Interface Process Engineering Lab.

Department of Applied Chemistry, Okayama University
PI: Tsutomu Ono (tono@okayama-u.ac.jp, http://achem.okayama-u.ac.jp/interface/en-home/)

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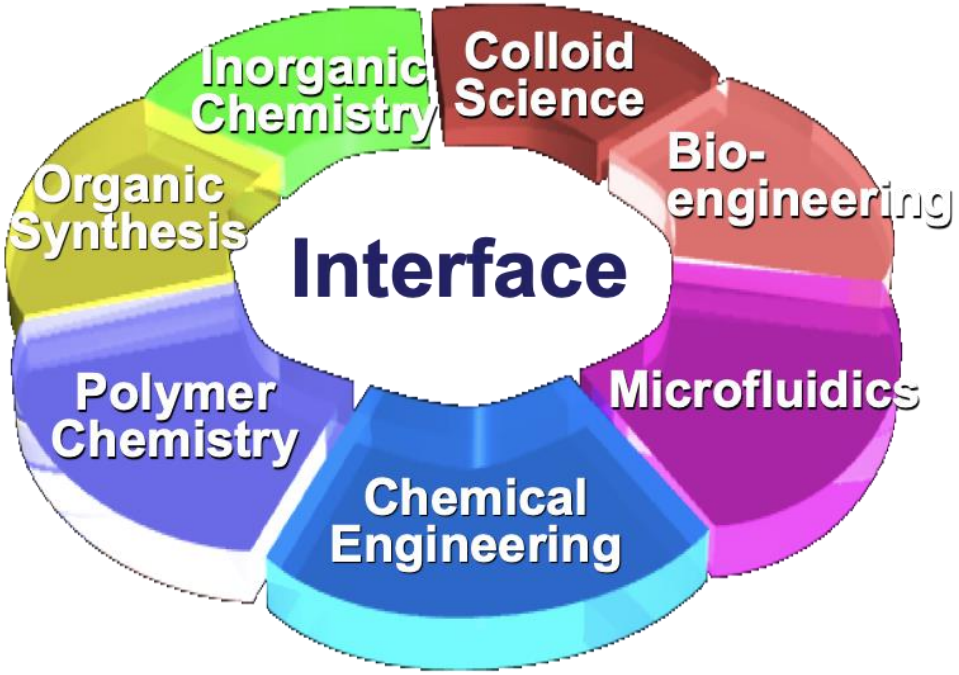
Professor : **Tsutomu Ono**
Assistant Professor : Takaichi Watanabe

10 MD students
7 BD students



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"Process innovation for product innovation"

We focus on the process innovation to improve the productivity, quality and functionality. To achieve our goals, we take advantage of some chemical and engineering approaches such as molecular design, materials science and process engineering.

Recently, we concentrate the following research topics.

Research Topics

- From microfluidics to flow process for manufacturing materials

- Design of functional particles and gels

- Material usage of ionic liquid properties:
Polymeric ionic liquid (PIL), Ionogel and Surface coating

From microfluidics to flow process for manufacturing materials

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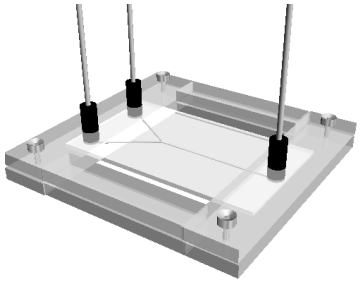
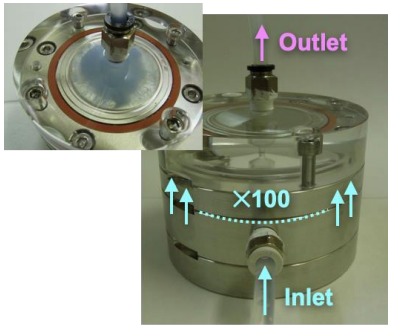
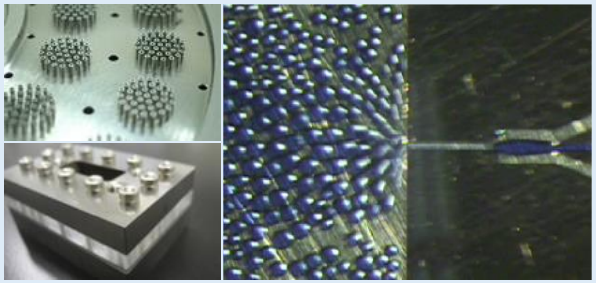
Space saving
High-throughput
Quick mixing
Precise heating



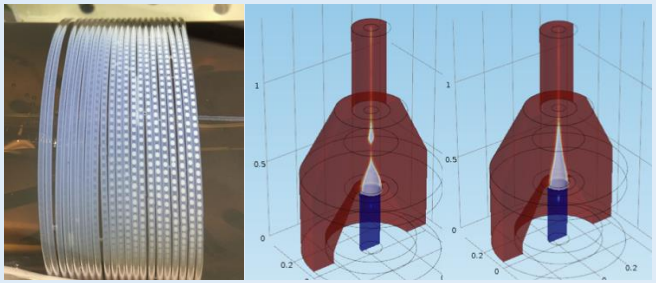
Numbering-up
Mass production



Geometry design



Fluid design



- Exploring the availability of flow process in material science:
  (ex.) microfluidic emulsification, polymerization, particle synthesis, crystallization and nanofiber wet-spinning

- Keywords: Microfluidic devices, Micro-chemical engineering, Microchannel geometry, CFD, slug flow, jet flow, droplets

Design of functional particles and gels

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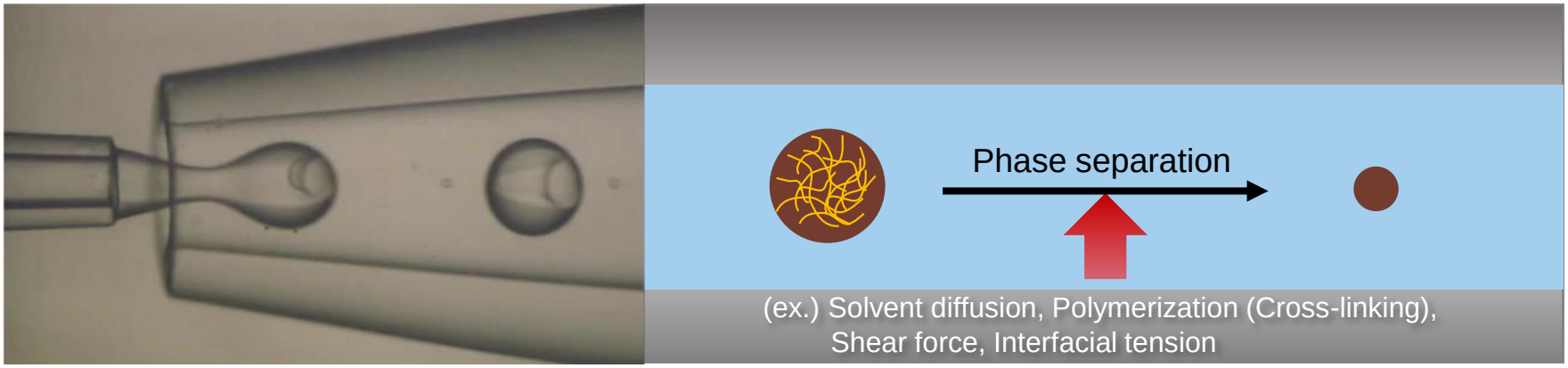
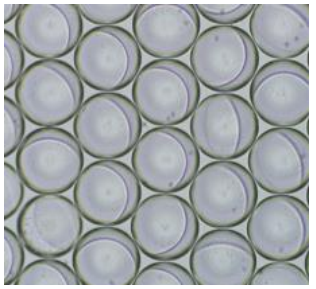


- Controlled phase separation facilitates the well-defined internal structure of monodisperse particles using microfluidics.

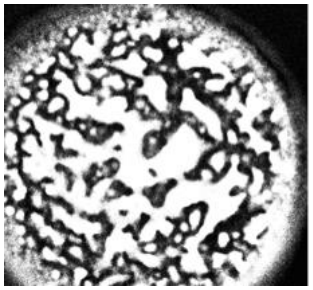
- We explore the phase separation behaviors induced by solvent diffusion, polymerization, shear and interfacial tension.

- Keywords: phase separation, capsule, gel, porous, core-shell, Janus, Bicontinuous, Spinodal decomposition, Nucleation and growth, Aqueous two-phase separation (ATPS), Liposome.

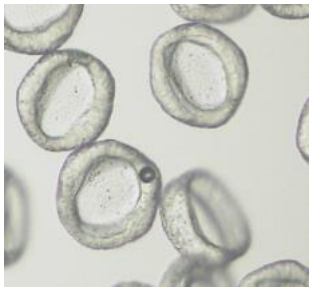
Hydrogel capsules



Janus particles



Porous particles



Doughnut particles

Material usage of ionic liquid properties: PIL, Ionogel and Surface coating

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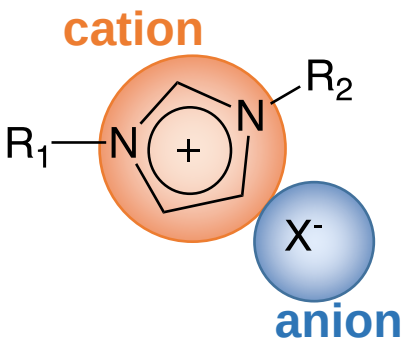
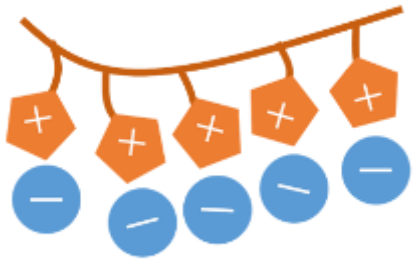
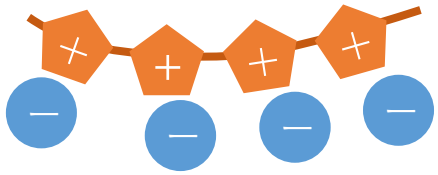


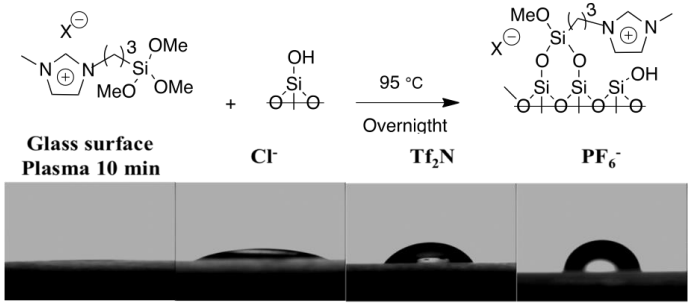
Polymerization

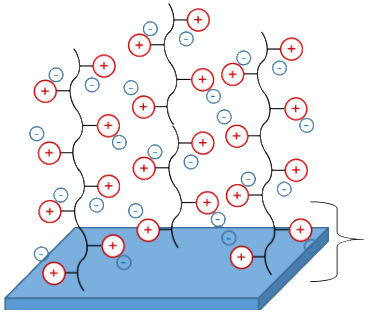


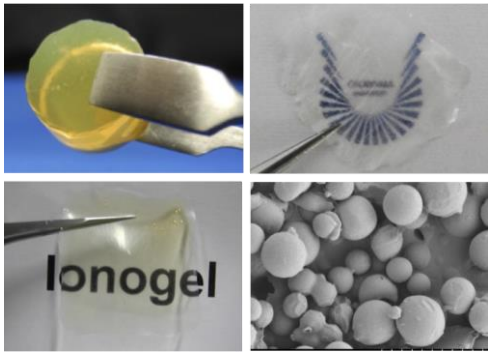


“pendant PIL” “backbone PIL”

Ionic liquid (IL) Polymer ionic liquid (PIL)



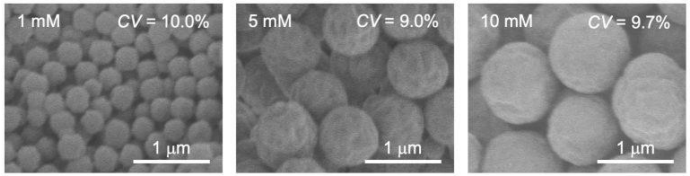




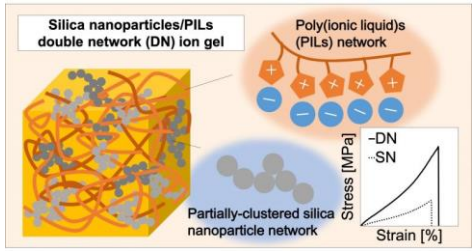
- We aim to develop the non-volatile soft materials using ionic liquid: polymer, gel, particles, film and surface coating. Molecular design of PIL and the network leads to exert the specific properties such as CO_2 absorption, ion conductivity and wettability.

- Keywords: PIL, Ionomer, click reaction, IL monomer, ionogel, double-network gel, Wettability, , Li-ion battery, CO_2 selective separation,

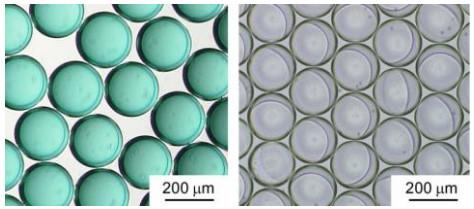
Recent activities



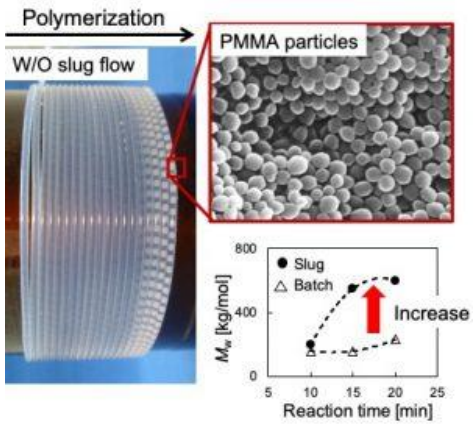
1) T. Watanabe, K. Karita, T. Ono “Flow synthesis of monodisperse micron-sized polymer particles by heterogeneous polymerization using water-in-oil slug flow with non-ionic surfactant” *Colloid Polym. Sci.*, in press (2020) Link



2) T. Watanabe, R. Takahashi, T. Ono “Preparation of tough, thermally stable, and water-resistant double-network ion gels consisting of silica nanoparticles/poly(ionic liquid)s through photopolymerisation of ionic monomer and subsequent solvent removal” *Soft Matter*, **16**, 1572-1581 (2020) Link

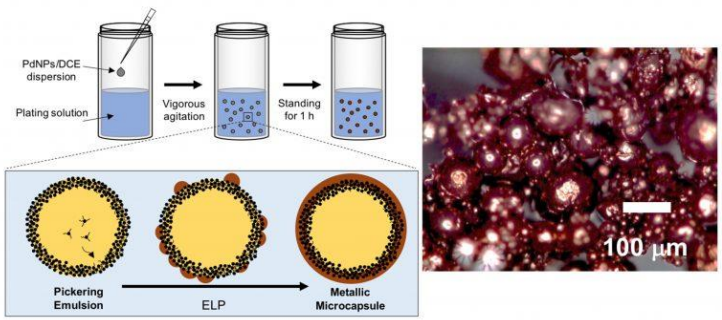


3) T. Watanabe, I. Motohiro, T. Ono “Microfluidic Formation of Hydrogel Microcapsules with a Single Aqueous Core by Spontaneous Cross-linking in Aqueous Two-Phase System Droplets” *Langmuir*, **35(6)**, 2358-2367 (2019) Link

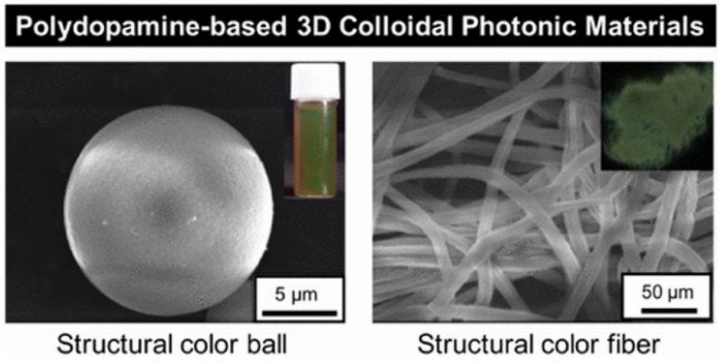


4) T. Watanabe, K. Karita, K. Tawara, T. Soga, T. Ono “Rapid synthesis of poly(methyl methacrylate) particles with high molecular weight by soap-free emulsion polymerization using water-in-oil slug flow” *Macromol. Chem. Phys.*,**220**, 1900021 (2019) Link

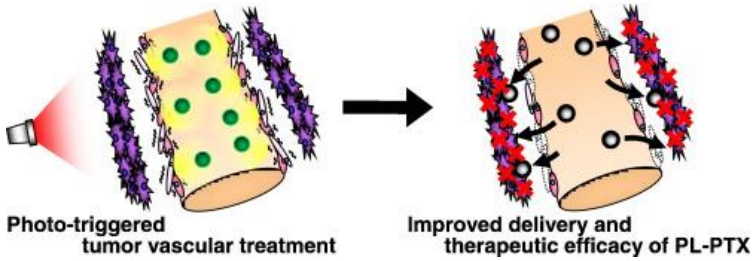
Recent activities



5) T. Tsuneyoshi, Y. Cui, H. Ishida, T. Watanabe, T. Ono “Metal Microcapsules Prepared via Electroless Plating at Liquid-Liquid Interface” *Langmuir*, **35**, 13311-13317 (2019) Link



6) M. Kohri, K. Yanagimoto, A. Kawamura, K. Hamada, Y. Imai, T. Watanabe, T. Ono, T. Taniguchi, K. Kishikawa “Polydopamine-Based 3D Colloidal Photonic Materials: Structural Color Balls and Fibers from Melanin-Like Particles with Polydopamine Shell Layers” *ACS Appl. Mater. Interfaces,* **10(9)**, 7640-7648 (2018) Link



7) T. Araki, K. Ogawara, H. Suzuki, R. Kawai, T. Watanabe, T. Ono, K. Higaki “Augmented EPR effect by phototriggered tumor vascular treatment improved therapeutic efficacy of liposomal paclitaxel in mice bearing tumors with low permeable vasculature” *J. Controlled Release*, **200(28)**, 106-114 (2015) Link