

アカデミックプログラム [B講演] | 19. コロイド・界面化学：口頭B講演

2025年3月27日(木) 15:55 ~ 17:15 [C]C506(第2学舎 2号館 [5階] C506)

[[C]C506-2vn] 19. コロイド・界面化学

座長：久米 晶子、近藤 剛弘

◆ 英語

15:55 ~ 16:15

[[C]C506-2vn-01]

Double spirals created by chiral interference pattern of plasmon scattering and circularly polarized light

○Hyo-Yong Ahn¹, Hiromi Okamoto¹ (1. Institute for Molecular Science)

◆ 日本語

16:15 ~ 16:35

[[C]C506-2vn-02]

電場増強チタンナノ構造体を用いた高分子ナノ粒子の光捕捉の実証

○東海林 竜也¹、中田 芳樹²、吉田 匡志¹、神谷 翼¹、御幡 千莉¹、田中 麗那¹ (1. 神奈川大理、2. 阪大レーザー研)

◆ 英語

16:35 ~ 16:55

[[C]C506-2vn-03]

Colorimetric response of polydiacetylene/ZnO nanocomposite to organic solvents and alkyl amines

○Rasel Ahmed¹, Jamuna Kannan¹, Yuna Kim¹, Ken-ichi Iimura¹ (1. Utsunomiya University)

◆ 日本語

16:55 ~ 17:15

[[C]C506-2vn-04]

酸化マグネシウムの水和機構に関する計算化学的研究

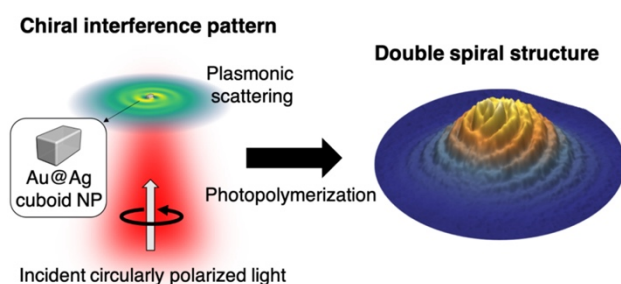
○稲垣 泰一¹、畑中 美穂¹ (1. 慶應義塾大学)

Double spirals created by chiral interference pattern of plasmon scattering and circularly polarized light

(¹*Institute for Molecular Science*) ○Hyo-Yong Ahn¹ and Hiromi Okamoto¹

Keywords: chiral nanostructure, photopolymerization, plasmon, chiro-optical effect **【5 words at most】**

Plasmonic nanostructures provide effective methods to create chiral nano-/microstructures, based on their capability to transfer the chirality of light to matter. Recent studies have shown that a simple achiral plasmonic nanostructure can induce dissymmetry (chirality) of the electromagnetic field under the excitation with circularly polarized light.¹ However, only the strong near-field effect in the vicinity of the nanostructure has been used to create the chiral structure at the nanometer scale. Our present study focuses on the effect of the scattering field extending over the few- μm regime, which is relatively weak compared to the near-field and therefore its effect has not been well addressed in previous studies. The secondary field induced by the nanoparticles can interfere with the incident light and give rise to a novel structure of the electromagnetic field at this spatial scale. Such fields can potentially provide unique nano-/micro-structured materials via photochemical reactions. Here, we have shown that the plasmonic scattering can be coupled with the incident circularly polarized light to generate characteristic chiral interference patterns.² We have succeeded in exploiting this phenomenon to create the well-defined double spiral structure from achiral Au core - Ag shell (Au@Ag) cuboid nanoparticles, by applying the photopolymerization reaction under the irradiation of visible light. Our numerical calculation further supports that the experimentally obtained photopolymerized structures are consistent with the interference pattern of the electromagnetic fields. **【ref. This body consists of 224 words.】**



1) S. Hashiyada, T. Narushima, H. Okamoto, *J. Phys. Chem. C* **2014**, *118*, 22229. 2) H.-Y. Ahn, T. Narushima, H. Okamoto, *J. Phys. Chem. C* **2024**, *128*, 7159.

電場増強チタンナノ構造体を用いた高分子ナノ粒子の光捕捉の実証

(神奈川大理¹・阪大レーザー研²) ○東海林 竜也¹、中田 芳樹²、吉田 匡志¹、神谷 翼¹、御幡 千莉¹、田中 麗那¹

Enhanced Optical Trapping of Polymer Nanoparticles Enabled by Titanium Nanostructures (¹*Faculty of Science, Kanagawa University*, ²*Institute of Laser Engineering, Osaka University*)

○Tatsuya Shoji¹, Yoshiki Nakata², Masashi Yoshida¹, Tsubasa Kamiya¹, Chiri Obata¹, Renna Tanaka¹

Optical tweezers, which trap nanoparticles using optical force, typically require a tightly focused intense laser beam. Recently, we demonstrated that polymer nanoparticles can be trapped using irradiation of incoherent light from a high-pressure mercury lamp on titanium nanopillar structures formed by plasma dry etching [1]. In this study, we used titanium nano-wrinkle structures formed by acid etching, and successfully trapped polymer nanoparticles in aqueous solutions using laser light. Furthermore, microorganisms such as *Escherichia coli* and black mold spores were captured. Real-time observation of mechanical sterilization was achieved, where *E. coli* trapped on the nanostructures was killed on the surface. This work highlights the potential of nanostructured titanium surfaces in optical trapping and microorganism control.

Keywords : *Non-plasmonic Optical Tweezers; Florescence Microspectroscopy; Polystyrene Nanospheres; Optical Force; Titanium Nano-wrinkle Structures*

光の力学作用（光圧）によるナノ粒子・マイクロ粒子の捕捉・操作方法である光ピンセットには、高出力・高集光性のレーザー光が必要不可欠である。一方、我々はプラズマドライエッチングにより形成したチタンナノピラー構造体を用いると、高圧水銀のインコヒーレント光でも高分子ナノ粒子を捕集できる興味深い現象を明らかにした [1]。本研究では酸腐食によりチタン箔に形成したチタンナノリンクル構造体を用いた光ピンセットについて報告する。チタンナノリンクル構造体にレーザー光を照射すると、構造体表面上にて水溶液中の高分子ナノ粒子を捕集することに成功した [2]。高分子ナノ粒子だけでなく、大腸菌や黒カビ胞子などの微生物も捕集できることがわかった。とくに大腸菌がナノリンクル構造に光捕捉されると、構造体表面上で大腸菌が死滅するメカニカル殺菌のリアルタイム観察に成功した。

1) Incoherent Optical Tweezers on Black Titanium, S. Hashimoto, T. Shoji, Y. Tsuboi *et al.*, *ACS Appl. Mater. Interfaces*, 13 (2021), 27586.

2) 光ピンセットを用いたナノ粒子の捕集, 東海林竜也ら, *分離技術*, 53 (2023), 39.

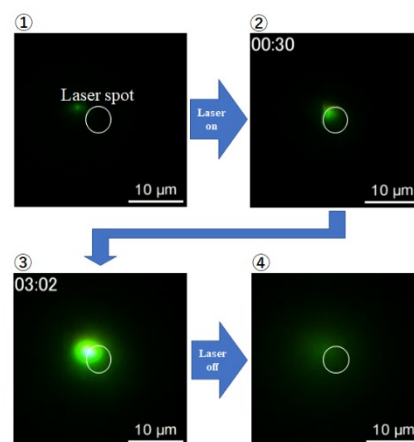


図 1 チタンナノリンクル構造体を用いた高分子ナノ粒子の光捕集の蛍光顕微鏡像

Colorimetric Response of Polydiacetylene/ZnO Nanocomposite to Organic Solvents and Alkyl Amines

(¹Graduate School of Regional Development and Creativity, Utsunomiya University, ²Center for Innovation Support, Institute for Social Innovation and Cooperation, Utsunomiya University) ○Ahmed Rasel¹, Kannan Jamuna², Yuna Kim¹, Ken-ichi Iimura¹

Keywords: Organic/inorganic nanocomposite, ZnO nanorod, Polydiacetylene, Organic solvents, Alkyl amines

Polydiacetylene (PDA) has been extensively studied for the creation of several kinds of chemosensors for the detection of diverse target analytes because of its special color-changing capabilities. Recently, it was reported that a poly(PCDA-IPA) molecular gel was used as chemosensor to differentiate volatile organic compounds (VOCs)¹⁾. In this contribution, we report the synthesis and characterization of a polydiacetylene-coated ZnO (PDA/ZnO) nanocomposite for colorimetric detection of VOCs and alkyl amines. The nanocomposite was prepared via dip coating method, yielding stable and uniform deposition of PDA on the surface of ZnO nanorods on ITO substrate (Fig. 1). This nanocomposite showed blue-to-red chromatic response in presence of triethylamine (Scheme 1), as verified by UV-vis, Raman and FT-IR spectroscopies. Additionally, we evaluated color-transition characteristics of the nanocomposite in response to acid and base exposure. It was observed that PDA/ZnO nanocomposite exhibits no color change under acidic conditions but shows pronounced colorimetric changes at higher pHs. Based on these findings, we aim to expand the application scope of this nanocomposite by investigating its interactions with alkyl amines. This study evaluates the possibility of PDA/ZnO nanocomposite for application as sensor for detecting alkyl amines through distinct colorimetric response.

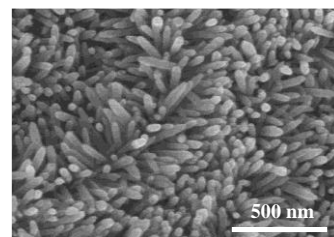
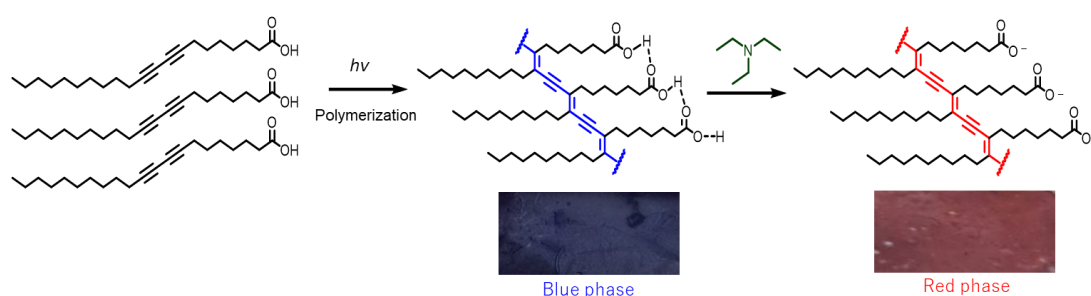


Fig. 1 A SEM image of PDA/ZnO nanocomposite on ITO substrate.



Scheme 1 Illustration of PDA-based colorimetric sensing of triethylamine.

- 1) Y. Xu *et al. European Polymer Journal*, 171 (2022) 111202.

酸化マグネシウムの水和機構に関する計算化学的研究

(慶大理工¹・分子研²) ○稲垣 泰一¹・畑中 美穂^{1,2}

Computational study on the hydration mechanism of magnesium oxide
(¹Keio University, ²Institute for Molecular Science) ○Taichi Inagaki¹ and Miho Hatanaka^{1,2}

Keywords : Molecular simulation; First-principles calculation; magnesium hydroxide; thermochemical heat storage

Magnesium oxide (MgO) reacts with water molecules to form magnesium hydroxide. Due to the simple solid structure and the ubiquitous presence of water, the reaction plays a fundamental role as a model for chemical reactions at the gas-solid interface. The reaction is also important in industry because of its application to thermochemical heat storage and cement production. The hydration process starts with the adsorption of water molecules onto the MgO surface, and the adsorption structure has been almost established by previous experimental and theoretical studies. However, the processes following the water adsorption and the crystal nucleation of magnesium hydroxide remain unclear. In this study, we investigate the mechanism of MgO hydration at the atomic level based on computational techniques. In particular, we analyze the structural changes of the MgO-water interface by generating and optimizing interface structures that occur along the hydration process using molecular simulations and first-principles calculations, respectively. In the presentation, we will report that the desorption of magnesium ions from the solid surface follows the adsorption of water molecules and that the crystal nucleation of magnesium hydroxide can occur by reaggregation of Mg-OH chains dissolved in the water layer.

酸化マグネシウム(MgO)は水と反応し、層状の水酸化マグネシウムに変化する。この単純な岩塩構造と普遍的な水との間の反応は、気固界面での化学反応のモデルとして基礎的な役割を有するとともに、化学蓄熱やセメント製造などの産業技術とも深く関係する重要な化学過程である。この水和過程は、水分子のMgO固体表面への吸着から始まる。低温および常温での水の数分子層までの吸着構造は、これまでの実験と理論研究からほぼ確定されつつある。しかしながら、水分子の吸着に続く素過程や水酸化マグネシウムの結晶核の生成機構については、十分な理解が進んでいない。本研究では、計算化学の手法に基づいてMgOの水和反応の機構を原子レベルで解析する。特に、水和過程に沿って生じる多様な界面構造の生成および最適化を分子シミュレーションと第一原理計算によってそれぞれ実施することで、一連の構造変化の過程を解析する。発表では、マグネシウムイオンの固体表面からの脱離が水分子の吸着に続く素過程であることや水酸化マグネシウムの結晶核生成は水層へ溶解したMg-OH鎖の再凝集によって起こり得ることを報告する。