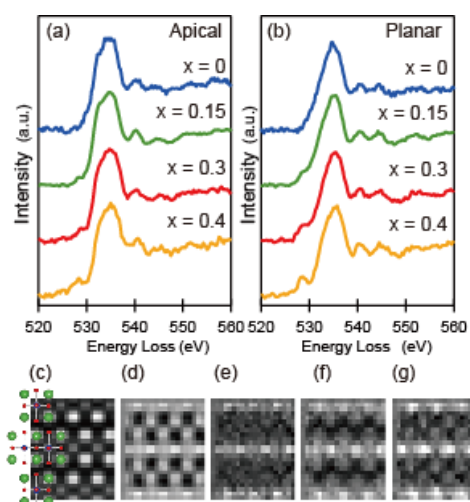

Fig. 1 Atomic resolution oxygen *K*-edge spectra of $La_{2-x}Sr_xCuO_4$ at (a) apical and (b) planar sites, respectively. (c) HAADF image. (d) Oxygen elemental mapping. Hole mapping of (e) x = 0.15, (f) x = 0.3 and (g) x = 0.4, respectively.

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Plasmons visualized by near-field optical microscopy

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Plasmons excited in metal nanostructures have gained much attention recently, because of their potential applications to molecular sensing, nano-optical devices, and photo chemical reactions. Spatial characteristics of the plasmons is closely related to the functions of the plasmons. To design the plasmon based applications, visualization of the plasmon is essential. Spatial resolution of the optical microscope is limited by the diffraction of light. Therefore, the super resolution imaging technique beyond the diffraction limit is indispensable to visualize the plasmons. We have developed various type of near-field spectroscopic imaging methods to visualize the plasmons [1-4]. We have studied plasmons excited in metal nanostructures with various shapes and found that periodic oscillating patters are visualized depending on the size and shape of the structures [1, 2, 5]. Using a simple model calculation, we revealed that spatial distribution of the plasmon can be uniquely understand based on the eigen functions of a particle confined in the potential well. We also demonstrated that the optical properties of the plasmons can be understood using the group theory. For the plasmon based applications, in addition to the spatial and optical character of the plasmons, light confinement capability, excited state dynamics, and plasmon molecule interactions [6,7] are crucial, and will be discussed at the symposium.
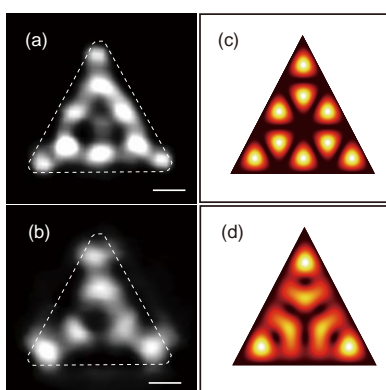

Figure (a,b) Near-field transmission image of gold nanotriangle observed at 800 and 880 nm, respectively. (c,d) Calculated square moduli of eigen functions. Scale bars: 200 nm.

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DNA-guided crystallization of nanoparticles: design strategy of high-crystallinity nanoparticle superlattice

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Free-standing colloidal crystal composed of sub-10 nm nanoparticles with periodic nanogaps is predicted to emerge excellent functional properties according to the spatial arrangement of the nanoparticles. However, it remains challenging to assemble nanoparticles into designed, higher-order structure with nanogaps, because of the difficulty in achieving both programmable assembly and arranging the nanogap spacing. DNA self-assembly, which enables programmable colloidal crystallization with nanoscale precision in buffer solution, is an expected methodology to produce well-ordered nanoparticle superlattice. We found that hydrated DNA-functionalized nanoparticle (DNA-NP) superlattices with properly controlled volume fraction and spatial arrangement of nanoparticles successfully maintained their crystallinity even after dehydration, which involves drastic contraction. A detailed study of the structural changes was performed for the self-assembled DNA-NP sample using small-angle X-ray scattering (SAXS) after dehydration. Then, an optimal volume fraction of nanoparticles in the superlattice, ϕ, which minimized the level of distortion of the dehydrated superlattice, was found. By acquiring clear SAXS diffraction patterns showing crystal symmetries for dehydrated DNA-NP superlattices, the successful formation of sub-10 nm nanoparticle superlattices with periodic nanogaps were confirmed. Geometrical calculation substantiated the ease of movement of a nanoparticle under the influence of repulsions from adjacent particles that mainly affect the dehydration stability. These results suggest that it is possible to design crystal structure of solid nanoparticle superlattices, via DNA-guided nanoparticle assembly under near-equilibrium state in solution, followed by dehydration under nonequilibrium conditions. By controlling the nanogap of less than 4 nm through DNA-guided nanoparticle crystallization, we show that nanostructures can be freely designed on a scale that exhibits quantum effects.

Figure (a) SAXS data of DNA-NP superlattices before and after dehydration, (b) scanning electron microscopy image of DNA-NP superlattice.
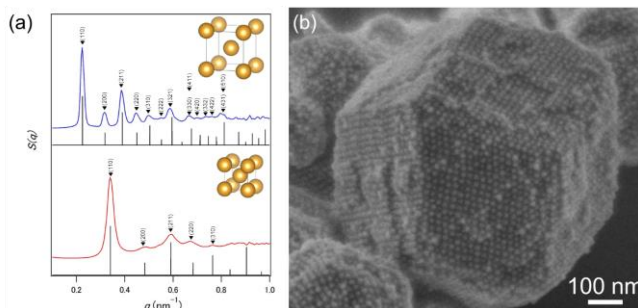
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Codesign of materials and circuits for neuromorphic edge computing

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Reducing the power consumption of information processing has become an urgent issue in all aspects from the cloud to the edge. Currently, raw data acquired at the edge is sent to the cloud for processing as big data, which consumes huge amount of power. In the future, it will be necessary to distribute information processing to the edge. In this presentation, we will introduce novel technologies for autonomous information processing at the edge that can control sensors and circuits based on ultra-low power supply. To achieve this, we exploit phase transition materials as shown in Figure (a,b) to mitigate the power *vs.* performance trade-offs inherent in conventional electronic circuits [1,2]. In parallel, we also utilize ultra-low power electronic control through neuromorphic asynchronous digital circuits as shown in Figure (c) [3]. By combining these with conventional CMOS techniques, we hope to enable highly autonomous and low-power edge computing, and to play a role in the distributed information processing systems centered on the edge.
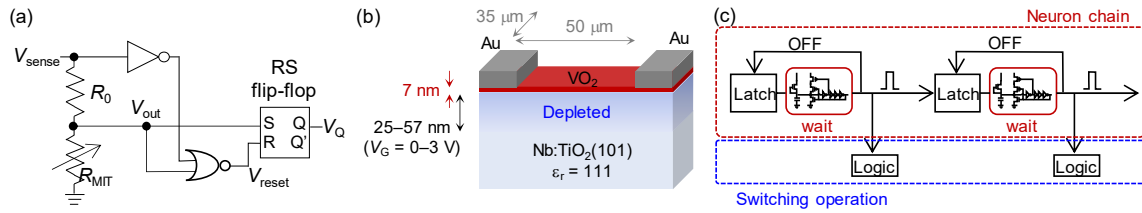

Figure (a) Codesign of phase transition material (R_{MIT}) and digital circuits for near-zero energy consumption temperature sensing. (b) Three-terminal device to systematically evaluate the sensing speed of phase transition material (VO_2). (c) A schematic illustration of asynchronous digital control using spiking neuron circuits.

References

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Synthesis and catalytic application of mixed metal oxide nanoparticles

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The design and development of new high-performance all-inorganic heterogeneous catalysts remains a strongly desired and challenging subject of research. On the basis of the knowledge of catalyst design for molecular mixed metal oxide POMs,[1] we have recently developed new heterogeneous catalysts based on crystalline mixed metal oxides such as perovskites,[2] β-MnO_2,[3] and metal phosphates.[4]

We focused on the oxidation catalysis over hexagonal and/or rhombohedral perovskite oxides because these materials have unique face-sharing octahedral units consisting of high valent metal species.[2] For example, $BaFeO_{3-\delta}$, $BaRuO_3$, and $SrMnO_3$ could efficiently catalyze selective oxidation of alkanes, sulfides, and alkylarenes, respectively, with O_2 as the sole oxidant. During the course of our investigation on biomass conversion, we found that β-MnO_2 can act as the most effective oxidation catalyst for the aerobic oxidation of 5-hydroxymethylfurfural (HMF) to 2,5-furandicarboxylic acid (FDCA) as a bioplastic monomer on the basis of combined computational and experimental studies.[3] The successful synthesis of the high-surface-area β-MnO_2 nanoparticles resulted in significant improvement of the catalytic performance. In addition, we found an acid-base $CePO_4$ catalyst for the chemoselective acetalization of HMF with alcohols, in sharp contrast to other catalysts.[4] Such a specific acid-base property of metal phosphates could lead to the development of $FePO_4$ nanoparticle catalyst for direct oxidation of methane into formaldehyde.
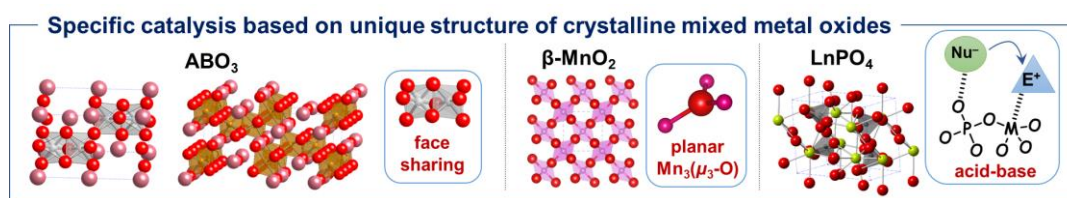

Figure Crystal structures and possible active sites of mixed metal oxide catalysts.

References

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Ionomers with Dynamic Crosslinks at Room Temperature

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Hydrophobic polymers containing a small number of ionic groups along the main chain are generally called "ionomers". In ionomers, the ionic groups form nanosized ionic aggregates that act as physical crosslinks. We recently designed new ionomers with polyisoprene [1] and poly(dimethyl siloxane) (PDMS) [2] backbones (Figure (A)). In these ionomers, the network is formed, but the polymer chains are not strictly restricted by the ionic aggregates; consequently, the network spontaneously rearranges even at room temperature as illustrated in Figure (B). Due to the dynamic nature of the network, these ionomers self-heal the injury as shown in Figure (C). Also, these ionomers exhibit "gas-plastic" properties (Figure (D)) because the network rearrangement is accelerated by CO_2 gas exposure as illustrated in Figure (B). Because of the accelerated network rearrangement, CO_2 gas effectively aids the self-healing of the ionomers.
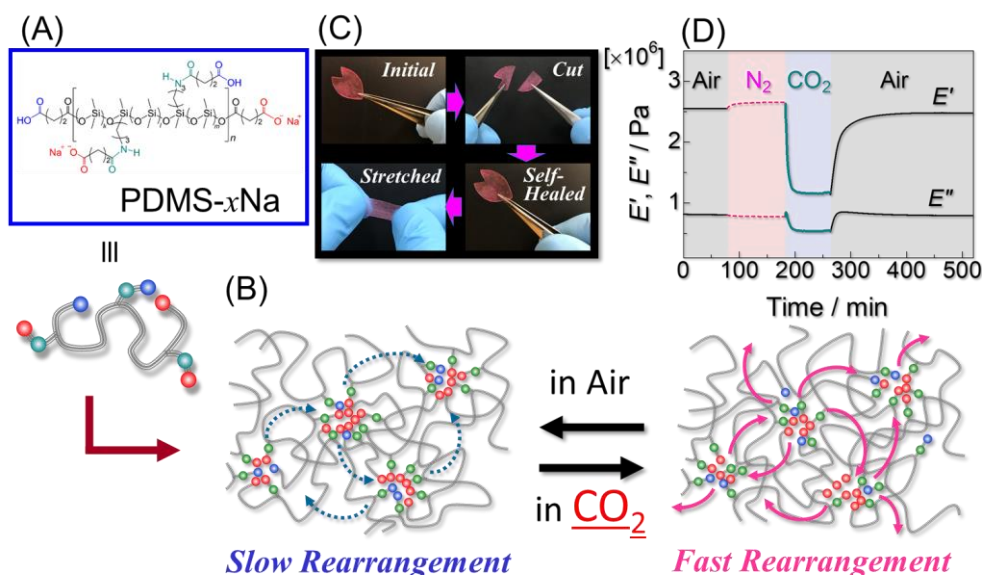

Figure (A) Chemical structures of PDMS ionomer (PDMS-xNa, where x indicates the degree of neutralization of carboxy group with sodium). **(B)** Schematic illustration of aggregations of ionic groups and network rearrangement of PDMS-xNa. The network rearrangement is accelerated by CO_2 gas exposure. **(C)** Photos for autonomous self-healing behavior of PDMS-80Na at room temperature. The cherry blossom petal shaped sample sheet was painted pink. **(D)** Changes in storage modulus (E') and loss modulus (E'') in different gases for PDMS-80Na measured at 1 Hz and 30°C [2].

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Extremely nonlinear interaction of strong laser fields with solids

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Advances in ultrafast intense laser techniques have enabled us to enter a new stage beyond nonlinear optics: strong-field physics. One particular important effect is that atoms and molecules interacting with strong laser pulses emit high-order harmonics of the fundamental driving laser field. The high-order harmonic generation (HHG) in gases is nowadays frequently used to produce attosecond pulses and coherent radiation ranging from the visible to soft X-rays. While the HHG in gases has already found its way into applied science, solids are one promising route towards more compact and brighter HHG sources because of their higher electronic density. Here, we study the high harmonic generation from semiconductors and show that the results can be well reproduced by calculations based on rigorous ab initio approach [1-3]. Additionally, we discuss the results of interaction of intense strong THz electric fields with the perovskite semiconductors [4] and also with phase-change compound material GeSbTe [5].
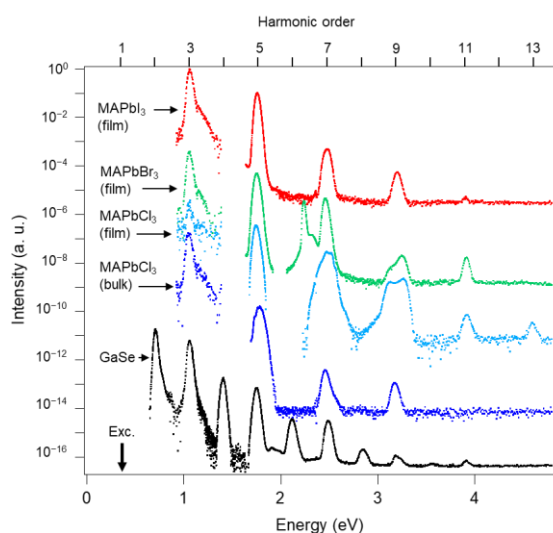

Figure 1. High-order harmonic generation spectra from halide perovskite semiconductors and GaSe by the irradiation of strong mid-infrared laser pulses (3.5 μm). The data used to prepare this graph are taken from refs. 2 and 3.

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Surface designs of side-chain liquid-crystalline polymer films by surface segregation

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The molecular orientations of liquid crystalline (LC) materials are strongly affected by free surfaces and interfaces in contact with other materials. By the excluded volume effect, rod-like LC mesogens of low-molecular-weight LCs and side-chain LC (SCLC) polymers tend to be oriented parallel to the substrate plane (random planar orientation) on a solid substrate. On the other hand, no excluded volume interactions occur at a free surface, and the mesogens exhibit a strong tendency to normally (homeotropically) orient by reducing the excluded volume. SCLC polymers, which are often used as free-standing films, are strongly influenced by the free surface, resulting in the adoption of a homeotropic orientation. Therefore, random planar-oriented films of SCLC polymers are difficult to prepare by LC alignment techniques even using alignment layers and high surface tension surfaces. The homeotropic orientation is not advantageous for photoalignments of azobenzene (Az) mesogens in SCLC polymer systems since light irradiation is generally applied normal to the film and the transition moment of Az is oriented perpendicular to the actinic electric field of the light irradiation for a photoreaction.

In this presentation, we focus on the surface segregation structure of block copolymers in thin films for inducing a random planar orientation in SCLC polymer films. Surface segregation of polymers is the phenomenon in which one component with a low surface free energy covers the surface in two or more polymer mixtures or block copolymer film. In block copolymer films, the polymer block component with a lower surface free energy covers the film surface; therefore, the microphase phase-separation (MPS) interface at the surface layer forms parallel to the film surface plane. In the case of SCLC diblock copolymers with amorphous coil blocks, the side-chain mesogens orient parallel to the MPS interface since the main chain direction is preferentially normal to the MPS interface (Figure 1). Therefore, at the segregated surface of SCLC diblock copolymers, a planar orientation can be spontaneously induced. The induced random planar orientation offers efficient in-plane photoalignment for SCLC polymer systems. The random planar orientation in SCLC polymer systems induced by surface segregation of coil block (Figure 1a) and high-density polymer brush structures with a random planar orientation in surface-segregated SCLC block layers (Figure 1b) are discussed [1-3].
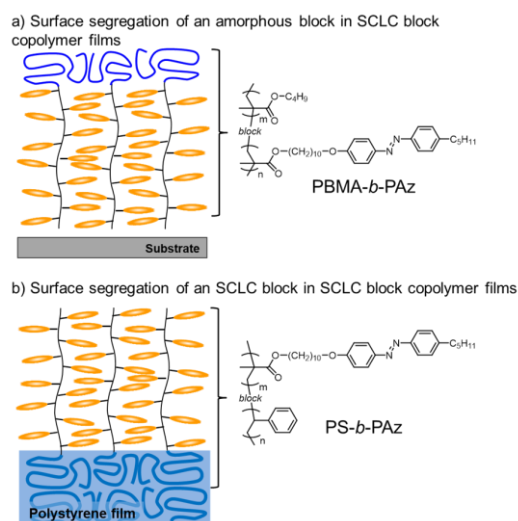

Figure 1. Surface and interface molecular orientations of photoresponsive SCLC diblock copolymer systems with surface segregation (induced random planar orientation structure).

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Precise Synthesis and Application of Thiolate-Protected Gold Clusters

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Thiolate (SR)-protected gold clusters ($Au_n(SR)_m$) show size-specific physical and chemical properties, such as photoluminescence, catalytic activity, and redox behavior, that are not observed in the case of bulk gold. Furthermore, it is possible to determine the geometrical structures of these clusters and therefore to elucidate correlations between their structures and physical properties. In addition, these clusters have been found to be highly stable both in solution and in the solid state. Owing to these numerous factors, $Au_n(SR)_m$ clusters are considered to have significant potential as constituent units of functional nanomaterials. To date, our research group has studied the following three aspects of $Au_n(SR)_m$ and related clusters: (1) the development of new methods allowing precise synthesis; (2) the establishment of new methods to impart high functionality; and (3) the utilization of these clusters as active sites in energu and environment catalysts. This presentation summarizes our most recent work concerning these three subjects [1,2].
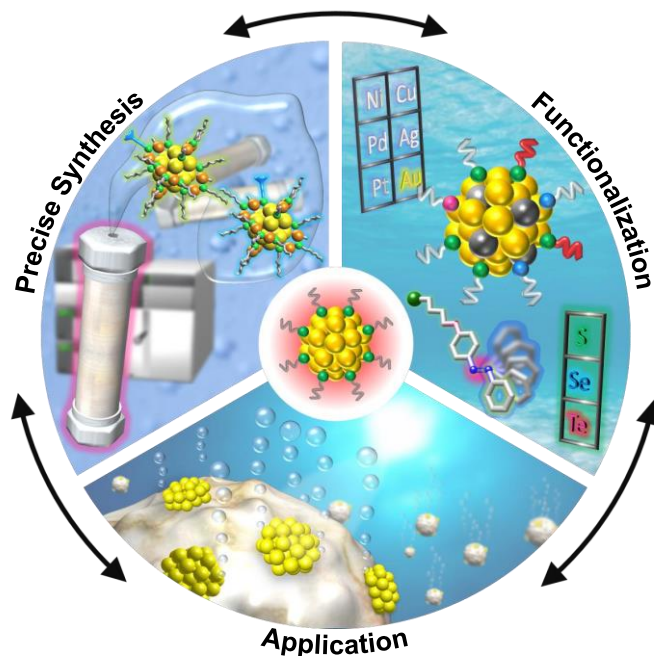

Figure 1. Graphical summary of the three aspects of our studies on thiolate-protected gold clusters.

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2D Nanospace Characteristic Design for Molecular Detection Material

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Layered inorganic compounds with ion-exchangeable ability have a 2D nanospace between inorganic layers (2D interlayer nanospace). It is known that various ionic/polar compounds can be intercalated into this 2D interlayer nanospace by ion exchange reaction. This indicates that the characteristics of 2D interlayer nanospace can be designed by the intercalated molecular species. Thus, many researchers have reported research on various 2D interlayer nanospace designs. We have studied on the design of this 2D interlayer nanospace for developing the solid materials with highly detection ability for specific molecules/ions [1-4]. In Figure 1, the schematic illustration of self-made *in-situ* photoluminescence measurement system (a), the dependence of enhancement factor, (a) E_{NH3} or (a) E_{NO2} on concentration of NH_3 or NO_2 of the solid material incorporating both 1-butanesulfonate (C4S) and anionic fluorescein dye (AFD) into the 2D interlayer nanospace of layered double hydroxide (LDH) under 78% of relative humidity (RH) are shown. It was found that the PL intensity of this hybrid material (LDH/C4S/AFD) sharply increased above 3 ppm, when the LDH/C4S/AFD was exposed to NH3 gas under N_2 wet atmosphere (78 % of RH). The reason of this NH_3 detection phenomenon is that the adsorption of NH_3 to LDH/C4S/AFD induced a change in the molecular structure of AFD from non-luminous type to luminous type by the increase in pH. On the other hand, when LDH/C4S/AFD was exposed to acidic gas NO_2 in N_2 wet gas (78 % of RH), PL intensity gradually decreased with an increase in the NO_2 concentration at above 7 ppm. This quenching behavior is due to the fact that the molecular structure of AFD gradually change from luminous type to non-luminous type as the pH of the 2D interlayer nanospace decreased, contrary to the case of NH_3. In my talk, I will also introduce other hybrid materials with highly selective molecule/ion detection ability we have developed.

Figure 1. (a)Schematic illustration of in-situ PL system, Dependence of (b) E_{NH3} on NH_3 concentration and (c) E_{NO2} on NO_2 concentration at 78 % of relative humidity.

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[3] Fujimura, T.; Akagashi, Y.; Aoyama, Y.; Sasai, R. *Int. J. Photoenergy* **2020**, 8870930.

[4] Sasai, R.; Yamamoto, S.; Naito, A. *Nanomaterials* **2021**, *11*, 914.
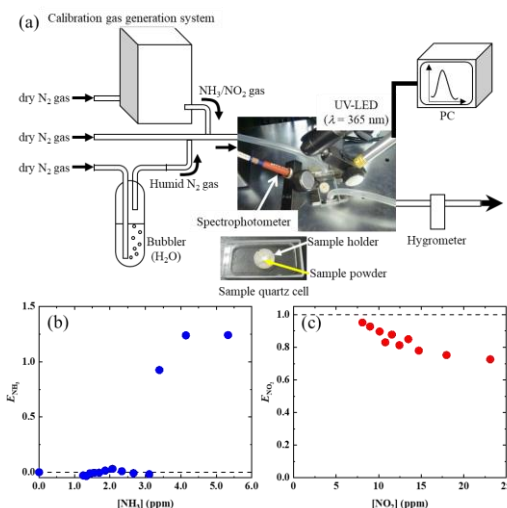
In-Materio Computing Devices Consisted of Random Network Nanoparticles for Autonomous robotics

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In recent years, superior computational power of deep learning based on software has been widely recognized, and the practical applications of artificial intelligence are rapidly expanding. On the other hand, the hardware for replacing to such artificial intelligence (AI) algorithms is facing the physical limits of scaling in silicon CMOS technology, and performance improvement is expected to hit the ceiling. For this reason, there is a growing interest in hardware technologies that physically implement artificial neural networks (ANNs), neuromorphic or brainmorphic information processing systems, and the applications (hereafter referred as AI systems in this paper), as well as new materials and devices. A critical difference between the presently required device functionality and that in conventional computational systems is the use of dynamics. By cleverly using nanomaterials' nonlinearity and network structure, devices that spontaneously generate pulses, noise, and other physical phenomena are expected to be realized to utilize for the AI hardware. These devices will enable drastically lower power consumption and higher integration of AI systems. In the learning process of ANNs, it is necessary to constantly change and store the weights of the weighted sum (sum-of-products) part. To avoid such an energy consumption tasks, our research center has been working on materials that can complement CMOS for AI systems by using molecules and nanocarbon materials, and further, we are trying to apply them to autonomous AI robotics. This paper introduces these nanomaterials and networks' formation as devices, the key points of the devices' functionalization, application to robots, and other recent research results.

Recently, we found that the device made of SWNTs and POMs generates neuron-like pulses when a high voltage is applied [1]. This enabled us to control noise and pulses generation. Such dynamic signal generation is attributed to the multiple discharges of POM molecules. Reservoir computing simulations also showed that this system could be used for time series memory [1]. In this study, we applied a sinusoidal signal to an SWNT random network using porphyrin-gradient sandwich POM (Por-POM), which is more redox-sensitive, and the Lissajous plot of the output signal from one of the multiple electrodes plotted against the input signal showed nonlinear switching behavior such as memristor. A memory state was generated due to the reversible redox of Por-POM, and the input signal was highly interacted with the reservoir system. The dynamics are also confirmed by the higher harmonic generation (HHG) from the FFT analysis. Boolean logic tasks including the XOR gate were performed to check the performance of the devices. Product classification task by haptic sensor signal from TOYOTA-HSR system were also performed which was successfully classify six different types of toys using a linear or ridge regression models. We also used Ag/Ag_2Se nanowires [2] and Ag/Ag_2S nanoparticles [3] as a reservoir device to obtain similar results with SWNT/Por-POM. The robot-hand product classification can be utilized in the HSR robot competition. [4] Details will be presented at the presentation.

Refs. [1] H. Tanaka et al., **Nat. Commun.** 9, 2693 (2018). The article was selected as the most read 50 articles published in **Nat. Commun.** in 2018 (Physics). [2] T. Kotooka, H. Tanaka et al., **submitted**. [3] Hadiyawarman, H. Tanaka et al., **Jpn. J. Appl. Phys.** 60, SCCF02 (2021). [4] Kyutech team won the **RoboCup world series** of Domestic Standard Platform League by TOYOTA HSR in 2017, 2018 and 2021. The same robot was used for the demonstration.
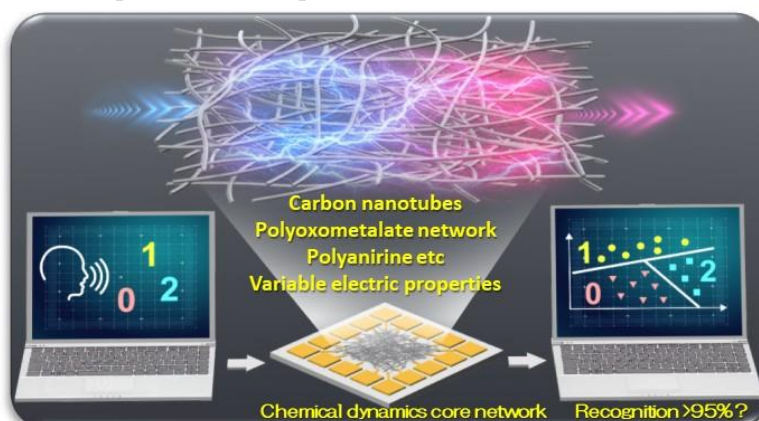
Fig.1 Schematic of reservoir computing using random network

Electrochemical ATR ultraviolet-visible spectroscopy

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Electric double-layer organic field-effect transistors (EDL-OFETs) have attracted much attention because of their significantly low operation voltage (<1 V) compared to conventional SiO2-gated OFETs (>10 V). In EDL-OFETs, a high electric field is generated in the EDL that accumulates in the interfacial region between the organic semiconductor and electrolyte, resulting in a low operation voltage. Therefore, the organic semiconductor/electrolyte interface is especially important.

Recently, we developed a new spectroscopic system, namely electrochemical-attenuated total reflectance (EC-ATR) ultraviolet-visible spectroscopy, which can access the interfacial area [1]. In this study, ionic liquid gated organic field-effect transistors (IL-gated OFETs) were fabricated on the ATR prism (Figure a). Two-layer single crystalline film of C_9-DNBDT-NW was used as an organic semiconductor, and two kinds of ionic liquids ([EMIM][FSA] and [TMPA][TFSA]) were cast on the film. Au films were evaporated to a thickness as the source and drain electrodes (working electrodes) on both sides of the ATR prism, and a Pt coil and a Pt wire were placed in the ionic liquids as pseudo counter and reference (gate) electrodes, respectively.

In response to the applied gate voltage, the spectral peaks of the organic semiconductor at ~470 nm shifted and bleached (Figure b). The magnitude of spectral changes was found to correlate positively with the drain current. Additionally, the spectral changes of not only the organic semiconductor at ~470 nm and ~280 nm, but also the Stark shift of the [EMIM][FSI] on the organic semiconductor films were detected at ~220 nm. Such a direct detection of the interfacial ionic liquids was achieved due to the short penetration depth (<50 nm) and the strong absorbance of [EMIM][FSI] in the UV region, which was a unique point of the new technique.
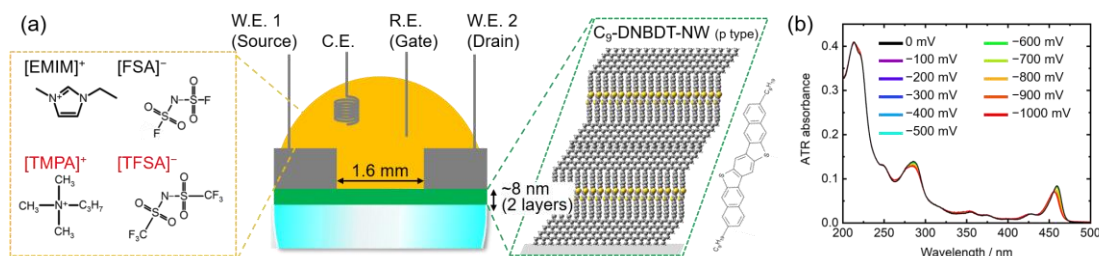

Figure (a) Schematics of EDL-OFET fabricated on ATR prism and (b) ATR spectra.

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Profiles

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Professional Career
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2009-2010.11: Postdoctoral Fellow, Hiroshima University, Japan
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2014-: Associate Professor, Nagoya University, Japan
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Prize
2005 IMFEDK Best Student Award (IEEE, The EDS Kansai Chapter)
2005 Award for Encouragement of Research of Materials Science (Materials Research Society of Japan)
2008 Award for Encouragement of Research of Materials Science (Materials Research Society of Japan)
2012 Young Scientist Presentation Award (The Japan Society of Applied Physics)
2012 ISPlasma2012 Best Presentation Award (ISPlasma2012 Organizing Committee Chair)
2017 IWDTF2017 Best Paper Award (IWDTF2017 Organizing Committee)
2017 MNC2017 Outstanding Pape Award (MNC2018 Organizing Committee Chair)

Selected recent publications

- "Effect of B-doping on photoluminescence properties of Si quantum dots with Ge core" K. Makihara, S. Fujimori, M. Ikeda, A. Ohta, and S. Miyazaki, *Materials Science in Semiconductor Processing 2020 120*, 105250.

- "Effect of H_2-dilution in Si-cap formation on photoluminescence intensity of Si quantum dots with Ge core" S. Fujimori, R. Nagai, M. Ikeda, K. Makihara, and S. Miyazaki, *Jpn. J. Appl. Phys. 2019*, *58* SIIA01.

- "Electroluminescence of superatom-like Ge-core/Si-shell quantum dots by alternate field-effect-induced carrier injection" K. Makihara, M. Ikeda, N. Fujimura, K. Yamada, A. Ohta, and S. Miyazaki, *Appl. Phys. Exp. 2018*, 11, 011305.

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Research Interests
My current interests and activities cover Si-based devices, process technologies and formation of Si-based semiconducting and metallic nanodots for Si-based functional devices.
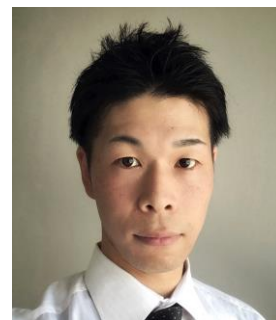
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Professional Career
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2017-2020:   Associate Professor, Kyushu University, Japan
2019-Present: JST PRESTO Researcher, Japan
2020-Present: Associate Professor, The University of Tokyo, Japan

Prize
2012   MNC 2011 Young Author's Award (International Microprocesses and Nanotechnology Conference, Japan)
2013   NF Foundation R&D Encouragement Award (NF Foundation, Japan)
2017   EMS Award (Electronic Materials Symposium, Japan)
2018   Wakashachi Best Award (Aich Prefecture, Japan)   more 24 prizes

Selected recent publications
- "The impact of surface Cu^{2+} of $ZnO/(Cu_{1-x}Zn_x)O$ heterostructured nanowires on the adsorption and chemical transformation of carbonyl compounds" J. Liu, K. Nagashima et al., **Chem. Sci. 2021**, *12*, 5073–5081. (Selected as Cover Art)
- "Face-Selecive Crystal Growth of Hydrothermal Tungsten Oxide Nanowires for Sensing Volatile Molecules" S. Nekita, K. Nagashima et al., **ACS Appl. Nano Mater. 2020**, *3*, 10252–10260.
- "Face-selective tungstate ions drive zinc oxide nanowire growth direction and dopant incorporation" J. Liu, K. Nagashima et al., **Commun. Mater. 2020**, *1*, 58.
- "Synthesis of Monodispesedly Sized ZnO Nanowires from Randomly Sized Seeds" X. Zhao, K. Nagashima et al. **Nano Lett. 2020**, *20*, 599–605.
- "Rational Method of Monitoring Molecular Transformations Metal-Oxide Nanowire Surfaces" C. Wang, K. Nagashima et al. **Nano Lett. 2019**, *19*, 2443–2449.

Research Interests
To design nanomaterials, control and understand surface molecular behaviors and realize robust molecular recognition sensors. My current research projects include:
(1) Design of metal oxide nanowires
(2) Design inorganic-organic interface by coordination chemistry
(3) Robust molecular recognition sensor
(4) Odor/bio-gas sensing/analysis by artificial intelligence

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2011-2013:   JSPS Fellow (PD), National Institute for Material Science (NIMS), Japan
2013-2019:   Assistant Professor, Kyoto University, Japan
2019-   :   Associate Professor, Kyoto University, Japan

Prize
2008   ICR award for Graduate Students (Institute for Chemical Research, Kyoto University, Japan)
2009   International EELS-Workshop, Best Poster Award
2012   Presidential Post-Doctoral Award (Microscopy Society of America)
2014   Young Scientist Presentation Award (The Japan Society of Applied Physics)
2015   16th Incentive Award (The Japanese Society of Microscopy)
2016   ICR award for Young Scientist (Institute for Chemical Research, Kyoto University, Japan)

Selected recent publications

• "Extraction of the local coordination and electronic structures of FeO6 octahedra using crystal field multiplet calculations combined with STEM-EELS", M. Haruta et al., ***Appl. Phys. Lett***., **2020**, 117,132902.

• "Extremely low count detection for EELS spectrum imaging by reducing CCD read-out noise", M. Haruta et al., ***Ultramicroscopy* 2019**, 207, 112827.

• "Local quantification of coordination number for perovskite-related oxides using atomic resolution EELS maps", M. Haruta, et al., ***Applied Physics Letters* 2018**, 113, 083110.

• "Atomic-resolution two-dimensional mapping of holes in the cuprate superconductor $La_{2-x}Sr_xCuO_{4\pm\delta}$", M. Haruta et al., ***Phys. Rev.* B 2018**, 97, 205139.

Research Interests
High spatial resolution atomic and electronic structure analysis by using scanning transmission electron microscopy (STEM) combined with electron energy loss spectroscopy (EELS). My current research projects include:
(1) Real space electronic state mapping
(2) Electron orbital mapping
(3) Understanding of fine structure of EELS spectrum

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Prize
2007 The Spectroscopical Society of Japan Award for Young Scientists (The
       Spectroscopical Society of Japan)
2007 The Chemical Society of Japan Award for Young Chemists (The Chemical
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2013 The Commendation for Science and Technology, The Young Scientists' Award
       (The Minister of Education, Culture, Sports, Science and Technology)

Selected recent publications
- "Plasmon-Enhanced Fluorescence near Single Gold Nanoplates Studied by
  Scanning Near-Field Two-Photon Excitation Microscopy" S. Hasegawa, K.
  Imaeda, K. Imura, *J. Phys. Chem.* **2021**, *125*, 21070-21076.
- "Enhanced and Polarized Photoluminescence from Carbon Dot - Metal
  Nanoparticle Composites" K. Kamura, K. Imura, *J. Phys. Chem. C.* **2020**, *124*,
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- "Near-field transmission and reflection spectroscopy for revealing absorption and
  scattering characteristics of single silver nanoplates" H. Mizobata, S. Hasegawa,
  M. Tamura, T. Iida, K. Imura, *J. Chem. Phys.* **2020**, *153*, 144703 (7 pages).
- "Characterization of Overlapped Plasmon Modes in Gold Hexagonal Plate
  Revealed by Three-Dimensional Near-Field Optical Microscopy" T. Matsuura, K.
  Imaeda, S. Hasegawa, H. Suzuki, K. Imura, *J. Phys. Chem. Lett.* **2019**, *10*,
  819-824.
- "Static and Dynamic Near-Field Measurements of Highly Order Plasmon Modes
  Induced in a Gold Triangular Nanoplate" T. Matsuura, K. Imaeda, S. Hasegawa,
  K. Imura, *J. Phys. Chem. Lett.* **2018**, *9*, 4075-4081.

Research Interests
Research interests include near-field optics, plasmonics, and photo-physical properties of
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(2) Plasmons assisted photochemical reactions
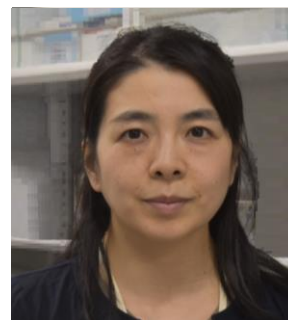(3) Development of advanced optical microscopy

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Prize
2012   Patent Incentive Award (Brookhaven Nat. Lab., USA)
2016   Patent Incentive Award (Brookhaven Nat. Lab., USA)
2018   Honor Award for Women Leaders (Nagoya University)
2019   Female researcher award (Soroptimist Japan Foundation)

Selected recent publications
• "Two-step nanoparticle crystallization via DNA-guided self-assembly and non-equilibrium dehydration process" Sumi H, Ohta N, Sekiguchi H, Harada S, Ujihara T, Tsukamoto K, Tagawa M, *Cryst. Growth Des. 2021*, 21, 8, 4506-4515.
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• "Diamond Family of Nanoparticle Superlattices" Liu W, Tagawa M et al., *Science* **2016**, *35*, 10846-10854.
• "Effect of magnesium ion concentration on two-dimensional structure of DNA-functionalized nanoparticles on supported lipid bilayer", Isogai T, Akada E, Nakada S, Yoshida N, Tero R, Harada S, Ujihara T, Tagawa M. *JJAP 2016*, 55, 03DF11.
• "Forming two-dimensional structure of DNA-functionalized Au nanoparticles via lipid diffusion in supported lipid bilayers" Isogai T, Piednoir A, Akada E, Akahoshi Y, Tero R, Harada S, Ujihara T, Tagawa M, *J. Cryst. Growth 2014*, *401, 494-498*.

Research Interests
To develop functional nanomaterials by using self-assembly of biomolecules and colloids in an aqueous phase for realization of sustainable society. My current research projects include:
(1) DNA-mediated self-assembly of nanoparticles
(2) Crystal growth of colloidal nanoparticles
(3) Development of a novel method of small angle X-ray scattering analysis for the structure analysis of colloidal crystals

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Professional Career
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2017-2021:   PRESTO Researcher, Japan Science and Technology Agency, Japan
2020-   Associate Professor, Kyushu University, Japan

Prize
2011   Graduate Student Award (MRS Spring Meeting)
2012   Nippon Broadcasting Award (Advanced Technology Award)
2019   Young Researcher Award (International Conference on Solid State Devices and Materials)
2019   The Oxide Electronics Prize for Excellency in Research (International Workshop on Oxide Electronics)

Selected recent publications
- "Low-power IoT circuit technology using spiking neuron circuits" T. Yajima, *Functional Materials* **2021**, *41*, 37-43.
- "Modulation of VO2 Metal–Insulator Transition by Ferroelectric HfO2 Gate Insulator." T. Yajima et al., *Adv. Elec. Mater.* **2020**, *6*, 1901356(5 Pages).
- "Regulating phase transformation kinetics via redox reaction in ferroelectric Ge-doped HfO2" T. Yajima et al., *Appl. Phys. Lett.* **2020**, *117*, 182902(5 Pages).
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- "Identifying the Collective Length in VO2 Metal-Insulator Transitions", T. Yajima et al., *Small* **2017**, *13*, 1603113(14 Pages).
- "Positive-bias gate-controlled metal-insulator transition in ultrathin VO2 channels with TiO2 gate dielectrics" T. Yajima et al., *Nature Commun.* **2015**, *6*, 10104(13 Pages).
- "Controlling band alignments by artificial interface dipoles at perovskite heterointerfaces" T. Yajima et al., *Nature Commun.* **2015**, *6*, 6759(5 Pages).

Research Interests
To develop low power electronics based on the phase transition materials and the neuromorphic circuits. My current research projects include:

(1) Development of asynchronous digital control technique by using spiking neuron circuits
(2) Study on fundamental dynamics of nano-scale phase transition using electrostatic gating
(3) Ultra-low power hardware for reservoir computing using CMOS and protonic devices

Keigo KAMATA

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Education
2001: B. S. The University of Tokyo, Japan
2006: Ph. D. The University of Tokyo, Japan

Professional Career
2008-2013:   Assistant Professor, The University of Tokyo, Japan
2014   Associate Professor, Tokyo Institute of Technology, Japan

Prize
2009   CSJ Presentation Award (The Chemical Society of Japan)
2010   CATSJ Presentation Award (Catalysis Society of Japan)
2012   CSJ Award For Young Chemists (The Chemical Society of Japan)
2017   TokyoTech Challenging Research Award 2017, Granted a special award by the president
        (Tokyo Institute of Technology)
2018   The Young Scientists' Prize of The Commendation for Science and Technology (MEXT)
2018   JACI The 7th Research Award for New Chemistry and Technology (JACI)

Selected recent publications
- "Iron Phosphate Nanoparticle Catalyst for Direct Oxidation of Methane into Formaldehyde: Effect of Surface Redox and Acid-Base Properties" A. Matsuda, H. Tateno, K. Kamata, M. Hara, *Catal. Sci. Technol.* **2021**, accepted (DOI: 10.1039/D1CY01265G).
- "Template-free Synthesis of Mesoporous β-MnO_2 Nanoparticles: Structure, Formation Mechanism, and Catalytic Properties" Y. Yamaguchi, R. Aono, E. Hayashi, K. Kamata, M. Hara, *ACS Appl. Mater. Interfaces* **2020**, *12*, 36004–36013.
- "Effect of MnO_2 Crystal Structure on Aerobic Oxidation of 5-Hydroxymethylfurfural to 2,5-Furandicarboxylic Acid" E. Hayashi, Y. Yamaguchi, K. Kamata, N. Tsunoda, Y. Kumagai, F. Oba, M. Hara, *J. Am. Chem. Soc.* **2019**, *141*, 890–900.
- "Heterogeneously Catalyzed Aerobic Oxidation of Sulfides with a $BaRuO_3$ Nanoperovskite" K. Kamata, K. Sugahara, Y. Kato, S. Muratsugu, Y. Kumagai, F. Oba, M. Hara, *ACS Appl. Mater. Interfaces* **2018**, *10*, 23792–23801.
- "A Bifunctional Cerium Phosphate Catalyst for Chemoselective Acetalization" S. Kanai, I. Nagahara, Y. Kita, K. Kamata, M. Hara, *Chem. Sci.* **2017**, *8*, 3146–3153.

Research Interests
Design and synthesis of inorganic catalyst materials and construction of highly efficient catalytic systems for realization of sustainable society.   My current research projects include:
(1) Development of novel synthesis methods for crystalline mixed oxide nanoparticles
(2) Catalytic application of nanomaterials to green organic synthesis including biomass conversion
(3) Catalyst design for efficient methane conversion

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Education

1999: B. S. Nagoya Institute of Technology, Japan
2005: Ph. D. Nagoya Institute of Technology, Japan

Professional Career

2005-2006:   Postdoctoral Fellow, University of Detroit Mercy, USA
2006-2012:   Mitsubishi Chemical Corporation, Japan
2012-2015:   Assistant Professor, Gifu University, Japan
2015-   Associate Professor, Gifu University, Japan
2019-   PRESTO, JST, Japan

Prize

2014   Award for Young Scientist (The Society of Polymer Science, Kansai Branch, Japan)
2020   10th Bridgestone Soft Material Frontier Prize (The Society of Rubber Science and Technology, Japan)

Selected recent publications

- "Autonomous Self-Healing Polyisoprene Elastomer with High Modulus and Good Toughness Based on Synergy of Dynamic Ionic Crosslinks and Highly Disordered Crystals", (***Y. Miwa**, M. Yamada, Y. Shinke, S. Kutsumizu) *Polym. Chem.* **2020**, *11*, 6549–6558.
- "Toward Strong Self-Healing Polyisoprene Elastomers with Dynamic Ionic Crosslinks", (***Y. Miwa**, J. Kurachi, Y. Sugino, T. Udagawa, S. Kutsumizu) *Soft Matter* **2020,** *16*, 3384–3394.
- "A Gas-Plastic Elastomer That Quickly Self-Heals Damage with the Aid of CO_2 Gas", (***Y. Miwa**, K. Taira, J. Kurachi, T. Udagawa, S. Kutsumizu) *Nat. Commun.* **2019,** *10*, No. 1828.
- "Dynamic Ionic Crosslinks Enable High Strength and Ultrastretchability in a Single Elastomer", (***Y. Miwa**, J. Kurachi, Y. Kohbara, S. Kutsumizu) *Commun. Chem.* **2018,** *1*, No. 5.
- "Subnanoscopic Mapping of Glass Transition Temperature around Ionic Multiplets in Sodium-Neutralized Poly(ethylene-*random*-methacrylic acid) ionomer", (***Y. Miwa**, T. Kondo, S. Kutsumizu) *Macromolecules*, **2013**, *46*, 5232–5237.

Research Interests

To reveal and design the relationship between microscopic structures and macroscopic mechanical properties of polymeric materials.

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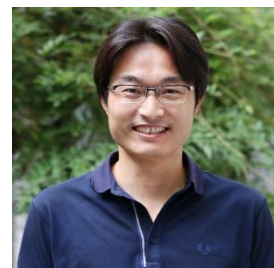
Education
1998: B. S. Hokkaido University, Japan
2006: Ph. D. Kyoto University, Japan

Professional Career
2005–2006:   Postdoctoral fellow, Institute for Chemical Research, Kyoto University
2006–2008:   Toray Industries Inc., Japan
2008–2017:   Postdoctoral fellow, Assistant Professor, and Associate Professor, Institute for Integrated Cell-Material Sciences, Kyoto University
2017–present: Associate Professor, Institute for Chemical Research, Kyoto University

Prize
2016:   The Young Scientists' Prize from the MEXT
2014:   German Innovation Award "Gottfried Wagener Prize 2014"
2013:   The 7th Young Scientist Award of the Physical Society of Japan
2012:   Kondo Prize of the Osaka University

Selected recent publications
- "Enhancing the hot-phonon bottleneck effect in a metal halide perovskite by terahertz phonon excitation", F. Sekiguchi, H. Hirori, G. Yumoto, A. Shimazaki, T. Nakamura, A. Wakamiya, and Y. Kanemitsu, **Phys. Rev. Lett.** 126, 077401 (2021).
- "Modifying angular and polarization selection rules of high-order harmonics by controlling electron trajectories in k-space", Y. Sanari, T. Otobe, Y. Kanemitsu, H. Hirori, **Nat. Commun.** 11, 3069 (2020).
- "Zener tunneling breakdown in phase-change materials revealed by intense terahertz pulses", Y. Sanari, T. Tachizaki, Y. Saito, K. Makino, P. Fons, A. V. Kolobov, J. Tominaga, K. Tanaka, Y. Kanemitsu, M. Hase, H. Hirori, **Phys. Rev. Lett.** 121, 165702 (2018).
- "Subcycle optical response caused by a dressed state with phase-locked wave functions", K. Uchida, T. Otobe, T. Mochizuki, C. Kim, M. Yoshita, H. Akiyama, L. N. Pfeiffer, K. W. West, K. Tanaka, H. Hirori, **Phys. Rev. Lett.** 117, 277402 (2016).
- "Extraordinary carrier multiplication gated by a picosecond electric field pulse", H. Hirori, K. Shinokita, M. Shirai, S. Tani, Y. Kadoya, K. Tanaka, **Nat. Commun.** 2, 594 (2011).

Research Interests
1) Dynamical optical processes of light-matter interactions in solids
2) Development of novel ultrafast and terahertz spectroscopic techniques.

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Education
1995: B. S. Gakushuin University, Japan
2004: Ph. D. Tokyo Institute of Technology, Japan

Professional Career
1998-1999: Researcher, the Central Research Laboratory, Nihon Parkerizing Co., Ltd., Japan
2001-2002: Researcher, the Central Research Laboratory, the central research center, Ricoh Company, Ltd., Japan
2002-2013: Assistant Professor, Nagoya University, Japan
2013-2019: Associate Professor, Nagoya University, Japan
2020- Professor, Rikkyo University, Japan

Prize
2007 Award for Encouragement of Research in Polymer Science (The Society of Polymer Science, Japan)
2008 Outstanding Paper Award (The Japan Liquid Crystal Society)
2009 Academic Award (Tokai Chemical Industry Association)
2015 Outstanding Paper Award (The Japan Liquid Crystal Society)
2017 SPSJ Hitachi Chemical Award (The Society of Polymer Science, Japan)

Selected recent publications
- "Photoswitchable Configuration of Nematic Liquid Crystal Droplets Embedded in a Honeycomb-Patterned Film," K. Mukai, M. Hara, H. Yabu, S. Nagano, T. Seki, *Adv. Mater. Interfaces*, 2100891 (1-8) (2021).
- "Induction of Highly Ordered Smectic Phases in Side Chain Liquid Crystalline Polymers by Means of Random Copolymerization," R. Imanishi, Y. Nagashima, K. Takishima, M. Hara, S. Nagano, T. Seki, *Macromolecules*, 53 (6), 1942-1949 (2020).
- "Photo-triggered large mass transport driven only by a photoresponsive surface skin layer," I. Kitamura, K. Kato, R.B. Berk, T. Nakai, M. Hara, S. Nagano, T. Seki, *Sci. Rep.*, 10 (1), 1-10 (2020).
- "Formation of High-Density Brush of Liquid Crystalline Polymer Block Associated with Dewetting Process on Amorphous Polymer Film", K Mukai, M Hara, S Nagano, T Seki, *Langmuir*, 35 (32), 10397-10404 (2019).
- "Photoinitiated Marangoni flow morphing in a liquid crystalline polymer film directed by super-inkjet printing patterns", I. Kitamura, K. Oishi, M. Hara, S. Nagano, T. Seki, *Sci. Rep.*, 9, 2556 (2019).

Research Interests
To build up and drive Meso/Nano architectures by using liquid crystal self-assembly and photoalignment. My current research projects include:
(1) Photoalignment of liquid crystal nanostructures and microphase structures in block copolymer thin films
(2) Monolayer assembly for semiconducting polymer
(3) Lyotropic liquid crystalline properties of proton conductive polymers

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Education
1996: B. S. Keio University, Japan
2001: Ph. D. Keio University, Japan

Professional Career
1998-2000: Assistant Professor, Department of Chemistry, Keio University, Japan
2000-2008: Assistant Professor, Institute for Molecular Science, Okazaki, Japan
2008-2013: Junior Associate Professor, Tokyo University of Science, Japan
2013-2017: Associate Professor, Tokyo University of Science, Japan
2017-   : Professor, Tokyo University of Science, Japan

Prize
2007 PCCP Prize for Outstanding Achievement of Young Chemists in Physical Chemistry and Chemical Physics (Royal Society of Chemistry)
2008 The Chemical Society of Japan Award for Young Chemists (Japan Chemical Society)
2012 Japan Society for Molecular Science Award for Young Scientists (Japan Society for Molecular Science)
2017 Yagami Prize (Keio University)
2018 Distinguished Award 2018 for Novel Materials and Their Synthesis (IUPAC etc.)
2020 International Investigator Awards of the Japan Society for Molecular Science (Japan Society for Molecular Science)

Selected recent publications
- "Creation of High-Performance Heterogeneous Photocatalysts by Controlling Ligand Desorption and Particle Size of Gold Nanocluster", T. Kawawaki, Y. Kataoka, M. Hirata, Y. Akinaga, **Y. Negishi***, et al., *Angew. Chem. Int. Ed.* 60, 21340−21350, **2021**.
- "Thiolate-Protected Metal Nanoclusters: Recent Development in Synthesis, Understanding of Reaction, and Application in Energy and Environmental Field", T. Kawawaki, A. Ebina, Y. Hosokawa, S. Ozaki, D. Suzuki, S. Hossain, **Y. Negishi***, *Small* (a review article), 17, 202005328, **2021**.
- "Toward the Creation of High-performance Heterogeneous Catalysts by Controlled Ligand Desorption from Atomically Precise Metal Nanoclusters", T. Kawawaki, Y. Kataoka, M. Hirata, Y. Iwamatsu, S. Hossain, **Y. Negishi***, *Nanoscale Horiz.* (a review article), 6, 409, **2021**.
- "Controlled Colloidal Metal Nanoparticles and Nanoclusters: Recent Applications as Cocatalysts for Improving Photocatalytic Water-splitting Activity", T. Kawawaki, Y. Mori, K. Wakamatsu, S. Ozaki, M. Kawachi, S. Hossain, **Y. Negishi***, *J. Mater. Chem. A* (a review article), 8, 16081, **2020**.
- "Activation of Water-Splitting Photocatalysts by Loading with Ultrafine Rh-Cr Mixed-Oxide Cocatalyst Nanoparticles", W. Kurashige, Y. Mori, S. Ozaki, M. Kawachi, S. Hossain, T. Kawawaki, C. J. Shearer, A. Iwase, G. F. Metha, S. Yamazoe, A. Kudo, **Y. Negishi***, *Angew. Chem., Int. Ed.* 59, 7076, **2020**.

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Education
1999: Ph. D. Hiroshima University, Japan

Professional Career
1997-1999: JSPS Postdoctoral Fellow, Nagoya University, Japan
1999-2007: Assistant Professor, Nagoya University
2007-2009: Associate Professor, Nagoya University
2009-2020: Associate Professor, Shimane University
2020- Professor, Shimane University
1999-2006: Visiting Researcher, NIMS
2003-2005: Visiting Researcher, Industrial Research Institute of Shizuoka Prefecture
2018- Technical Advisor, ARBIZ corporation
2019-2020: Visiting Professor, iMaSS, Nagoya University

Prize
2003 Academic Award (Tokai Chemical Industry Association, Japan)
2006 Incentive Award (The Clay Science Society of Japan, Japan)

Selected recent publications
- "Photoluminescence Gas Sensing by Fluorescein-Dye Anions/1-Butanesulfonate/Layered Double Hydroxide Hybrid Materials under Humid Environment Conditions" Sasai, R.; Yamamoto, S.; Naito, A. *Nanomaterials*, **2021**, *11*, 914. (https://doi.org/10.3390/nano114914)
- "Preparation of Transparent Film of Layered Double Hydroxide with Anionic Pyrene Derivatives and Its Luminous Toluene Detection Ability" Fujimura, T.; Akagashi, Y.; Aoyama, Y.; Sasai, R. *Int. J. Photoenergy*, **2020**, 8870930. (https://doi.org/10.1155/2020/8870930)
- "Influence of Gas Adsorption on the Luminous Properties of Layered Double Hydroxide/Anionic Fluorescein Dye Hybrid Think Solid Films" *Bull. Chem. Soc. Jpn.*, **2017**, *90*, 148. (https://doi.org/10.1246/bcsj.20160289)
- "Luminous Relative Humidity Sensing by Anionic Fluorescein Dyes Incorporated into Layered Double Hydroxide/1-Butanesulfonate Hybrid Materials" *Sens. Actuators B*, **2017**, *238*, 702. (https://doi.org/10.1016/j.snb.2016.07.109)

Research Interests
My research interests are preparation and characterization of (1) luminous dyes incorporated in the interlayer space of inorganic layered compound and (2) dyes/inorganic layered compound with high selectivity molecular sensing ability. Additionally, I have some research projects as follows.
- Mechanism of anion exchange reaction and anion selectivity of layered double hydroxide with anion exchangeable properties and application of layered double hydroxide to practical water purification
- Development of eco-friendly technique for recovering metal resource from solid wastes

Hirofumi TANAKA

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Education
1996: M. Eng., Waseda University, Japan
1999: Ph. D., Osaka University, Japan

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Professional Career

1998-1999	Special doctoral student of Japan Science Promotion Society（DC2）(JPN)
1999-2002	RIKEN (JPN), Special Postdoctoral Researcher
2002-2003	The Pennsylvania State University (USA), Postdoctoral Researcher
2003-2008	Institute for Molecular Science (JPN), Assistant Professor
2008-2014	School of Science, Osaka University (JPN), Assistant Professor
2014	School of Science, Osaka University, Associate Professor (only in March)
2014-Present	School of Life Science and Systems Engineering, Kyushu Institute of Technology (JPN), Professor.
2017-Present	Ho Chi minh University of Technology (Vietnam), Invited Professor
2019-2021	Fuzzy Logic Systems Institute (JPN), Chief Scientist
2019-Present	Suranaree University of Technology (Thailand), Distinguished Professor
2020-Present	Research Center for Neuromorphic AI Hardware, Kyutech (JPN), Director

Selected recent publications:
1. M. E. Anderson, L. P. Tan, M. Mihok, **H. Tanaka**, M. W. Horn, G. S. McCarty, P. S. Weiss, **Adv. Mater.** 18, 1020 (2006).
2. **H. Tanaka**, T. Yajima, T. Matsumoto, T. Ogawa, **Adv. Mater.** 18, 1411-1415 (2006).
3. C. Subramaniam, T. S. Sreeprasad, T. Pradeep, G. V. P. Kumar, C. Narayana, T. Yajima, Y. Sugawara, **H. Tanaka**, T. Ogawa, J. Chakrabarti, **Phys. Rev. Lett.** 99, 167404 (4pp) (2007).
4. T. Hino, **H. Tanaka**, T. Hasegawa, M. Aono, T. Ogawa, **Small** 6, 1745-1748 (2010).
5. W. Huang, **H. Tanaka**, T. Ogawa, and X.-Z. You, **Adv. Mater.** 22, 2753-2758 (2010).
6. A. Klamchuen, **H. Tanaka**, D. Tanaka, H. Toyama, G. Meng, S. Rahong, K. Nagashima, M. Kanai, T. Yanagida, T. Kawai, T. Ogawa, **Adv. Mater.**, 25, 5893-5897 (2013).
7. **H. Tanaka**, M. Akai-Kasaya, A. TermehYousefi, L. Hong, L. Fu, H. Tamukoh, D. Tanaka, T. Asai, T. Ogawa, **Nature Commun.** 9, 2693 (2018).
8. Y. Usami, B. van de Ven, D. G. Mathew, T. Chen, T. Kotooka, Y. Kawashima, Y. Tanaka, Y. Otsuka, H. Ohoyama, H. Tamukoh, **H. Tanaka**, W. G. van der Wiel, T. Matsumoto, **Adv. Mater.**, published online. (2021).

Research Interests
Biomimic electric devices, neuromorphic electric devices using nanomaterials. Recently down-sizing of electric devices are facing physical fabrication limit. To overcome the problems, one of the solutions is to utilize non-Neumann computing. One of the non-Neumann computing is brain computing which behavior is learning from human brain. I focus for electric devices utilized for next generation neuromorphic AI computing. My knowledge is widely bridging many materials from metal, inorganic materials to organic materials, and techniques on measurement in nanoscale and nanofabrication, which lead the next generation electric devices.

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Education
2008: B. S. The University of Tokyo, Japan
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Professional Career
2010-2013:   JSPS Postdoctoral Fellow (DC1), The University of Tokyo, Japan
2013-2014:   Postdoctoral Fellow, Kwansei Gakuin University, Japan
2014-2015:   JSPS Postdoctoral Fellow (PD), Kwansei Gakuin University, Japan
2015-2016:   Assistant Professor, Kwansei Gakuin University, Japan
2020-   Assistant Professor, Osaka University, Japan

Prize
2020   PCCP Prize (The Chemical Society of Japan & Royal Society of Chemistry)
2020   Encouragement Award (The Spectroscopical Society of Japan)
2019   Encouragement Award (The Japan Society for Analytical Chemistry)

Selected recent publications
- "Electronic Excitation Spectra of Organic Semiconductor/Ionic Liquid Interface by Electrochemical Attenuated Total Reflectance Spectroscopy" I. Tanabe, I. Imoto, D. Okaue, M. Imai, S. Kumagai, T. Makita, M. Mitani, T. Okamoto, J. Takeya and K. Fukui, **Commun. Chem. 2021**, *4*, 88 (8 pages).
- "Enhanced Surface Plasmon Resonance Wavelength Shifts by Molecular Electronic Absorption in Far- and Deep-Ultraviolet Regions" I. Tanabe, Y. Y. Tanaka, K. Watari, W. Inami, Y. Kawata and Y. Ozaki, **Sci. Rep. 2020**, *10*, 9938 (6 Pages).
- "Far- and Deep-Ultraviolet Surface Plasmon Resonance using Al Film for Efficient Sensing of Organic Thin Overlayer" I. Tanabe, M. Shimizu, R. Kawabata, C. Katayama and K. Fukui, **Sens. Actuators A 2020**, *301*, 111661 (6 pages).
- "Potential Dependence of Electronic Transition Spectra of Interfacial Ionic Liquids Studied by Newly Developed Electrochemical Attenuated Total Reflectance Spectroscopy" I. Tanabe, A. Suyama, T. Sato and K. Fukui, **Anal. Chem. 2019**, *20*, 3436–3442.
- "Systematic Analysis of Various Ionic Liquids by Attenuated Total Reflectance Spectroscopy (145–450 nm) and Quantum Chemical Calculations" I. Tanabe, A. Suyama, T. Sato and K. Fukui, **Analyst 2018**, *143*, 2539–2545.

Research Interests
My current research focuses on far- and deep-ultraviolet spectroscopy for functional materials; (1) titanium dioxide–metal nanocomposites and their photocatalytic activities, (2) far-ultraviolet surface plasmon resonance sensor researches, and (3) electronic structure of ionic liquids and organic semiconductors in electrochemical environment.

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Education
1999: B. S. The University of Tokyo, Japan
2004: Ph. D. The University of Tokyo, Japan

Professional Career
2004-2007:   JSPS Postdoctoral Fellow, Tokyo Medical and Dental University, Japan
2007-2008:   JSPS Postdoctoral Fellow, California Institute of Technology, USA
2008-2013:   Assistant Professor, The University of Tokyo, Japan
2014-2020:   Associate Professor, Nagoya University, Japan
2020-   Professor, Nagoya University, Japan

Prize
2011   Award for Encouragement of Research in Polymer Science (The Society of Polymer Science, Japan)
2016   Encouragement Award (Japan Association for Chemical Innovation)
2016   Award for Women Chemists (The Chemical Society of Japan)
2017   Honor Award for Women Leaders (Nagoya University)

Selected recent publications
- "Tough and Three-Dimensional-Printable Poly (2-methoxyethyl acrylate)–Silica Composite Elastomer with Antiplatelet Adhesion Property" F. Asai, A. Sugawara-Narutaki, Y. Takeoka et al., *ACS Appl. Mater. Interfaces* **2020**, *12*, 46621–46628.
- "Rheology of Dispersions of High-Aspect-Ratio Nanofibers Assembled from Elastin-Like Double-Hydrophobic Polypeptides" A. Sugawara-Narutaki et al., *Int. J. Mol. Sci.* **2019**, *20*, 6162(12 Pages).
- "Bioinspired Approach to Silica Nanoparticle Synthesis Using Amine-Containing Block Copoly (vinyl ethers): Realizing Controlled Anisotropy" A. Sugawara-Narutaki et al., *Langmuir* **2019**, *35*, 10846–10854.
- "Ring-Like Assembly of Silica Nanospheres in the Presence of Amphiphilic Block Copolymer: Effects of Particle Size", A. Sugawara-Narutaki et al., *Langmuir* **2019**, *34*, 7751–7758.
- "Elastin-Like Polypeptides as Building Motifs toward Designing Functional Nanobiomaterials" D. H. T. Le, A. Sugawara-Narutaki, *Mol. Syst. Des. Eng.* **2019**, *4*, 545–565.

Research Interests
To develop nanomaterials by using self-organization of molecules, ions, and colloids in an aqueous phase for realization of sustainable society. My current research projects include:
(1) Development of nanobiomaterials through protein engineering
(2) Polymer-mediated self-assembly of nanocolloids
(3) Bioinspired materials design and synthesis

Tomohiro SHIMIZU

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Education
2003: M. Sci., Nihon University, Japan
2006: Ph. D. Hiroshima University, Japan

Professional Career
2006-2008	Postdoctoral Fellow, Max-Planck Institute for Microstructure Physics (GER)
2008-2010	Senior Researcher, Grid Inc.
2010-2013	Assistant Professor, Faculty of Engineering Science, Kansai University
2013-2020	Associate Processor, Faculty of Engineering Science, Kansai University
2015-2016	Visiting Researcher, Martin Luther University of Halle-Wittenberg (GER)
2020-Present	Processor, Faculty of Engineering Science, Kansai University

Prize
2021   The 15th International Symposium in Science and Technology 2021, Poster Awards

2019   IEEE International 3D systems Integration Conference 2019, Poster Award

Selected recent publications:

- "Formation of MoS_2 nanostructure arrays using anodic aluminum oxide template", T. Okamoto, T. Shimizu, K. Takase, T. Ito, S. Shingubara, Micro and Nano Engineering, 9 (2020) 100071.

- "Effect of a metal interlayer under Au catalyst for the preparation of microscale holes in Si substrate by metal-assisted chemical etching", T. Shimizu, R. Niwa, T. Ito, S. Shingubara, *Jpn. J. Appl. Phys.* **58** (2019) SAAE07-1-5.

- "Origin of visible photoluminescence from arrays of vertically arranged Si-nanopillars decorated with Si-nanocrystals"*Nanotechnology*, A. Kuznetsov, T. Shimizu, S. Kuznetsov, A. Klekachev, S. Shingubara, J. Vanacken, V. Moshchalkov,**23** (2012) 475709-475715.

- "Extended arrays of vertically aligned sub-10 nm diameter [100] Si nanowires by metal-assisted chemical etching", Z. Huang, X. Zhang, M. Riche, L. Liu, W. Lee, T. Shimizu, S. Senz, and U. Gösele,   *NanoLetters* **8**, (2008) pp. 3046-3051.

- "Synthesis of vertical high density epitaxial Si (100) nanowire arrays on Si (100) substrate using anodic aluminum oxide template", T. Shimizu, T. Xie, J. Nishikawa, S. Shingubara, S. Senz, and U. Gösele, *Advanced Materials* 19, (2007) pp. 917- 920.

Research Interests

To develop high performance and cost effective electronic devices, my studies mainly focus on:
・Preparation of one-dimensional inorganic materials using self-organization technique, and fabrication of electronics devices using the 1D materials.
・Development of fabrication process of through-Si via (TSV) for 3D-LSI by wet-chemical process.