Academic Program [Oral B] | 22. Resources Utilization Chemistry, Environmental and Green Chemistry：Oral B

Fri. Mar 28, 2025 10:00 AM - 11:20 AM JST | Fri. Mar 28, 2025 1:00 AM - 2:20 AM UTC
[A]D502(D502, Bldg. 4, Area 3 [5F])

[[A]D502-3am] 22. Resources Utilization Chemistry, Environmental and Green Chemistry

Chair: Riyo Yamanaka, Kunihiro Funasaka

English
10:00 AM - 10:20 AM JST | 1:00 AM - 1:20 AM UTC
[[A]D502-3am-01]

Glycine betaine: a by-product of sugar production process as a promising feedstock for development of novel multifunctional biologically active compounds

○Michał Niemczak[1], Tomasz Rzemieniecki[1], Damian K. Kaczmarek[1], Witold Stachowiak[1], Adriana Olejniczak[1] (1. Poznan University of Technology)

Japanese
10:20 AM - 10:40 AM JST | 1:20 AM - 1:40 AM UTC
[[A]D502-3am-02]

Preparation of Fuel Cell Electrode Catalysts via the Composite Formation of Chitosan Nanofibers and Keggin-type Di-platinum-coordinated Polyoxotungstate

○KOSUKE TOMITA[1], Masashi Nakano[1], Keisuke Kikuchi[2], Chika Kato[1] (1. Shizuoka University, 2. Industrial Research Institute of Shizuoka Perfecture)

Japanese
10:40 AM - 11:00 AM JST | 1:40 AM - 2:00 AM UTC
[[A]D502-3am-03]

Exploring the Structure-Selectivity Relationship in Alcohol Oxidation Using Ozone Fine Bubbles

○Takuya Kurahashi[1], Natsuki Yokoyama[1], Yuka Nakao[1] (1. University of Nagasaki)

Japanese
11:00 AM - 11:20 AM JST | 2:00 AM - 2:20 AM UTC
[[A]D502-3am-04]

Dependence of Extraction Efficiency of Solid−State Sampling Agents for Work Environment Measurement on the Concentration of Organic Solvents

○Hironobu Abiko[1] (1. Japan Organization of Occupational Health and Safety)

Glycine betaine: a by-product of sugar production process as a promising feedstock for development of novel multifunctional biologically active compounds

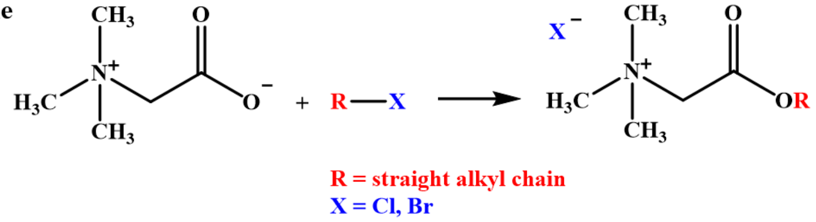
([1] *Faculty of Chemical Technology, Poznan University of Technology, Berdychowo 4, 60-965, Poznań, Poland*) ○Michał Niemczak,[1] Tomasz Rzemieniecki,[1] Damian K. Kaczmarek,[1] Witold Stachowiak,[1] Adriana Olejniczak[1]

Keywords: Betaine; Plant Protection; Cleaning Products; Biological Activity; Esterquats

To reduce the environmental impact of new chemicals, it is essential to source substances from renewable materials and ensure they are highly biodegradable. Their synthesis should ideally use non-toxic, reusable reaction media. Glycine betaine, a biodegradable and non-toxic compound, meets these criteria and can account for over 25% of the waste mass from sugar beet processing. By *O*-alkylating its carboxylate group, specific quaternary ammonium salts (QASs) with ester groups, known as esterquats, can be synthesized. These betaine esters hydrolyze rapidly into low-toxicity substances, thereby reducing environmental pollution compared to entirely synthetic QASs.[1,2]

Currently known methods for the synthesis of alkylated derivatives of glycine betaine require the use of toxic reagents. Additionally, the majority of these methods are time-consuming and involve numerous unit operations. Therefore, an attempt was made to improve the process and establish more favorable synthesis conditions for commercial production. Optimization of betaine *O*-alkylation allows for process simplification, cost reduction, and decreased energy expenditure. The conducted research paves the way to scaling up the synthesis of betaine esters to a large laboratory and industrial scale. Furthermore, promising results regarding their cleaning and herbicidal properties, along with ecotoxicity assays, underscore their significant potential for commercial applications.

O-alkylation of glycine betaine with halogenoalkanes



The research was financed by the National Centre for Research and Development (Poland) as part of the LIDER XIII project (grant no. LIDER13/0029/2022)

1) W. Stachowiak, A. Olejniczak, T. Rzemieniecki, M. Smolibowski, M. Wysokowski, T. Jesionowski, A. Mezzetta, L. Guazzelli, M. Niemczak, *ACS Sustainable Chem. Eng.* **2024**, *12*, 50, 18187. 2) M. Wysocki, W. Stachowiak, M. Smolibowski, A. Olejniczak, M. Niemczak, J. L. Shamshina, *Int. J. Mol. Sci.* **2024**, *25*, 5761.

キトサンナノファイバーとケギン型二核白金種配位ポリオキソタングステートとの複合化による燃料電池電極触媒の調製

（静岡大理 ^{1}・静岡県工技研 ^{2}）○冨田 昂佑 ^{1}・中野 将志 ^{1}・菊池 圭祐 ^{2}・加藤 知香 ^{1}

Preparation of Fuel Cell Electrode Catalysts via the Composite Formation of Chitosan Nanofibers and Keggin-type Di-platinum-coordinated Polyoxotungstate

([1]*Faculty of Science, Shizuoka University*, [2]*Industrial Research Institute of Shizuoka Prefecture*) ○Kosuke Tomita,[1] Masashi Nakano,[1] Keisuke Kikuchi,[2] Chika Kato[1]

Platinum-supported carbon (Pt/C), commonly used as a cathode catalyst in polymer electrolyte fuel cells (PEFCs), faces significant challenges due to cost issues and degradation phenomena, such as catalyst particle growth, depletion, agglomeration, and corrosion of the carbon support under operating conditions. In this study, we prepared Pt/C with highly dispersed platinum nanoparticles by integrating and carbonizing biomass-derived chitosan nanofibers (ChNFs), which possess high specific surface areas and surface functional groups such as amino and hydroxyl groups that facilitate platinum dispersion, with Keggin-type di-platinum-coordinated polyoxotungstate ($Cs_3[\alpha\text{-}PW_{11}O_{39}\{cis\text{-}Pt(NH_3)_2\}_2]\cdot 8H_2O$; Cs-P-Pt), which have been reported to exhibit excellent platinum aggregation suppression under high-temperature calcination. The resulting solid was applied as a cathode catalyst in PEFCs, and its power generation performance was evaluated using a membrane-electrode assembly (MEA).

Keywords : Polyoxotungstate; Chitosan Nanofibers; Platinum-supported Carbon; Polymer Electrolyte Fuel Cell; Cathode Catalyst

固体高分子形燃料電池（PEFC）用カソード触媒に用いられる白金担持カーボン（Pt/C）は、コスト面の課題や作動環境下での触媒の粒成長、減耗、凝集や担体カーボンの腐食等による劣化現象が重大な課題となっている。本研究では、高い比表面積を有し、アミノ基やヒドロキシ基等の表面官能基による白金粒子の高分散担持が期待できるバイオマス由来キトサンナノファイバー（ChNF）と、高温焼成条件下で優れた白金凝集抑制効果を発現することが報告されているケギン型二核白金種配位ポリオキソタングステート（$Cs_3[\alpha\text{-}PW_{11}O_{39}\{cis\text{-}Pt(NH_3)_2\}_2]\cdot 8H_2O$; Cs-P-Pt）[1)]を複合化・炭化することで、白金ナノ粒子が高分散担持した Pt/C を作製した（図 1）。得られた固体を PEFC 用カソード触媒として用い、膜電極接合体（MEA）による発電性能評価を実施した。

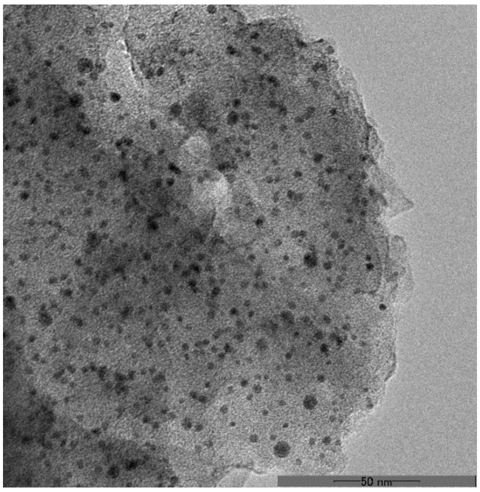


図 1. ChNF と Cs-P-Pt を複合化・炭化することで得た Pt/C の TEM 像

1) C. N. Kato T. Kubota, K. Aono, N. Ozawa, *Catal. Lett.* **2022**, *152*, 2553.

オゾンファインバブルによる アルコール酸化の構造-選択性相関の探究

（長崎県立大学）○倉橋 拓也・横山 渚月・中尾 友香

Exploring the Structure-Selectivity Relationship in Alcohol Oxidation Using Ozone Fine Bubbles

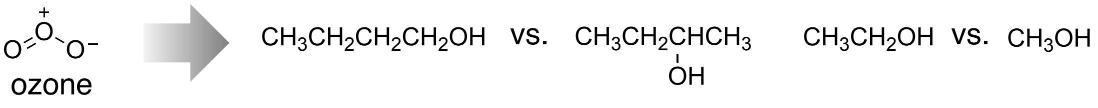
(*Department of Nutrition Science, University of Nagasaki*) ○Takuya Kurahashi, Natsuki Yokoyama, Yuka Nakao

Ozone, which is produced cost-effectively from atmospheric dioxygen, is an environmentally benign oxidant that generates only dioxygen as a byproduct. Its high reactivity without the need for a catalyst makes it particularly suitable for applications where even trace contaminants are not tolerated, such as in the food industry. However, ozone has traditionally been regared as an uncontrollable oxidizing agent that reacts indiscriminately with organic compounds. In this study, we employed ozone fine bubbles with an expanded gas-liquid interface to enable reproducible reactions between gaseous ozone and water-soluble substrates, focusing on fundamental organic transformations. The results revealed that ozone exhibits intrinsic selectivity in alcohol oxidation, preferentially oxidizing secondary alcohols over primary alcohols and ethanol over methanol.

Keywords : Ozone; Fine Bubbles; Alcohol Oxidation

オゾンは空気中の酸素ガスから低コストで製造可能で反応後に副生するのは酸素ガスのみであるため、環境負荷の低い反応剤とされる。さらに、他の反応剤では必要になる触媒を添加しなくても、必要十分な高い反応活性を示す。これらの特性は、食品産業のように、微量の不純物も許容されない分野で極めて大きな優位性を持つ。一方で、オゾンは有機化合物と無分別に反応する制御不可能な酸化剤であると一般的には考えられてきた。

本研究では、オゾンガスを水溶液中で微細化して得られるオゾンファインバブルを用いて反応検討を行うことにした。この手法により気液界面が極限まで拡張され、ガス状オゾンと水溶性基質を再現性よく反応させることが可能になる。この条件下で基礎的かつ重要な有機化学反応で反応選択性を検証した結果、オゾンによるアルコール酸化で、一級アルコールに比べて二級アルコールが、メタノールに比べてエタノールが優先的に反応することがわかった。今回明らかになったオゾンの特徴的な反応選択性は、従来の有機物の完全分解用途に加えて、より付加価値の高い高度な化学変換への応用可能性を示唆している。



$CH_3CH_2CH_2CH_2OH$ vs. $CH_3CH_2CH(OH)CH_3$ CH_3CH_2OH vs. CH_3OH

作業環境測定での固体捕集剤における有機溶剤抽出効率の濃度変化

（独立行政法人労働者健康安全機構 労働安全衛生総合研究所）○安彦 泰進

Dependence of Extraction Efficiency of Solid−State Sampling Agents for Work Environment Measurement on the Concentration of Organic Solvents

（*Work Environment Research Group*, *National Institute of Occupational Safety and Health*, *Japan Organization of Occupational Health and Safety*）○Hironobu Abiko

Activated carbon and silica gel are commonly used as solid-state sampling agents of organic solvent vapor in work environment measurement established by the Industrial Safety and Health Act in Japan. In the measurement, extraction efficiency of organic solvent from the agents is particularly important for accuracy of determination especially in the low concentration region of the vapor. In this study, we have measured the efficiencies of the agents using various types of organic solvents to investigate their concentration dependence. Clarification of the concentration dependence is necessary in development of effective measurement methods using the agents in combination.

Keywords : *Activated Carbon*; *Extraction Efficiency*; *Organic Solvent Vapor*; *Silica Gel*; *Work Environment Measurement*

労働安全衛生法に基づく作業環境中の有機溶剤蒸気濃度の測定方法には、活性炭などの捕集剤が充填された捕集管と吸引ポンプにより一定時間の濃縮捕集を行った後、各種の有機溶媒で対象の有機溶剤成分を捕集剤から抽出して測定を行う固体捕集法がある1-3)。この濃度測定では、従来よりもさらに低濃度の領域の精確な測定にも近年関心が持たれている。ここで、代表的な捕集剤である活性炭は有機溶剤の種類や濃度によっては抽出効率（脱着率）が好ましくなく、測定精度に影響を生じることが指摘されている。一方、シリカゲルは疎水性の活性炭を補う捕集剤とされ、この併用による改善に大きな関心が持たれるが、現状において双方の捕集剤の適切な使い分けの詳細は多くが不明である。

本研究では活性炭捕集剤とシリカゲル捕集剤での各種有機溶剤脱着率の比較を進め（Fig.1）、幾つかの有機溶剤における抽出効率の濃度依存性の考察より、有機溶剤蒸気の濃度に応じて双方の捕集剤を併用することの効果について検討を行う。

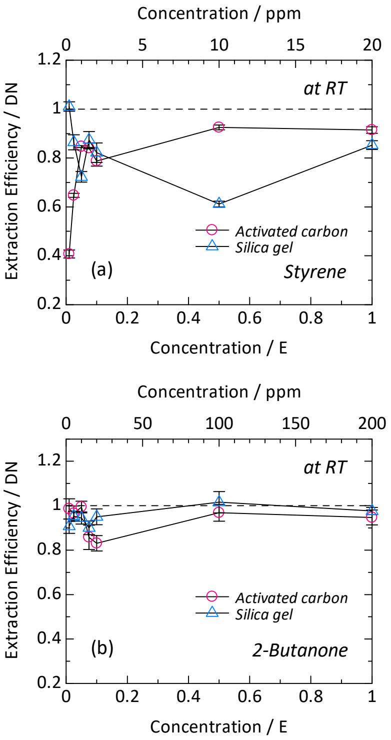


Fig.1 Examples of comparison of extraction efficiencies of organic solvent components determined by the direct addition method 3) between the petroleum−based activated carbon specimen (40 mg) and the silica gel specimen (70 mg). E= the control concentration as defined by the Industrial Safety and Health Act in Japan. DN= dimensionless number. RT= room temperature (approximately 290 − 297K).

【参考文献】

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