TSUKUBA GLOBAL SCIENCE WEEK 2022

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

筑波大学
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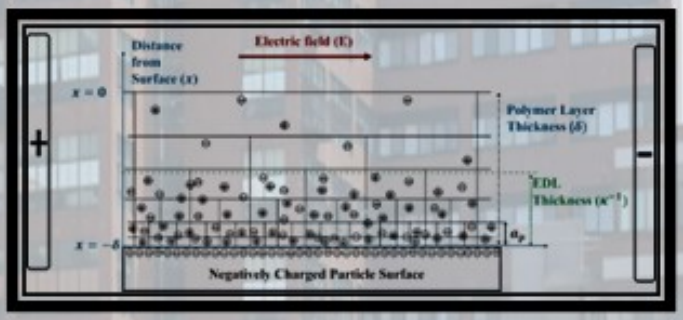
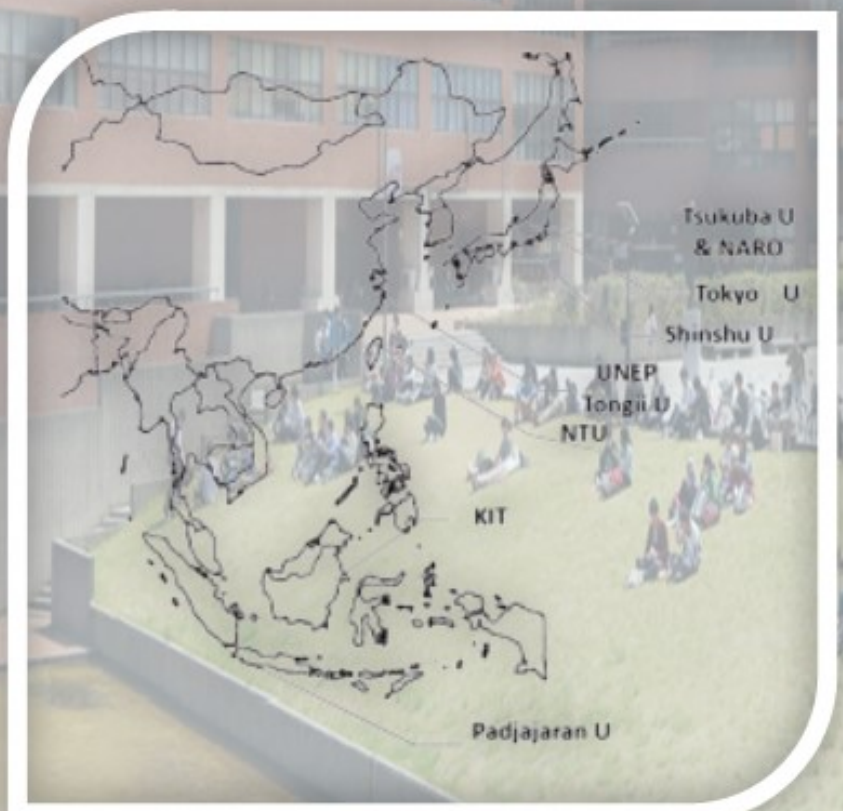
IMAGINE THE FUTURE.

Book of Abstract

Bio-flocculation and Smart Sludge toward Soil Improvement



筑波大学リサーチユニット
生物資源コロイド工学
University of Tsukuba Research Unit
Colloid Engineering in Bio-resources



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All the session details can be found at :
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Book of Abstract is Created by: SAHA Santanu

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About Us

Dear Colleagues and Friends,

Welcome to the online session of Bio-flocculation and Smart Sludge toward Soil Improvement

This session was firstly organized in line with the activity of the JSPS research project of the name of 'Environmental Interface Engineering based on the Dynamic Analysis of Colloidal Flocculation' which has been carried out for the last six years.

This conference used to be onsite before the COVID 19 took over the wold pandemic. Fortunately or unfortunately TGSW2022 made a decision to carry out as an online conference.

I really express my sincere thanks for the collaboration and dedicated effort of my friends, colleagues, advisors, students, and staff.

Let us wish that all attendees and participants of TGSW2022 will have a fruitful and meaningful time.

Sincerely,

Yasuhisa ADACHI
Faculty of Graduate School of Life and Environmental Sciences
University of Tsukuba
1-1-1 Tennodai, Tsukuba, Ibaraki 35-8572, Japan

Bio-flocculation and Smart Sludge toward Soil Improvement

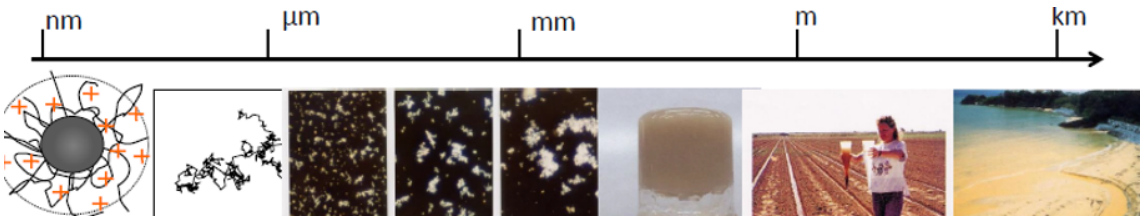
In this session, we will discuss various issues related to colloid and interface science and confirm its effectiveness in the development of research and education in bioresources environmental engineering, which is aiming in a sustainable direction.

Water treatment and civil engineering problems, and we will connect an excellent group from the Netherlands, which is at the technological forefront of this field, and researchers from Asia, which is considered to have great potential for future development due to its high biological productivity.

Discussing point is linking floc rearrangement, granulation, dehydration, etc. to soil physical water retention and movement phenomena.Through such discussion the effectiveness of DX and their reasonable utilization in the related graduate education will be clarified.

Mission of summer school (DSSIBEE2021 (digital summer school interface for bioresources and environmental engineering 2021), TGSW2021(Colloid and interface for civil and environmental engineering), DSSBEE2022(digital spring school in bioresources and environmental engineering) , and NARO(national agricultural organization) and Industrial collaboration are all included.

In addition to TGSW2022,the session of Bio-Flocculation and Smart Sludge for Soil Improvement is carried out by the support of Kyoikusuishinsenryaku Project (University of Tsukuba), JSPS Kakenhi 22H00387, Auspices Research Unit Bio-resource colloid engineering University of Tsukuba. The Electrokinetic Society of Japan, Japanese Society of Soil Physics, Bio-flocculation Seminar, ETC (will be updated)



Colloidal Flocculation is the Key To Connect the Micro and Macro

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Timetable

Information about the Book of Abstract:
For your kind Information, this book of abstract is click friendly. If you click on either the session name or the title of any speaker, it will direct you the abstracts of the session or the presenter. Some texts are linked with convenient url, please feel free to use them.

Abbreviations:
GL: Group Lectures, PL: Plenary lecture, KT: Keynote Talke, IT: Invited Talk, YT: Yong-researcher Talk

Day 1: Monday, 26 of September 2022

12:50 - 13:00	**Session Start**		
	Welcome Remarks		
13:00 - 15:30	**Digital summer school in Bio-resources and Environmental Eng.**		
	Chair. Dr. Hongtao Wang, Dr. Hideyuki Sugioka		
13:00 - 13:30	**Hideyuki Sugioka Group (Shinshu University, Complex thermal fluid Lab.)**		
	GL	**Hiroki Yoshijima and Hideyuki Sugioka** Shinshu University	Spiral light-driven BL pump for water problem
	GL	**Shunsuke Takahashi and Hideyuki Sugioka** Shinshu University	Fluidic switch using ICEO for healthcare
	GL	**Ryo Takeda and Hideyuki Sugioka** Shinshu University	Vector separator using ICEO for healthcare
	GL	**Atsushi Miyauchi and Hideyuki Sugioka** Shinshu University	Bubble water pump using oblique structures for the use of waste heat
	GL	**Yuki Arai and Hideyuki Sugioka** Shinshu University	Micro rotary engine for microrobot

	GL	**Katsuaki Murata and Hideyuki Sugioka** Shinshu University	Side-shooter using discharge
	GL	**Wataru Tomita and Hideyuki Sugioka** Shinshu University	Hydrodynamic interaction between thermal cilia
	GL	**Hiroya Nakamura** Shinshu University	Weaving technique for ICEO carbon actuators
13:30 - 14:00	**Yasuhisa Adachi Group (Colloid Lab, University of Tsukuba)**		
13:30 - 13:45	GL	**Lifan Duan** University of Tsukuba	Particle-induced aggregation by adsorption of oppositely charged small particles
13:45 - 14:00	GL	**Zheng Ju** University of Tsukuba	Effects of pH and dosage of polyaluminium chloride on initial-stage kinetics of flocculation of polystyrene latex particles
14:00 - 14:30	**Motoyoshi Kobayashi Group (University of Tsukuba)**		
14:00 - 14:15	GL	**Yue Lyu** University of Tsukuba	Strength of Floc of Leonardite Humic Acid with Cationic Polyelectrolytes
14:15 - 14:30	GL	**Zhengjian Tian** University of Tsukuba	Effect of lysozyme on the aggregation and charging of oxidized carbon nanohorn (CHNox) in aqueous solution
14:30 - 15:00	**Hongtao Wang Group (UNEP Tongji University)**		
14:30 - 14:40	GL	**Hongtao Wang** UNEP Tongji University	Introduction to Laboratory of Environmental System Engineering
14:40 - 14:45	GL	**Bomin Fu** UNEP Tongji University	The influence of humic substances on environmental behavior of antibiotic resistance genes

14:45 - 14:50	GL	**Junsen Wang** UNEP Tongji University	Enhancement of sludge dewaterability by electrolysis coupled with peroxymonosulfate oxidation process: Performance, mechanisms and implications
14:50 - 14:55	GL	**Hongtao Wang** UNEP Tongji University	Insight into advanced oxidation processes for the degradation of fluoroquinolone antibiotics: Removal, mechanism, and influencing factors
14:55 - 15:00	**Discussion (Q&A)**		
15:00 - 15:30	**Zhongfang Lei Group (University of Tsukuba**		
	GL	**Zhongfang Lei** University of Tsukuba	Introduction to Laboratory of Bioresource Process Engineering
	GL	**Xingyu Chen** University of Tsukuba	A comparative study on simultaneous recovery of phosphorus and alginate-like exopolymers from bacterial and algal-bacterial aerobic granular sludges: Effects of organic loading rate
	GL	**Zejiao Li** University of Tsukuba	Stable and high-efficacy nitrogen removal from wastewater by algal-bacterial aerobic granular sludge under no mechanical aeration
	GL	**Xiaochuan Dong** University of Tsukuba	Carbon fixation and heavy metal adsorption by soil particles supplemented with microalgal-bacterial granules
	GL	**Yankai Zhao** University of Tsukuba	Wastewater treatment by microalgal-bacterial granules under heavy metal inhibition and its sustainable solutions
15:30 - 16:00	**30 minutes Break**		
16:00 - 18:40	**Colloids in Civil and Environmental Eng.**		
	Chair: Dr. Motoyoshi Kobayashi, University of Tsukuba		
16:00 - 17:00	PL	**Claire Chassagne** TU Delft	Bio-flocculation and applications in Smart Soils

17:00 - 17:30	**Takashi Matsushima Group (Project & Graduate Study) (University of Tsukuba)**		
17:00 - 17:05	GL	**Takashi Matsushima** University of Tsukuba	Role of granular mechanics in civil and environmental engineering
17:05 - 17:15	GL	**Opu Chandra Debnath** University of Tsukuba	3D grain shape evolution during rotating drum abrasion experiment
17:15 - 17:25	GL	**Haoran Jiang** University of Tsukuba	DEM-SPH coupling for simulating complex erosion/sedimentation process
17:25 - 17:30	**Discussion (Q&A)**		
17:30 - 18:00	**Key note lecture on Fundamental Colloid**		
17:30 - 17:50	KT	**Lester C. Geonzon** The University of Tokyo	Adsorption kinetics of polyelectrolytes onto a silica particle in a unidirectional flow field studied using microfluidics and optical tweezers
17:50 - 18:10	KT	**Santanu SAHA** University of Tsukuba	Poly(ethylene oxide) (PEO) Adsorption on Polystyrene Sulfate (PS) Latex: An Electrophoretic Analysis
18:10 - 18:30	KT	**Maolin Li** University of Tsukuba	The effect of diverse ion species on the charging and aggregation of natural allophane particles
18:30 - 18:40	**Closing Remarks by Prof. Hiroyuki Ohshima, Tokyo University of Science**		
	(This excess time can be managed by the extension)		

Day 2: Tuesday, 27 of September 2022

12:50	**Session Start**		
13:00 - 15:30	**NARO & Industrial and Agriculture Session**		
	Chair: Teruhito Miyamoto, NARO		
13:00 - 13:40	IT	**Koji Kameyama** Institute for Rural Engineering, NARO	Biochar: sorption mechanism and its application for agriculture
13:40 - 14:00	IT	**Mii Fukuda** Toshiba Infrastructure Systems & Solutions Corporation	Development of Sensors that Detect the Coagulation State of Flocs for Controlling the Coagulant Dose -Streaming Current Sensor and Image Processing Coagulation Sensor
14:00 - 14:45	**Chihhao Fan & Shu-Yuan Pan Group, National Taiwan University**		
14:00 - 14:20	GL	**Chihhao Fan** Department of Bioenvironmental Systems Engineering, National Taiwan University, Taiwan	Strategies on source control for fertilizer non-point source pollution mitigation in Agricultural Farmlands
14:20 - 14:40	GL	**Shu-Yuan Pan** Department of Bioenvironmental Systems Engineering, National Taiwan University, Taiwan	Green Technology Lab at NTU `https://homepage.ntu.edu.tw/~sypan/Default.html`
14:40- 14:45	**Discussion (Q&A)**		
14:45 - 15:15	**Shoichiro Hamamoto Group, The University of Tokyo**		
14:45 - 14:50	GL	**Shoichiro Hamamoto** The University of Tokyo	Lab of Soil Physics and Soil Hydrology at UoT
14:50 - 15:00	GL	**Tatsuya Kobayakawa** The University of Tokyo	Seasonal variations in methane emissions via plant and ebullition from rice paddies

15:00 - 15:10	GL	**Rikutaro Higashi** The University of Tokyo	Effects of cation exchange on colloid transport in saturated porous media
15:10 - 15:15	**Discussion (Q&A)**		
15:15 - 15:30	**Small Break**		
15:30 - 17:00	**Asian students and young researcher session**		
	Chair: Akiko Nakagawa, Oviyanti Mulyani, Toshiharu Enomae		
	University of Tsukuba, Universitas Padjajaran		
15:30 - 15:45	YT	**Oviyanti Mulyani** Universitas Padjajaran	Utilization of Adsorbent from Organic Matter in Reducing Heavy Metal Levels
15:45 - 16:00	YT	**Nadia N. Kamaluddin** Alumni of Biomaterial Chemistry Laboratory	Short introduction “Lignocellulose Biomass Utilization as Soil Conditioners”
16:00 - 16:15	YT	**Que Nguyen Ho** Energy Environment Institute Kyungpook National University	Bio-mediated flocculation of cohesive sediment and microalga in different growth phases
16:15 - 16:30	YT	**Nurani Ikhlas** Faculty of Engineering, Universitas Diponegoro	Struvite Recovery from Industrial Wastewater via Coagulation and Flocculation using Magnesium Chloride as Coagulant
16:30 - 16:45	YT	**Yudha Gusti Wibowo** Department of Mining Engineering Institut Teknologi Sumatera	Performance of Novel Biochar-Clamshell Composite for Real Acid Mine Drainage Treatment
16:45 - 17:00	YT	**Meher Sultana** Graduate School of Life and Environmental Sciences, University of Tsukuba	Analysis of rate of flocculation of positively charged monodisperse spheres induced by the montmorillonite using standardized mixing approach
17:00 - 17:15	**Coffee Break**		

17:00 - 18:10	**Discussion on the education of fundamental subjects of**		
	Bio-resource and environmental Engineering		
	Chair: Tofael Ahamed, University of Tsukuba		
5-10 min	GL	**Dr. Mito Kokawa** University of Tsukuba	Electromagnetics
5-10 min	GL	**Takuya Sugimoto** University of Tsukuba	Thermodynamics
5-10 min	GL	**Yohei Asada** University of Tsukuba	Hydroulics
5-10 min	GL	**Tian Yuan** University of Tsukuba	TBA
18:00 - 18:10	**Closing Remarks by Prof. Chiaki Matsukura**		
	Chair of Degree Program in Agricultural Sciences, University of Tsukuba		

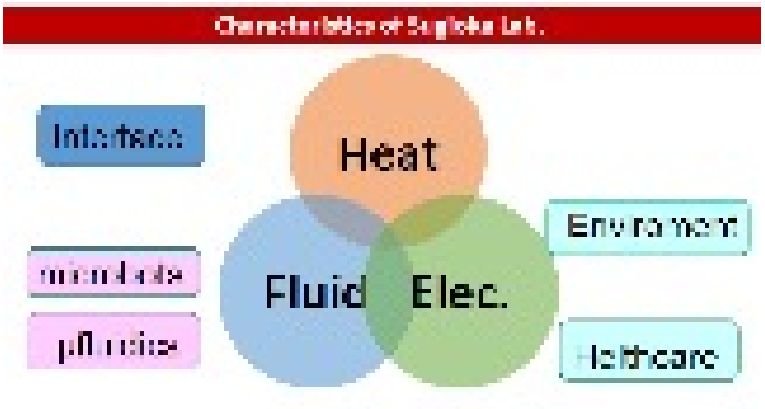
List of Abstracts – Talks

Day 1: Monday, 26^{th}

Approach from the electric and thermal interface for environment and healthcare

Hideyuki Sugioka GL

Complex thermal fluid Lab, Shinshu University



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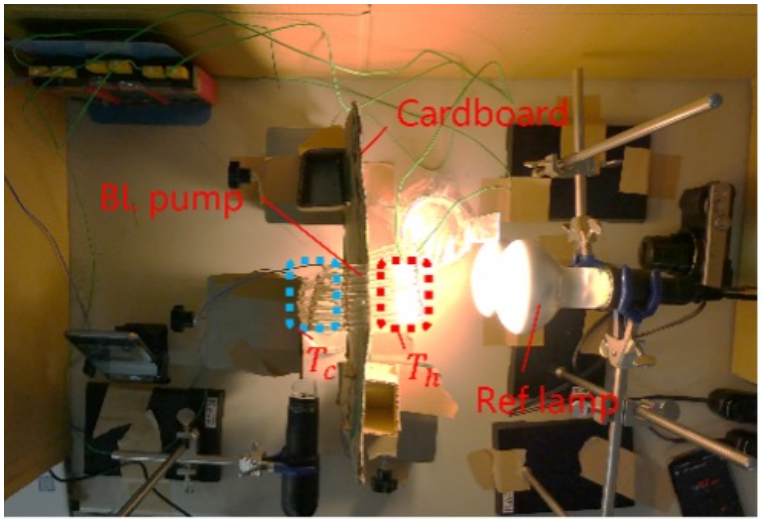
WATER PROBLEM: Spiral light-driven BL pump for water problem

Hiroki Yoshijima, Hideyuki Sugioka

GL

Complex thermal fluid Lab, Shinshu University

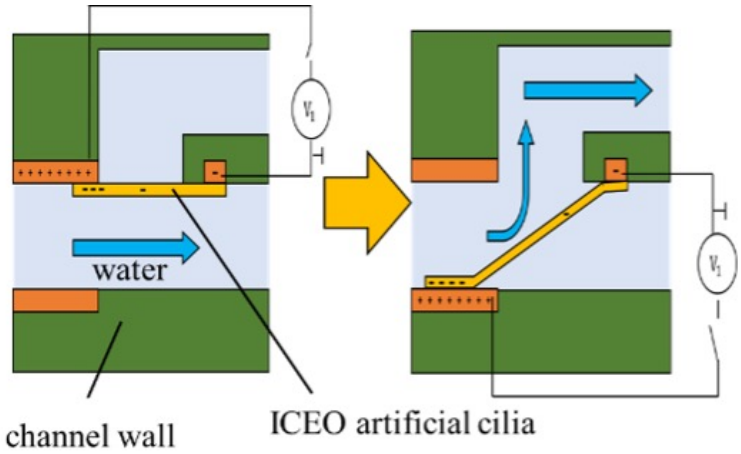


HEALTH CARE: Fluidic switch using ICEO for healthcare

Shunsuke Takahashi, Hideyuki Sugioka

GL

Complex thermal fluid Lab, Shinshu University



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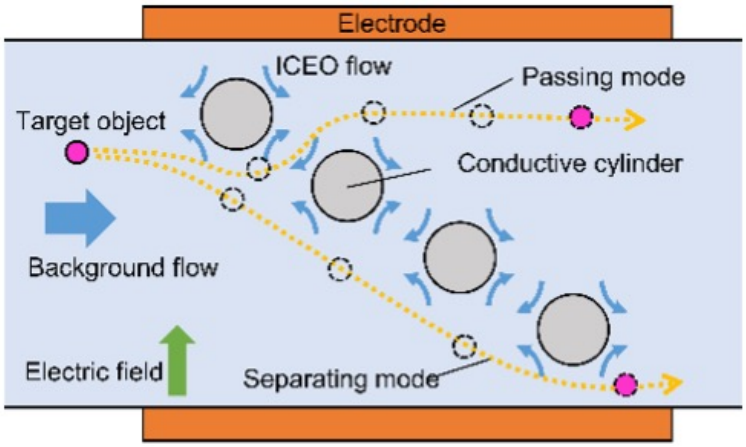
HEALTH CARE: Vector separator using ICEO for healthcare

Ryo Taked, Hideyuki Sugioka

GL

Complex thermal fluid Lab, Shinshu University

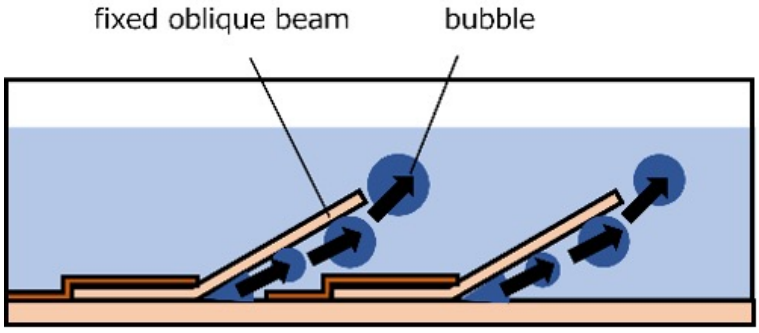


USE OF WASTE HEAT: Bubble water pump using oblique structures for the use of waste heat

Atsushi Miyauchi, Hideyuki Sugioka

GL

Complex thermal fluid Lab, Shinshu University



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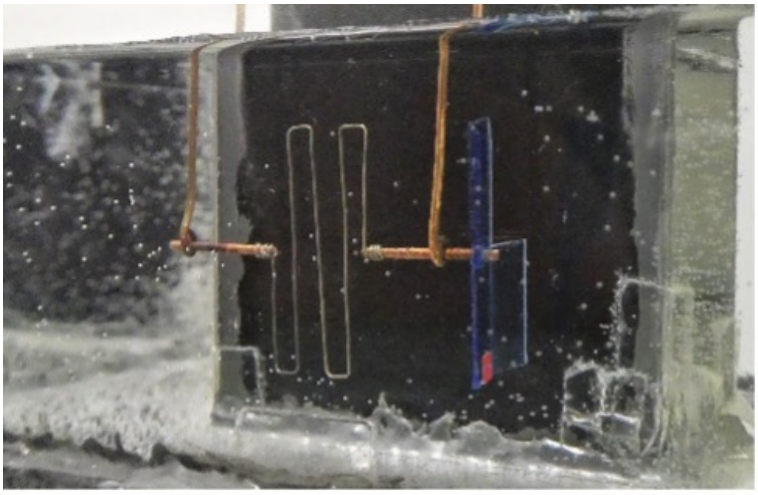
MICRO ACTUATOR: Micro rotary engine for microrobot

Yuki Arai, Hideyuki Sugioka

GL

Complex thermal fluid Lab, Shinshu University

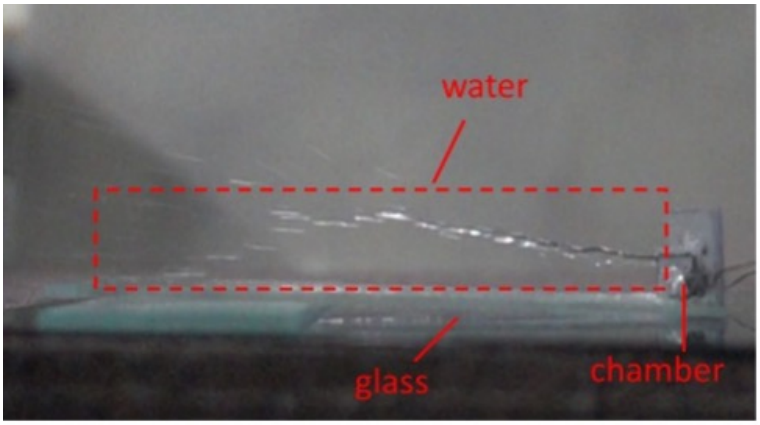


MICRO ACTUATOR: Side-shooter using discharge

Katsuaki Murata, Hideyuki Sugioka

GL

Complex thermal fluid Lab, Shinshu University



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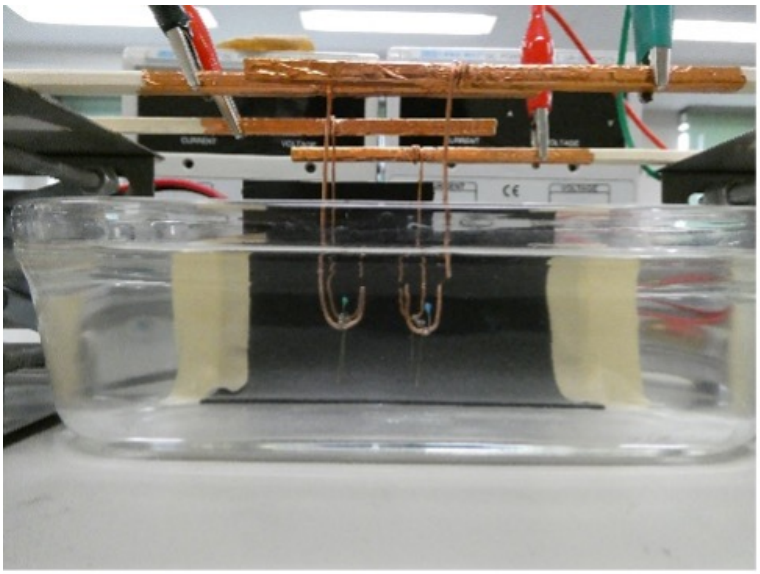
MICRO ACTUATOR: Hydrodynamic interaction between thermal cilia

Wataru Tomita, Hideyuki Sugioka

GL

Complex thermal fluid Lab, Shinshu University

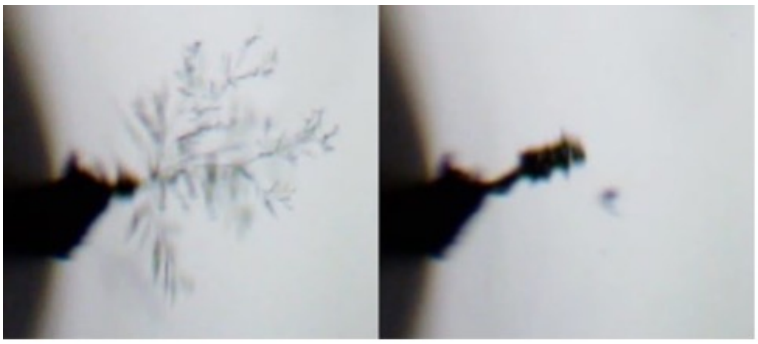


Weaving technique for ICEO carbon actuators

Hiroya Nakamura

GL

Complex thermal fluid Lab, Shinshu University



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Particle-induced aggregation by adsorption of oppositely charged small particles

***Duan Lifan*[1], *Yasuhisa Adachi,*[2], *Takuya Sugimoto*[2]**

[1] Graduate School of Life and Environmental Sciences, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8572, Japan,
[2] Faculty of Life and Environmental Sciences, University of Tsukuba, Japan

Abstract: The rate of aggregation induced by the adsorption of oppositely charged particles is analyzed as the temporal decrease of the number of larger colloidal particles in a turbulent flow. Particle tracking analysis by microscope is employed to distinguish the formation of homoaggregation and heteroaggregation through the development of adsorbed layer thickness. The results show that heteroaggregation process is dominant in the relatively low salt level, and the particle-induced aggregation becomes faster with the decreasing salt concentration.

Introduction: Aggregation of oppositely charged colloidal particles is widely present in many industrial processes, such as paper making, water treatment and food processing [1]. Aggregation of colloidal particles occurs due to collisions between the particles motivated by Brownian motion and external forces. The aggregation between monodisperse colloidal particles is regarded as homoaggregation. Alternatively, aggregation of different types of particles is referred to heteroaggregation [2]. Substantial researches have been conducted on the measurements of homoaggregation rate coefficients in the presence of polyelectrolytes, which are oppositely charged [1]. The main obstacle to deepen our understanding on polymer-induced aggregation is that the adsorbed polymer layer thickness can vary with time due to the temporal change of polymer-chain conformation associated with polymer-polymer and polymer-particle interactions. Instead of using polyelectrolytes, we can exclude the difficulty in the adsorbed layer thickness by using oppositely charged smaller particles as flocculants since the particles do not change their size and shape and also adsorbs onto the oppositely charged particle surfaces. Hence, the adsorbed particles drive aggregation between adsorbing larger particles by charge-patch attraction, causing particle-induced aggregation. Therefore, in this study, we examine how adsorption of oppositely charged smaller particles, in another word, heteroaggregation affect aggregation between larger particles based on the measurements of adsorbed particle layer thickness via particle tracking analysis (PTA) and aggregation rate coefficients via particle counting.

Materials and methods:

(1) Materials: Two different types of colloidal particles were used to measure the charging and aggregation behavior at different ionic strength. These particles were positively charged amidine Latex and negatively charged sulfate latex, which properties provided by manufacturer are shown in Table 1.

Materials	d (μm)	σ (μC/cm^2)
Polystyrene sulfate latex	1.6±0.1	6.2
Amidine latex	0.25–0.35	13.7

Table 1: Diameter and Charge density of particles investigated

(2) Aggregation kinetics by Coulter Counter

The rate of aggregation can be determined by monitoring the temporal evolution of the total number concentration of clusters as a function of elapsed time, by means of a Coulter Counter (Beckman Multisizer 3). 5 ml of polystyrene sulfate latex suspension with desired concentrations were added to 5 ml of amidine latex suspension. Then the suspension was rotated in a home-made end-over-end rotation apparatus with the frequency of 1 Hz to induce aggregation.

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(3) Particle tracking analysis by microscope
Particle Tracking Analysis (PTA) is a mainstream technique for rapidly and inexpensively characterizing particles in a liquid suspension [3]. PTA involves the tracking of the Brownian motion of individual particles to determine the size and the layer thickness of multiple particles through microscope based on the Stokes-Einstein equation [3].. After mixing by end-over-end rotation for a certain time, the mixture of particle suspensions was sucked through a capillary tube, then placed the sample under the microscope to observe the change of layer thickness as the function of time.

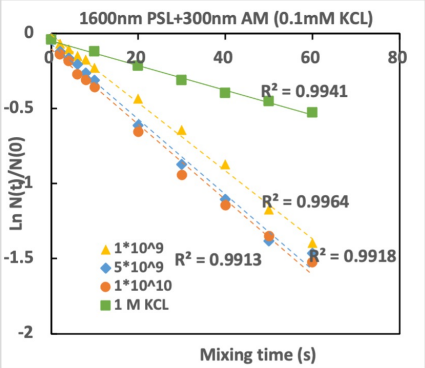

Figure 1: The rate of aggregation at 0.1 mM KCl as a function of mixing time

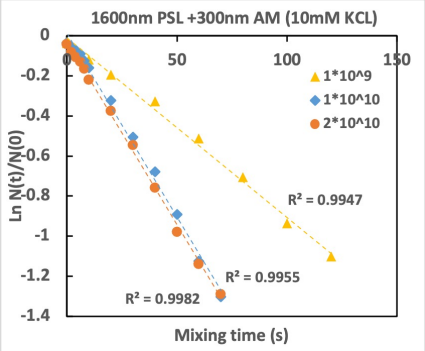

Figure 2: The rate of aggregation at 10.0 mM KCl as a function of mixing time

(4) **Results and Discussions:**Figure 1 indicates that the aggregation rate does not show obvious increase with the increasing concentration of amidine latex particles at fixed ionic strength since the enhancement factors are almost the same. However, the particle-induced aggregation is faster than salt-induced aggregation due to the enhancement of attractive electric double layer forces.

In Figure 2, at higher ionic strength, the aggregation rate presents a slight increase as the function of the concentration of the amidine latex particles. In this case, the homoaggregation has a strong impact on the heteroaggregation efficiencies with a more significant increase of aggregation rate. The heteroaggregation process is controlled by the probability of collision between polystyrene sulfate latex particles and amidine latex particles. At higher concentration of amidine particles, surface coverage is more important hence promoting heteroaggregation and consequently increase the aggregation rate.

(5) **Conclusion**
In this study, the enhancement of homoaggregation of amidine latex particles adsorbed on to polystyrene sulfate latex particles has been investigated in details. Salt concentration has been found to influence the heteroaggregation process to some extent. The attraction forces between oppositely charged particles become stronger with decreasing salt concentration, and the aggregation becomes faster as well.

Keywords: layer thickness, particle-induced aggregation, heteroaggregation

References

[1] Leonid O. Ilyasov, Kazuyoshi Ogawa, Irina G. Panova, Alexander A. Yaroslavov, and Yasuhisa Adachi, Langmuir 2020, vol.36, pp. 8375-8383, June 17, 2020, doi: org/10.1021/acs.langmuir.0c00619

[2] Cao T, Sugimoto T, Szilagyi I, Trefalt G, Borkovec M. Physical Chemistry Chemical Physics : PCCP,. 2017 Jun;vol.19(23),: 15160-15171, 2017,. DOI: 10.1039/c7cp01955f.

[3] Chapter 3.1.2 - Particle Tracking Analysis (PTA), Editor(s): Vasile-Dan Hodoroaba, Wolfgang E.S. Unger, Alexander G. Shard, Elsevier, 2020, pp. 79-96, doi: 10.1016/B978-0-12-814182-3.00007-9.

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Effects of pH and dosage of polyaluminium chloride on initial-stage kinetics of flocculation of polystyrene latex particles

***Ju Zheng*[1], *Yuji Yamashita*[2], *Yasuhisa Adachi*[2],**

GL

[1] Graduate School of Life and Environmental Sciences, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8572, Japan,
[2] Faculty of Life and Environmental Sciences, University of Tsukuba, Japan

(1) Introduction
Polyaluminium chloride (PAC) is widely utilized as an efficient flocculant in water treatment because hydrolysis products of Al ions with higher charge and larger molecular structure play a crucial role in flocculation progress. The transformation of different Al species occurs under various condition such as pH, and flocculation mechanism changes accordingly. Since adsorption of flocculants takes place during tens of seconds after mixing, it is important to examine the initial stage of flocculation. However, many studies pay more attention to the flocculation effect of PAC under various conditions, and little studies have focused on the flocculation behavior of PAC at initial stage. In this study, the initial-stage flocculation kinetics of model colloids induced by PAC at various dosage and final pH value was examined in the standardized mixing condition. (2) Methods
Negatively-charged polystyrene latex (PSL) particles with a diameter of 1356 nm were used at the initial number concentration, N(0), of 1×10^8 cm^{-3}. The PSL suspension was mixed with different dosage of PAC250A with 50% basicity (Taki Chemical Co., Ltd.) by using an end-over-end mixing device. Salt concentration was adjusted to 10 mM with NaCl. The final pH value of mixture was adjusted at 5.5 and 7.5 by using NaOH, which was added into PSL side before mixing. Electrophoretic mobility (EPM) was measured by using an electrophoretic light scattering instrument (Zetasizer nano, Malvern). Number concentration of flocs, N(t), with mixing time was measured by using a Coulter counter (Multisizer 4e, Beckman Coulter).
(3) Results and discussion
Figure 1 shows the EPM of PSL as a function of dosage of PAC250A at different final pH value. As the increasing of PAC250A dosage, the EPM increased from a negative value and became zero at 0.16 ppm at pH 5.5 and 1.5 ppm at pH 7.5, reaching isoelectric point (IEP). The EPM continued to increase and remained basically unchanged above 0.50 ppm at pH 5.5 and above 2.5 ppm at pH 7.5. It indicates that as the increasing of pH value from acidic to neutral, the charge of hydrolysed Al in PAC250A decreased significantly, which related to the presence of high positive charged Al polymer at a pH of less than 6 such Al_{13} with +7 charge while gels or precipitates as Al(OH)3 at neutral pH or above.

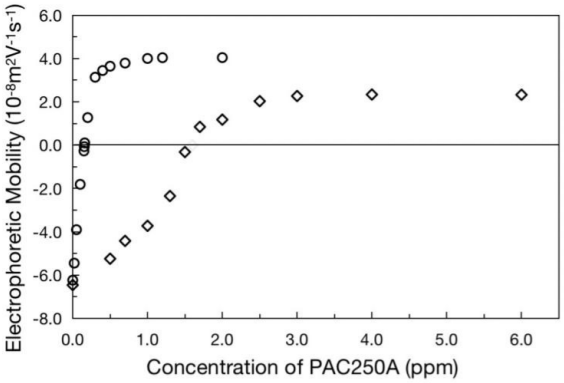

Fig. 1 Electrophoretic mobility for PSL particles as a function of the dosage of PAC250A at 10 mM NaCl at pH 5.5 (hollow circle) and pH 7.5 (o)

In Fig. 2 and Fig. 3, the values of ln(N(t)/N(0)), the degree of flocculation, were plotted as a function of mixing time for PSL particles with different dosage of PAC250A. The dashed line represents

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the kinetics of a salt-induced rapid coagulation in 1 M NaCl as a comparison. The slope indicates the rate of flocculation. Consistency with the rate of salt-induced rapid coagulation means that the flocculation mechanism is charge neutralization, the slope greater than that of salt-induced rapid coagulation implies that bridging effect occurs.

As shown in Fig. 2, at pH 5.5, rates of flocculation around the IEP (0.10 and 0.16 ppm of PAC250A) were detected basically same as that of a salt-induced rapid coagulation, which implies predominant mechanism of flocculation was the charge neutralization. At excess dosage, the rate of flocculation was faster than that at the charge neutralization condition, indicating that the adsorption of a precipitated PAC on particle surface increased the effective collision radius and the bridging effect dominated. As for 2.0 ppm, flocculation terminated quickly because of the saturation of particle surface.

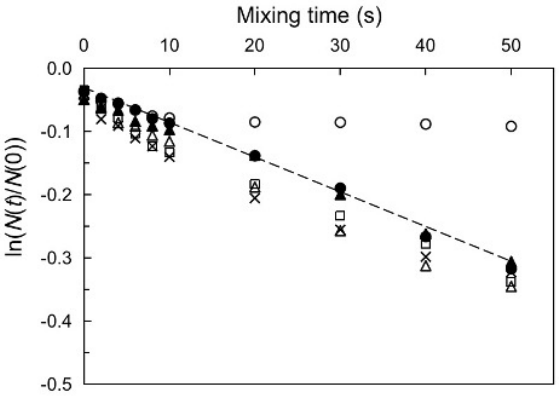

Fig. 2 The degree of flocculation as a function of the mixing time for PSL particles at pH 5.5with different dosage of PAC250A at 10 mM NaCl without PAC 250A at 1 M NaCl.

In Fig. 3, at pH 7.5, the rate of flocculation is faster than that of a salt-induced rapid coagulation in all cases, regardless of the amount of PAC250A added, and the rate of flocculation is fastest at IEP. It indicates that flocculation mechanism was not the charge neutralization, that is, the precipitates produced under neutral conditions adsorbed to the surface of particles and the bridging effect dominated.

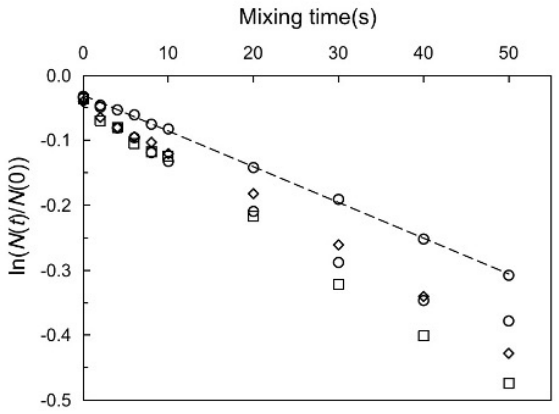

Fig. 3 The degree of flocculation as a function of the mixing time for PSL particles at pH 7.5 with different dosage of PAC250A at 10 mM NaCl without PAC 250A at 1 M NaCl.

(4) Conclusions

A smaller dosage of PAC250A was required to reach the isoelectric point because of higher amount of positive charge of Al ions. The charge neutralization effect dominated around the IEP whereas the bridging effect dominated at an excess dosage. At neutral condition, bridging effect dominated in all tested PAC dosage. These results qualitatively consistent with transformation behavior of Al species.

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Strength of Floc of Leonardite Humic Acid with Cationic Polyelectrolytes

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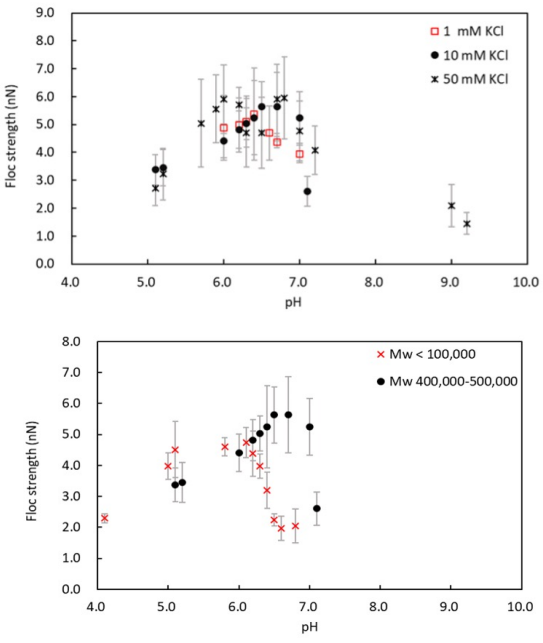
(1) **Introduction:** Humic acids (HAs) are negatively charged macromolecules and ubiquitous in soil and water environments. The role of humic acid as a carrier for contaminant transport in soil and water environments makes it necessary to understand the transport of humic acids in these media. Poly (diallyldimethylammonium chloride) (pDADMAC) is a man-made cationic polymer used as flocculants. The movement of flocs of HA and pDADMAC in soil and water depends on their sizes, which are determined by floc strength against hydrodynamic forces rupturing flocs during transport. The strength of flocs formed by the binging of HA with pDADMAC is expected to depend on the environmental conditions such as pH, ionic strength, mass ratio, salt concentration, temperature, etc. Considering the lack of previous related studies on floc strength of HA, this study focuses on the effects of pH, the molecular weight of pDADMAC, and KCl concentration on the strength of floc of HA with pDADMAC.

(2) **Methods:** The syringe pump connected to a glass capillary creates a converging flow to break up the flocs. The maximum floc size is determined by the high elongation rate near the capillary entrance, which leads to floc breakage. The strength of the flocs is determined by the maximum size of broken flocs. Images of single and largest aggregates were taken using a microscope to fit the best ellipse for analysis.

(3) **Results and discussion:** Under all conditions, the largest flocs were obtained near the isoelectric point. The maximum floc strength close to 6 nN was obtained at a KCl concentration of 50 mM as can be seen in Fig. 1 (A). The curves of the floc strength vs. pH were narrow for 1 mM KCl and wider for 50 mM KCl. These trends could be explained by the DLVO theory, the interparticle repulsion is reduced for weakly charged particles at higher KCl concentration.



The figure. 1. (A) shows the increase in pH and KCl concentration increase the floc strength. The increasing strength of complex with pH can be explained by the more electrostatic attraction between the negatively charged deprotonated sites of LHA through the bridging of pDADMAC. High KCl concentration means high surface charge density. At a significant excess, the competition of the macroions for the surface sites may lead to the formation of longer loops and tails, therefore the steric stabilization leads to higher floc strength.

(4) **Conclusions:** The strength of the flocs was investigated as a function of salt concentrations, molecular weight, and pH. The aggregation of LHA-pDADMAC occurred around their isoelectric point (IEP). Thus, the aggregation was mainly caused by charge neutralization. The maximum strength of LHA-pDADMAC flocs was about 6 nN found near the IEP. The curves of the floc strength vs. pH were narrow for 1 mM KCl and wider for 50 mM KCl. The high molecular weight of pDADMAC has higher flocculation efficiency and stronger flocs obtained at high salt concentrations.

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Effect of lysozyme on the aggregation and charging of oxidized carbon nanohorn (CHNox) in aqueous solution

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Carbon nanohorn (CNH) has received extensive attention because of its high conductivity and large surface area. The oxidized carbon horn (CNHox) is prepared from the CNH. The tips of the CNH can be opened due to the process of oxidation, and some holes on the CNHox allow molecules to access in CNHox and lead to a large specific surface area. The colloidal stability of CNHox was systematically studied by Omija et al. [1], where the applicability of Derjaguin-Landau-Verwey-Overbeek (DLVO) theory in aqueous solution was shown. However, there is still lack of research on the aggregation and charging behaviors of CNHox in the presence of biological and environmental macromolecules such as proteins, polysaccharides, and humic substances.

In this study, we investigated the effect of model proteins lysozyme (LSZ) on the aggregation and charging of CNHox by time resolved dynamic light scattering and electrophoretic light scattering methods. We measured the reciprocal stability ratio (1/W) as a function of KCl concentrations at different LSZ concentrations, and the electrophoretic mobility (EPM) as a function of the concentration of LSZ. The experiments were carried out at pH 5.59 $\pm$ 0.34.

The EPMs of CNHox were negative at low LSZ dose. The magnitude in EPMs decreased with LSZ dose and reached isoelectric point (IEP) at the mass ratio of LSZ/CNHox of 0.0875 g/g, which means the addition of positively charged LSZ neutralize the negative charges on the CNHox particles. Further increase in LSZ dose resulted in charge reversal.

Figure 1 shows the results of the 1/W against KCl concentration for bare CNHox, CNHox with lower LSZ dose at mass ratio of 0.01 g/g, CNHox with LSZ around IEP, and CNHox with higher LSZ dose at mass ratio of 50 g/g. The aggregation behavior of CNHox was DLVO-like, meaning that there are distinct slow and fast aggregation regimes, and a critical coagulation concentration (CCC) in between. The addition of small dose of LSZ did not affect the stability ratio. This insignificant result is probably because the small dose of LSZ hardly changed EPMs. The 1/W at IEP was almost unity, and the salt concentration had no effect on the aggregation rates. The addition of high dose of LSZ dramatically increase the CCC, a non-DLVO attraction can be found at low electrolyte concentration, this trend indicates the weak charge-patch attraction for CNHox with LSZ at high mass ratio.

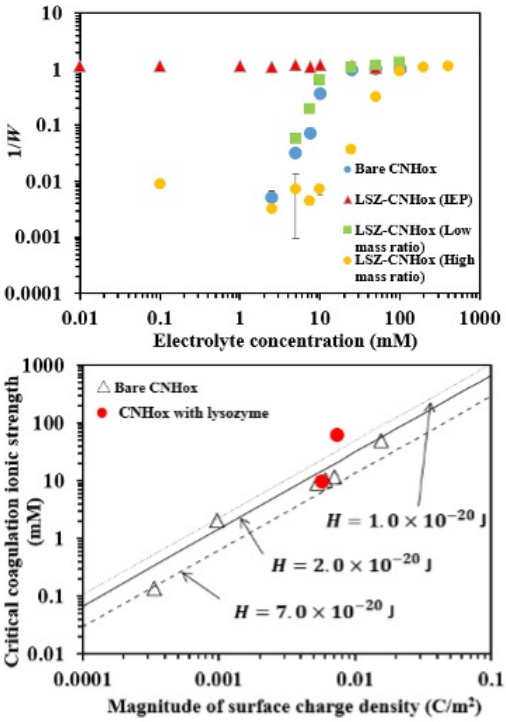

Figure 2 shows the comparison between experimental data of CNHox in the presence of LSZ and DLVO prediction. From these points, DLVO theory works well for CNHox with LSZ. The experimental value of CNHox with high dose of LSZ located at lower Hamaker constant. This result indicates smaller attractive forces would work after a large adsorption of LSZ at CCC point.

Figure 1. Reciprocal stability ratio (1/W) against KCl concentration for bare CNox (blue circles), CNoz with LSZ at IEP (red triangles), and CNHox with LSZ at low mass ratio (green squares).

Figure 2. Comparison between experimental data of CNHox in the presence of lysozyme (red circle) and DLVO theory with Hamaker constant H=2.0 $\times$ 10^{-20} J (solid line). Open symbols are experimental values of bear CNHox from Omija et al. [1]

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References:

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Introduction to Laboratory of Environmental System Engineering

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- Introduction to UNEP-Tongji Institute of Environment for Sustainable Development
- Introduction to Laboratory of Environmental System Engineering
  - Water-energy-carbon nexus
  - Influence of humic substances on environmental behavior of antibiotic
  - Enhancement of sludge dewaterability
  - AOPs for the degradation of fluoroquinolone antibiotics
- Introduction to proposed NSFC-JSPS seminar
- Introduction to related journals

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The influence of humic substances on environmental behavior of antibioticresistance genes

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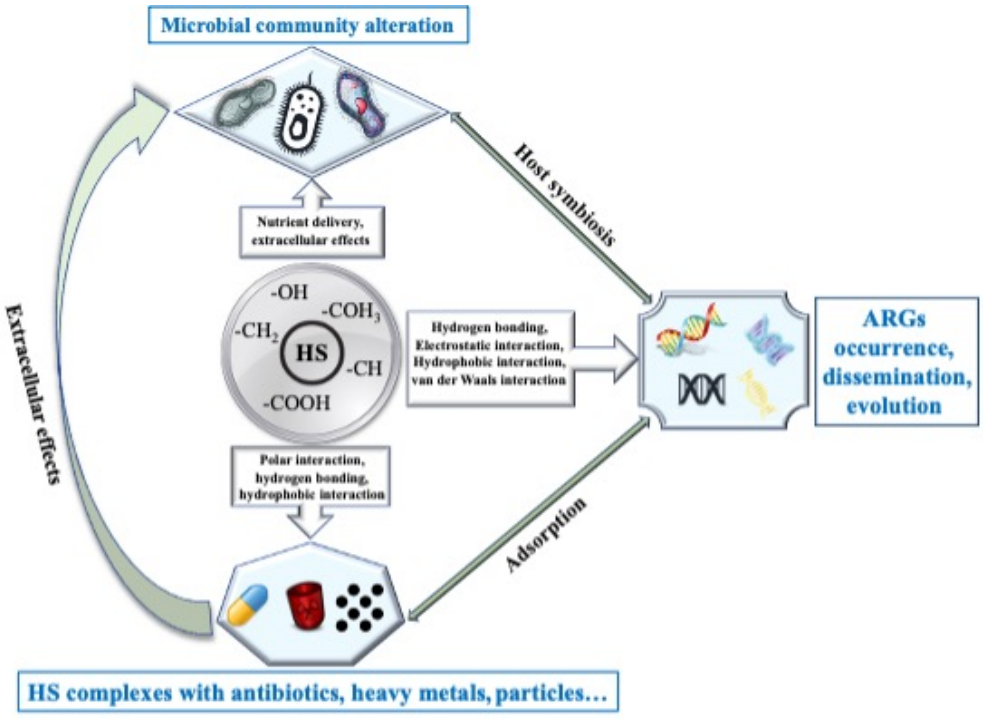
The global antibiotic resistance pollution caused by antibiotic resistance genes (ARGs) has led to serious harm to the ecological environment and human beings. As a type of organic matter that commonly exists in the environment, humic substances (HS) may affect the fate of contaminants. Based on the high possibility of ARGs coexisting with HS in the environment, it is necessary to understand the influence of HS on environmental behavior of ARGs.



Through a systematic review, we found that the environmental behavior of ARGs is not only affected by HS and its by-products, but also frequently implicated through antibiotics, heavy metals and particles in various environments, such as wastewater, activated sludge and soil. The main mechanisms by which HS affects the ARGs evolution include electrostatic interactions, hydrophobic interactions, hydrogen bonding, non-specific van der Waals interactions, and microbial community alterations. This work can contribute to the prevention and control of ARGs pollution in practical applications.

- Humic substances (HS) affected the fate of antibiotic resistance genes (ARGs).
- HS usually suppressed the expression of ARGs in the environment.
- HS generally facilitated ARGs removal in various treatment processes.
- Changes in microbial communities could impact the occurrence of ARGs.

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Enhancement of sludge dewaterability by electrolysis coupled with peroxymonosulfate oxidation process: Performance, mechanisms and implications

Junsen WANG, Hongtao WANG

GL

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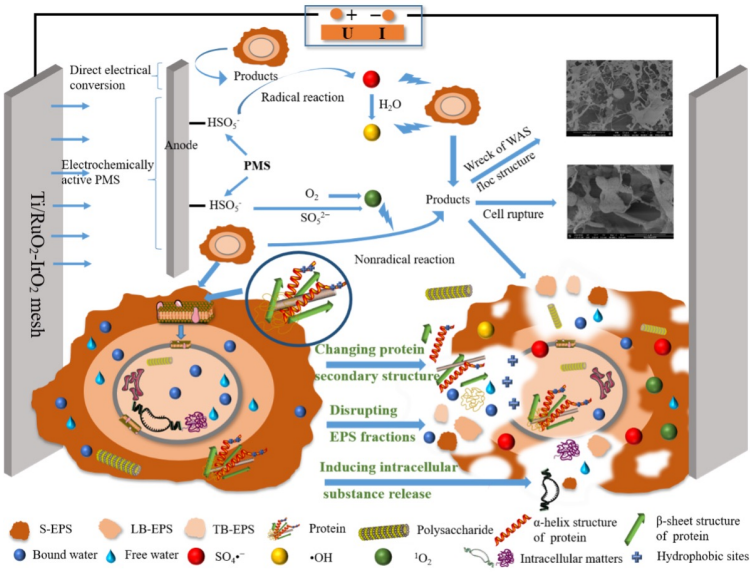

With the rapid increase in waste activated sludge (WAS), it is urgent to develop appropriate dewatering processes to diminish sludge volume and improve disposal efficiency. In this study, an advanced oxidation process using electrolysis coupled with peroxymonosulfate (E/PMS) was applied to improve the dewaterability of WAS. The results indicated that the sludge water content (WC) and capillary suction time (CST) dropped from 98.4 $\pm$ 0.2% and 220.1 $\pm$ 2.3 s to 70.7 $\pm$ 0.8% and 63.0 $\pm$ 1.2 s, respectively, under the following conditions: an electrolysis voltage of 20 V, an electrolysis time of 20 min, and 200 mg/g TS PMS. The increase in sludge zeta potential, surface hydrophobicity, and flowability indicated a significant improvement in sludge dewaterability. SO_4^{-}, OH, and $^1O_2$ generated in the E/PMS process were responsible for the improvement of WAS dewaterability. These reactive oxygen species damaged extracellular polymeric substances (EPS), decreased fluorescent EPS components, and transformed the extracellular protein secondary structures by influencing the H-bond actions that maintain the α-helix. The bound water content, and apparent viscosity of WAS were found to be reduced, which was also attributed to an increase in dewatering capacity. Additionally, E/PMS treatment enhanced the degradation of organic matter in sludge and reduced the toxicity of the filtrate as well as the bioavailability of heavy metals. The cost analysis found that the E/PMS process was relatively economical and has great potential for practical application.

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Insight into advanced oxidation processes for the degradation of fluoroquinolone antibiotics: Removal, mechanism, and influencing factors

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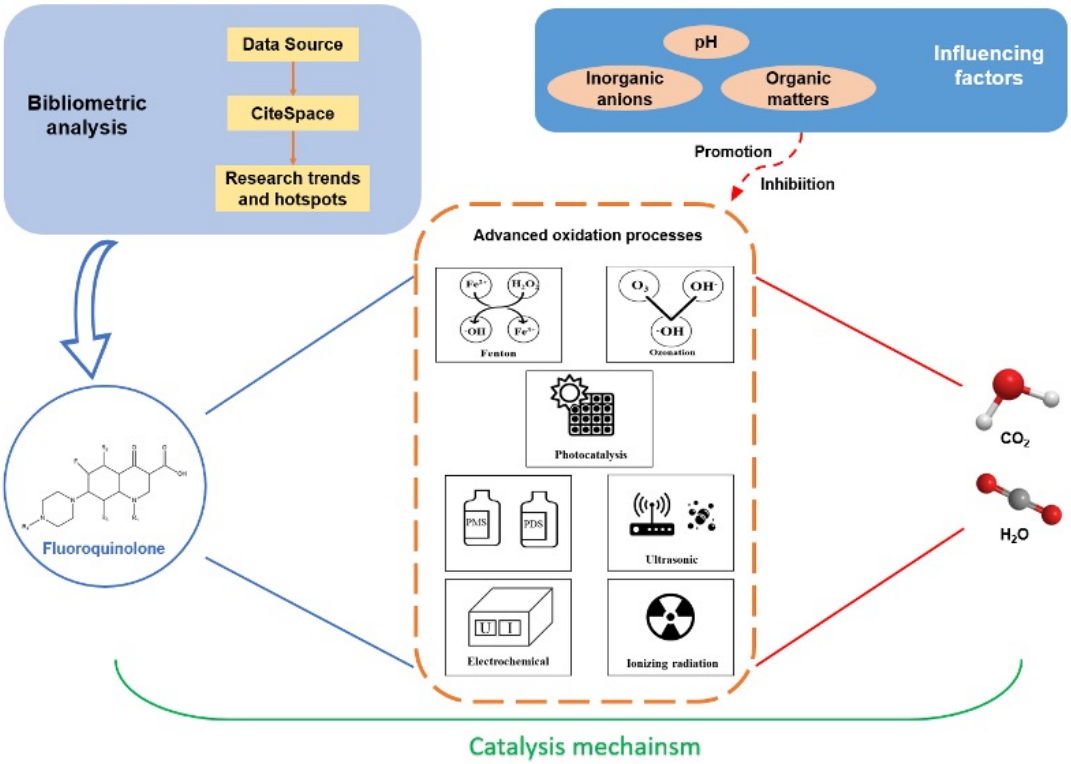

- Photo-Fenton and photo-O_3 are more suitable for degradation of Fluoroquinolones.
- The removal effect, influencing factors and mechanisms were analyzed and summarized.
- The trend and hotspot of antibiotic treatment wereanalyzed by bibliometric.
- The research direction, limitations and challenges of AOPs were discussed.

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Introduction to Laboratory of Bioresource Process Engineering

Zhognfang Lei **GL**

Faculty of Life and Environmental Sciences, University of Tsukuba, Japan

A comparative study on simultaneous recovery of phosphorus and alginate-like exopolymers from bacterial and algal-bacterial aerobic granular sludges: Effects of organic loading rate

Xingyu Chen

GL

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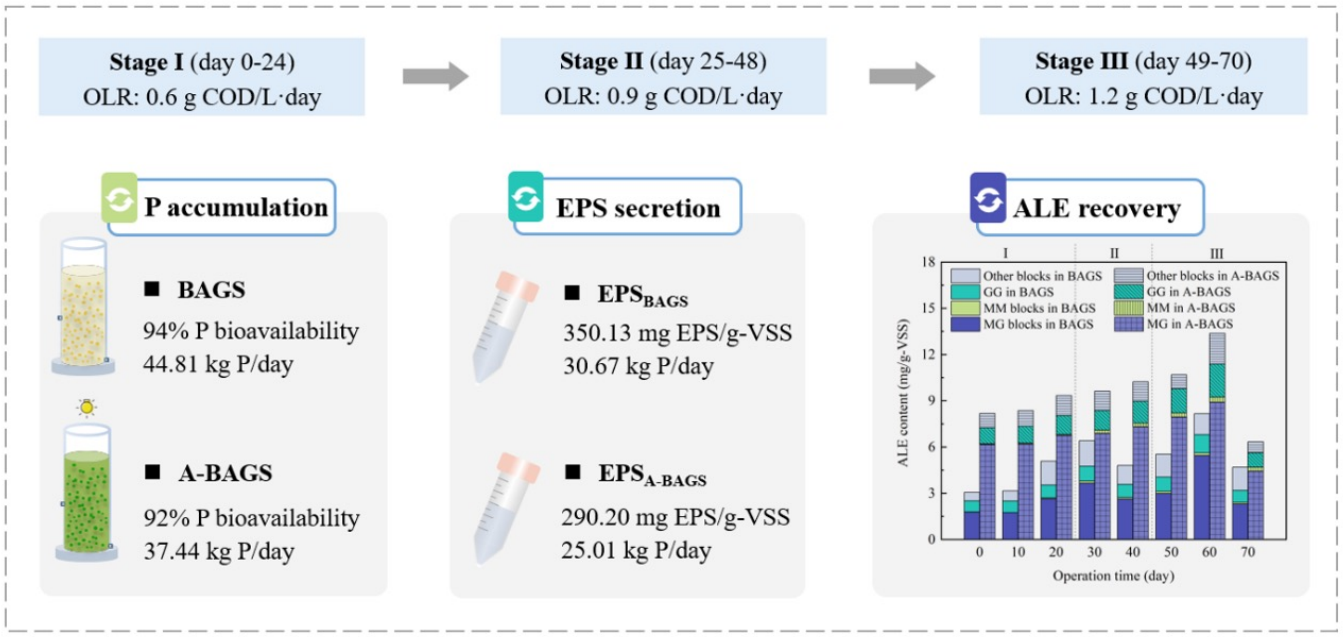

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Stable and high-efficacy nitrogen removal from wastewater by algal-bacterial aerobic granular sludge under no mechanical aeration

Zejiao Li **GL**

Doctoral Program in Environmental Studies, Graduate School of Science and Technology, University of Tsukuba

In this study, the newly developed algal-bacterial aerobic granular sludge (AGS) was adopted to achieve highly efficient nitrogen (N) removal with photosynthetic O_2 provided by the coexisting microalgae instead of mechanical aeration. Stably high efficient N removal of 79.40 ± 2.11 % was achieved through simultaneous short-cut nitrification and denitrification under controlled dissolved oxygen (DO) concentration of 3-4 mg/L, short hydraulic retention time (HRT) of 6 h, and high chlorophyll content of 11.11 ± 0.92 mg/g of mixed liquor volatile suspended solids (MLVSS.) Meanwhile, greater than 68% of influent dissolved organic carbon (DOC) could be fixed in the algal-bacterial granule biomass under the test conditions. At the same time, the applied DO controller via automatically switch on/off the LED lights can further reduce light energy consumption by 10-30%. In addition, the photosynthetic O2 was found more advantageous on N removal when compared to the mechanical aeration. This study provides an in-depth understanding of carbon fixation and N removal by algal-bacterial AGS under no mechanical aeration, targeting sustainable design and operation of wastewater treatment plants with low carbon emissions and energy consumption.

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Carbon fixation and heavy metal adsorption by soil particles supplemented with microalgal-bacterial granules

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Bioremediation has been widely applied in soil pollution control, which is a long-term and complex process. Many efficient approaches have been trialed on biological soil crusts (BSCs) in arid and semi-arid areas, like biochar application to enhance the carbon sink, or use of microalgae amendment to influence the microorganism community and increase fertility. However, under some extreme conditions such as seriously heavy metal contaminated mining sites or saline-alkali soils, currently no efficient biological method is available. Recently, in the field of wastewater treatment, a newly promising biotechnology named algal-bacterial aerobic granular sludge (AGS) system is attracting increasing attention. Compared to the conventional activated sludge (AS) and bacterial AGS processes, the novel algal-bacterial AGS system has many advantages such as excellent granular stability, improved nutrients removal and less carbon source requirement. Previous studies show that exposure to light can trigger microalgal growth symbiotically on bacterial AGS and form algal-bacterial AGS system with improved nutrients uptake or removal and better operation stability. The produced algal-bacterial AGS biomass contains various biological materials such as high value-added extracellular polymeric substances (EPS), organic nitrogen/phosphorus or non-apatite inorganic phosphorus (NAIP) in addition to the microalgae, making its possible application in increasing soil fertility, carbon fixation, and heavy metal immobilization. Therefore, in this research, the effects of algal-bacterial AGS application on soil samples will be explored, especially on soil particle properties, microbial community, carbon sink, and heavy metal behaviors in the system.

Wastewater treatment by microalgal-bacterial granules under heavy metal inhibition and its sustainable solutions

Yankai Zhao

GL

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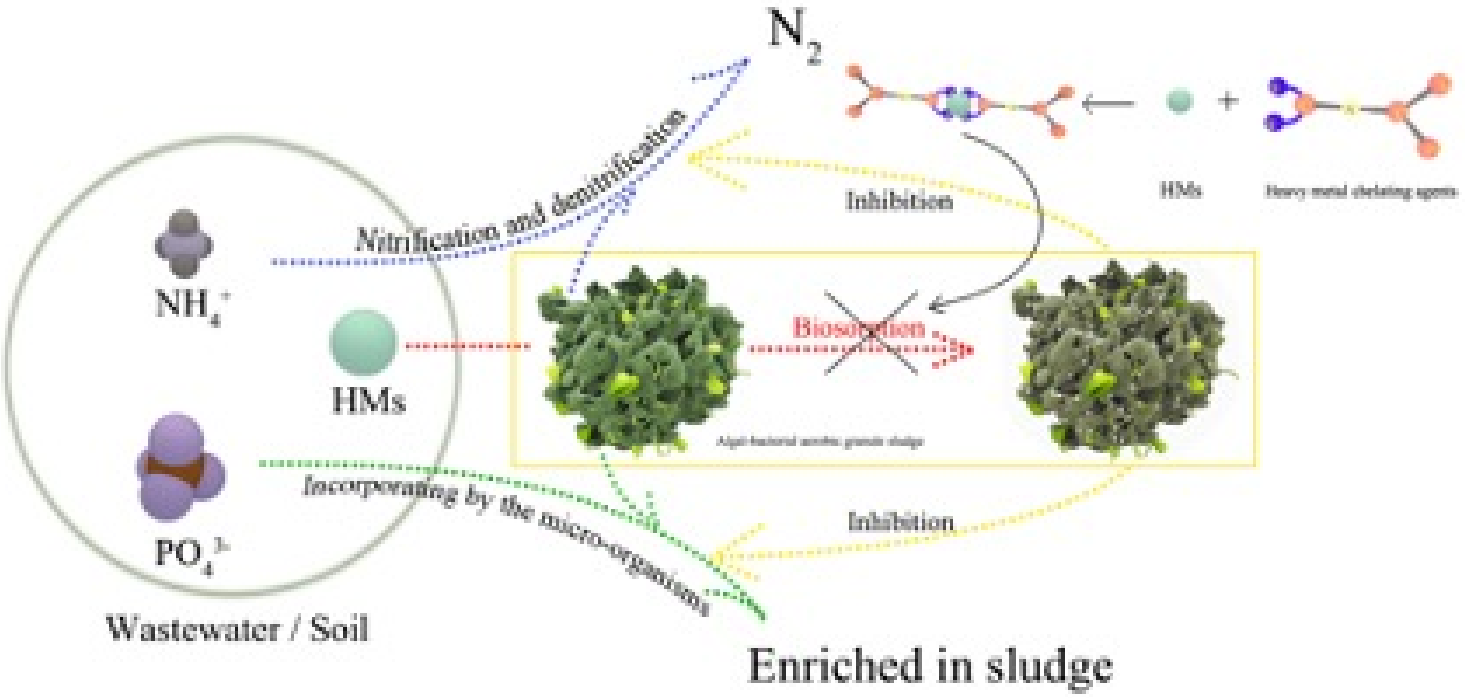

- Effect of heavy metal chelating agent on algal-bacterial granular sludge system.
- Possible means to replace heavy metal biosorption of algal-bacterial granular sludge.
- Efficient removal of contaminants with the co-existence of high concentration of heavy metal.

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Bio-flocculation and applications in Smart Soils

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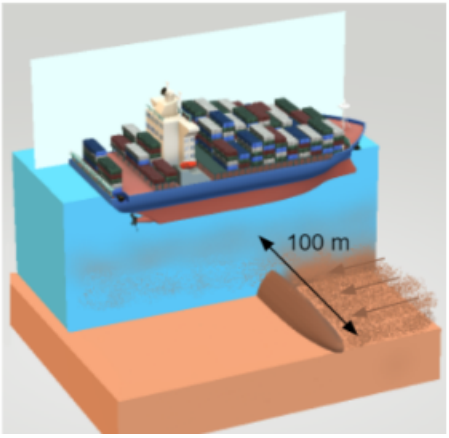
Smart soils can be used in different applications. The one that will be highlighted in the present talk is the use of a gelled sediment product ('gel barrier') that helps to control the sediment import in the Rotterdam port area (The Netherlands). The objective of the project was to manufacture an eco-friendly product that contributes to circular economy and is commercially viable. The particular questions to be answered for this project were:

- what should be the properties of the gel barrier?
- which gelation agent should be used?
- where should the created gel barrier be placed in the port?
- is the gel barrier an economically feasible solution?

All these questions will be answered during the presentation. Connected projects will be discussed.



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3D grain shape evolution during rotating drum abrasion experiment

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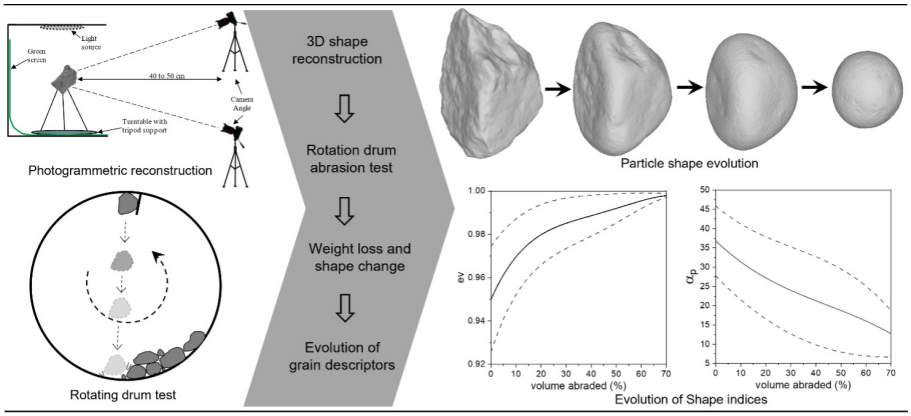
Natural stones are the most common material with various engineering applications since prehistoric times. The characteristics of granular materials, particle shape, hardness, and abrasion resistance, are important parameters to predict its geological behavior. The granular particles progressively evolve their shape in various ways, for example, through geological action like weathering, riverbed-load transportation, or external loading induced by mechanical abrasion when used in infrastructure. The present study attempts to observe the shape evolution of granular material using a rotating drum device to look up the in-depth morphological transformation using 3D shape analysis. The material used in this study was irregularly shaped andesite rock particles of about 5cm. The Photogrammetric reconstruction technique is used to measure the 3D surface morphology of about 50 particles. Among them, some selected particles are considered for morphological evolution keeping the variety of grain shapes. The evolution of particle mass, 3D shapes, and grain indices are recorded at various stages of the abrasion process. In this study, we consider two overall grain indices, i) flakiness (S/I), ii) elongation (I/L), and two detailed morphological indices, iii) ellipsoid volume ratio (ev), and iv) rotational resistant angle (α_p), respectively. The particle mass loss data reveals the high abrasion initially and slower rate afterward, except for some abrupt changes due to fragmentation. Significant shape change is observed during the long-term abrasion process, where all the particles change their initial shape. The corner breaking and particle fragmentation also occurred throughout the test and were reflected as sudden transitions of mass loss and shape index. The experimental result shows that the evolution of elongation and flakiness that describe overall particle shape is inconsistent during abrasion. In contrast, the equivalent ellipsoid volume ratio and rotational resistant angle mainly describe particle surface angularity evolving gradually throughout this long-term abrasion process. The current findings suggest that the latter two indices can be taken as more suitable parameters to demonstrate the grain shape evolution.

Keywords:
Rotating drum test, Grain shape analysis, Photogremetric reconstruction



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DEM-SPH coupling for simulating complex erosion/sedimentation process

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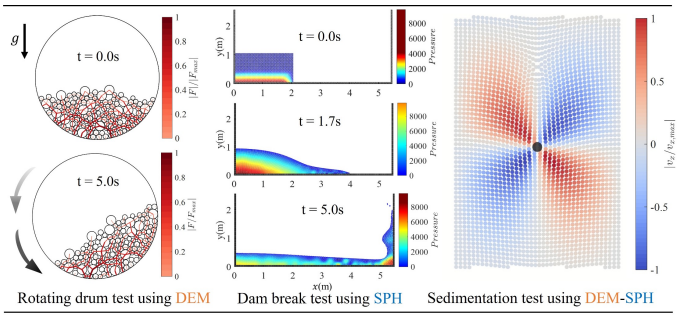
Coupled solid-fluid flow can be found in various natural processes, and accurate numerical simulations can be helpful in modeling or understanding these processes. In general, there are two types of approaches [1]: the discrete approaches at the microscopic level that treat particles as separate bodies, and the continuum approaches at the macroscopic level allowing the interpenetrations between the fluid phase and the solid phase. Due to high computational efficiency, the latter has hitherto been widely recognized in applied research. Even though Eulerian schemes are adopted in many of these papers, the current study chooses a fully Lagrangian algorithm, a discrete element method coupled with a smoothed particle hydrodynamics method (DEM-SPH), since it is prevailing in some scenarios, such as issues involving large deformation and free surface. Sun et al. [1] and Gao and Herbst [2] reported that the results obtained using this method for modeling slurry flow and abrasive wear seem promising. However, more efforts are required to clarify different aspects of DEM-SPH coupling. In this study, the calibration for each method via validation tests is applied first. Then the interactive forces (i.e., drag and pressure gradient forces) are considered to account for the solid-fluid interaction. Finally, some test cases, including a single particle sedimentation test and a multi-body sedimentation test, are performed using described DEM-SPH method. Although only some preliminary results are presented, we expect more efforts in this study in the future.



Keywords:
Discrete element method (DEM), Smoothed particle hydrodynamics (SPH), Solid–fluid interaction

References

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Adsorption kinetics of polyelectrolytes onto a silica particle in a unidirectional flow field studied using microfluidics and optical tweezers

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Polymer adsorption has been considered a key aspect in controlling the stability of colloids and a subject of intensive research both experimentally and theoretically over the past decades. The general understanding of polymer adsorption is developed at equilibrium conditions, but in most cases, the adsorption process occurs mainly under non-equilibrium conditions [1]. To better understand the kinetics of polymer adsorption onto a single colloid, we investigated the kinetics of polymer adsorption onto a colloid in a controlled flow field using microfluidics and optical tweezers.

In optical tweezers, a colloid was trapped and exposed to a unidirectional flow field with and without polymer. The balance between the trapping and drag force furnishes the hydrodynamic radius of the trapped colloidal particle. The polymer layer thickness, δ_H , was monitored directly by exploiting the balance of the trapping force and the hydrodynamic drag force of the flowing solution past the particle, as shown in Fig. 1(a) [2].

In this study, a negatively charged silica particle and polyelectrolyte with different charged densities were used as a model system. Representative temporal change in the δ_H of silica particles exposed to flowing polymer solutions is shown in Fig. 1(b). For 100%charged cationic PDADMAC, the δ_H is almost undetectable due to a highly flattened conformation of the polymer by the attractive interactions between particle and polyelectrolyte. In the case of PAAM-co-DADMAC (45% DADMAC), a detectable δ_H and a much more rapid initial increase were seen. As the charge of the polymer becomes neutral (PEO) and partly negative (PAAM-co-AA), a slower adsorption rate with a large layer thickness was observed. This is attributed to the decrease in the attractive interaction between the particle and the polyelectrolyte. Furthermore, as the attractive interaction between polymer and particle decreases, the adsorbed polymer will have an open conformation consisting of loops and tails, resulting in the large δ_H [1, 2].

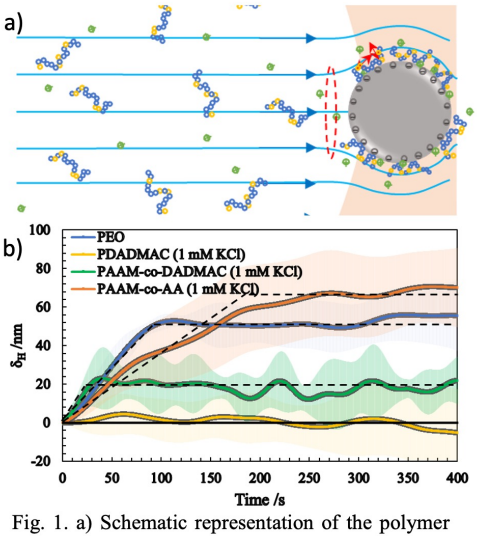

Fig. 1. a) Schematic representation of the polymer adsorption detected by optical tweezers, b) Temporal change of δ_H for different polyelectrolyte.

Keywords: adsorption kinetics, microfluidics, optical trapping

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Poly(ethylene oxide) (PEO) Adsorption on Polystyrene Sulfate (PS) Latex: An Electrophoretic Analysis

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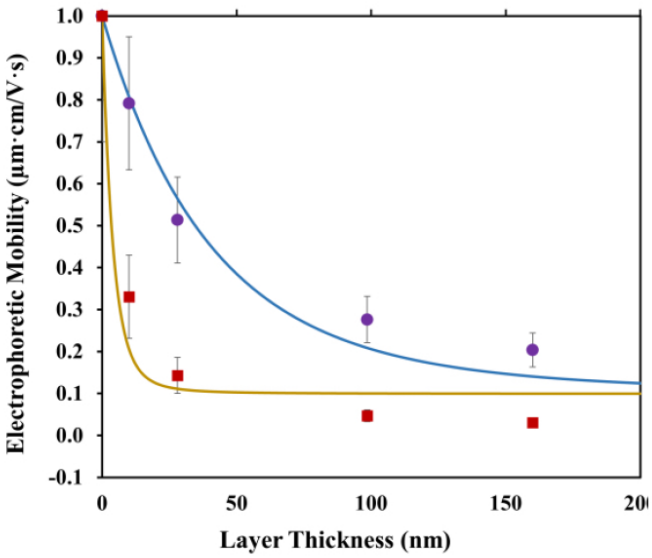
Electrophoretic mobility (EPM) of negatively charged Polystyrene spheres with sulfate groups coated with electrically neutral polymers (here, polyethylene oxide) with different molecular weights were measuredas a function of ionic strength to evaluate the shielding behavior in order to comprehend the fundamental mechanism of electrokinetic properties.The findings show that a significant quantity of neutral polymer adheres to the surface of the particle, decreasing electrophoretic mobility.

The following reduction in electrophoreticmobility is thought to be the result of the growth of steric polymer layers, which has the effect of revealing the shielding of electrokinetic characteristics.The electrophoretic mobility (EPM) never reaches zero, despite the polymer layer being appropriately thick relative to the thickness of the electric double layer (EDL), indicating that the electric shielding provided by an adsorbed neutral polymer is insufficient.



In order to explain these surprising observations, a straightforward mathematical model has been put forth, according to which the Poisson-Boltzmann distribution of ions in the electric double layer is unaffected by the scaling structure of adsorbed polymer layers (EDL). It has been possible to construct an analytical expression of electrophoretic mobility under the Debye-Huckel approximation using the Ohshima-Kondo theory, which supports the results of the experiment.

Keywords:
Electrophoresis; Electrophoretic mobility; Polymer adoption; Polyethylene oxide; Polystyrene latex

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Santanu Saha, Yasuhisa Adachi, Shielding behavior of electrokinetic properties of polystyrene latex particle by the adsorption of neutral poly(ethylene oxide), Journal of Colloid and Interface Science, Volume 626, 2022, Pages 930-938, ISSN 0021-9797, https://doi.org/10.1016/j.jcis.20

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The effect of diverse ion species on the charging and aggregation of natural allophane particles

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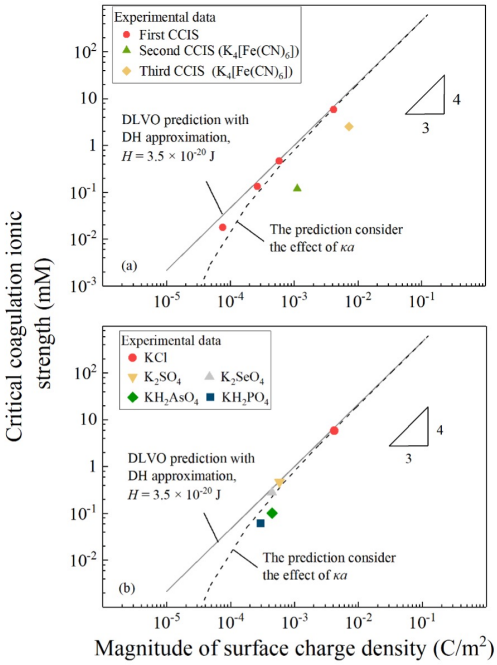
The aggregation-dispersion and charging behaviors of natural clay allophane may have implications on sustainable agriculture and environment. Allophane is one of the main clay minerals among the young volcanic ash soils with complex structures and special surface properties. Diverse ion species may have different effects on the aggregation process of allophane particles due to the different ion valence and ion specificity. Therefore, it is meaningful to study the effect of diverse ion species on the charging and aggregation behaviors of natural allophane particles.

To understand the charging and aggregation of the allophane particles, we measured the hydrodynamic diameters (d_h) and electrophoretic mobilities (EPM) of the particles by the methods of dynamic and electrophoretic light scattering. The experiments were performed at pH 5 with 6 mg/L allophane suspension as a function of potassium salt concentration, where the potassium salts containing diverse ion species, such as multivalent counter-ions (KCl, K_2SO_4, $K_3[Fe(CN)_6]$ and $K_4[Fe(CN)_6]$), and various oxyanions (KH_2PO_4, KH_2AsO_4, K_2SO_4, and K_2SeO_4). We can further obtain the stability ratio, critical coagulation concentration (CCC), critical coagulation ionic strength (CCIS), zeta potential, and surface charge density.



The results of the stability ratio can be qualitatively explained by DLVO theory within electrophoretic mobility results. However, it is hard to use DLVO theory for explaining whether the results of CCC follow the empirical Schulze-Hardy rule under the experimental conditions. Therefore, we examined the applicability of the DLVO theory with the Debye-Huckel (DH) approximation for the relationship between CCIS and surface charge density, which is determined by the ionic valence and ion species. The predicted and experimental relationships between CCIS and surface charge density are in good agreement taking account of particle size effect (Fig. 1). We conclude that the DLVO forces are the main driving forces for determining the CCC in the aggregation process of natural allophane particles in the presence of multivalent counter-ions or different oxyanions.

Fig.1: The critical coagulation ionic strength against surface charge density of allophane particles in the presence of (a) multivalent counter-ions, and (b) different oxyanions. The lines are the DLVO prediction. H is the Hamaker constant.

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Biochar: sorption mechanism and its application for agriculture

Dr. Koji Kameyama **IT**

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Biochar is charcoal like substances produced from pyrolysis of biomass feedstock. Biochar is highly stable against microbial decomposition, and most of it is likely to be stable for at least hundreds of years when added to soil. Therefore, applying biochar to farmland has the potential to mitigate GHG emissions (IPCC, 2019). In addition, biochar is known to sorb dissolved ions and metals. For this presentation, I introduce following two examples: [1] reduction of nitrate leaching from a soil amended with biochar (Kameyama et al., 2012; Kameyama et al., 2016) and [2] reduction of plant Cd uptake from a Cd-contaminated soil amended with biochar (Kameyama et al., 2021).

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Development of Sensors that Detect the Coagulation State of Flocs for Controlling the Coagulant Dose -Streaming Current Sensor and Image Processing Coagulation Sensor-

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IT

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Water purification plants in Japan mainly use surface water as rivers. Since the raw water quality of surface water changes drastically, it is necessary to adjust the coagulation dosage in a timely manner. Frequent adjustment of the coagulant dose is a workload for the operator. To reduce this workload, we proposed a technology that automatically controls the coagulant dose by applying a sensor detecting the coagulation state.

In phase1, we have realized to control the coagulant dose by introducing the streaming current sensor(SCS). SCS is a sensor measuring the streaming current value which correlates to the zeta potential. As a result, we were able to reduce the coagulant dose and achieve stable operation for a certain period of time. At the same time, we found the following problems, reducing sensor sensitivity due to high turbidity water, requiring to correct by water quality for each plant, and taking time to repair.

In phase2, in order to solve problems of phase1, we developed a newly unique sensor using an imaging recognition technology. This sensor can quantify charge state by floc electrophoresis velocity, a principal based on zeta potential measurement. This sensor measured the charge state of the floc immediately after injecting the coagulant, and made it possible to adjust the coagulant injection rate with a target value near charge neutralization.

This presentation introduces the application to coagulant injection control in water purification plants and its introduction effect in phase1 SCS and phase2 the image processing coagulation sensor.

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Strategies on source control for fertilizer non-point source pollution mitigation in Agricultural Farmlands

Chihhao Fan **GL**

Professor, Department of Bioenvironmental Systems Engineering, College of Bioresources and Agriculture, National Taiwan University

Non-point source pollution resulting from agricultural activities may enter neighboring water bodies through the surface, intermediate, or groundwater flows due to rainfall or irrigation and causes negative impacts on water quality. This study aimed to evaluate the efficiency of using green farming technology for agricultural non-point source pollution control by fertilization reduction during agricultural practices. With the collaboration with farmers in the upper catchment area of Shihmen Reservoir in Taiwan, biochar addition with 50% fertilization reduction was applied to control non-point source discharge in red plum cultivation. Through mass balance evaluation, the nitrogen nutrient absorption by crops was increased by 25.61% and nitrogen nutrient in the infiltration and runoff waters was reduced by 3.18%. Additionally, an empirical nitrogen nutrient release model using principal component analysis and regression algorithm was established to estimate possible nutrient loss from the investigated farmland. As a result, the results showed that the pollution loading from non-point sources can be assessed as long as important environmental parameters are considered.

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Green Technology (GT) Laboratory at National Taiwan University

Shu-Yuan Pan GL

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n this presentation, we will briefly introduce the ongoing research directions in the Green Technology (GT) Laboratory at National Taiwan University. Currently, we at the GT lab focus on the GREAT (Green Research for Environmental and Agricultural Technologies) to realize circular economy system. We have four major research themes: (1) precision separation for water reuse and resource recovery, (2) agricultural (bio)waste utilization as energy and chemicals, (3) healthy watershed practices, and (4) CO2 utilization technologies towards negative emissions. In particular, our group specializes in practical applications of water reuse, as well as solid waste and CO2 conversion technologies, especially in electrochemical systems. We have our own laboratory focusing on separation systems for agricultural and environmental applications towards a circular economy. In some cases, we also collaborate with experimental groups around the world. Current research topics relate to water technology (selective sorption,1 electrokinetic separation)2 and biosolid valorisation technology (electrofermentation, anaerobic digestion, low-oxygen thermal conversion), as well as healthy watershed practices from scientific aspects (carbon and nutrient cycles)3 to engineering domain (water quality improvement, carbon farming).

Acknoledgement:
Sincere appreciation goes to the Ministry of Science and Technology (MOST) of Taiwan (ROC) under Grant Number MOST 111-2636-M-002-026 for the financial support. This study is also supported by National Taiwan University under the Project Number 110-B-CD-5602-24910.

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Lab of Soil Physics and Soil Hydrology at UoT

Shoichiro Hamamoto GL

The University of Tokyo

Soil is an extremely valuable natural resource. Recently, problems such as soil degradation (e.g., desertification and salinization), soil and groundwater contamination, and soil erosion, which results in the loss of valuable soil in agricultural lands, have been occurring. These are important global environmental problems. However, there are still many black boxes regarding various physical, chemical, and biological phenomena related to soil. Laboratory of soil physics and soil hydrology aim to elucidate the mechanisms governing the phenomena in soils, including physical, chemical and biological perspectives in order to solve issues related to soils. Our recent research works include bubble and colloid transport in porous media, greenhouse gas transport in agricultural field, mass transport in rhizosphere, and model development of soil erosion. We are also involved in project research on the digitization of agroecosystems through multiomics analysis. In the presentation, current laboratory studies are briefly introduced. `http://soil.en.a.u-tokyo.ac.jp/`

Seasonal variations in methane emissions via plant and ebullition from rice paddies

Tatsuya Kobayakawa GL

The University of Tokyo

It is well known that rice paddies is one of importance source for methane emissions. Methane is released from rice paddies into the atmosphere via three pathways: molecular diffusion of dissolved methane across atmosphere-water, ebullition of gas bubbles, and the aerenchyma tissue of rice plant. It has been considered that methane is mainly released via the aerenchyma tissue of rice plant in previous studies. However, portable methane analyzers with high precision and high-time-resolution have recently revealed that methane ebullition also greatly contributes to methane emission from rice paddies. The purpose of this study was to clarify the seasonal variation of methane fluxes by ebullition and via rice plant from rice paddies, and to identify the factors that affect methane fluxes. Field monitoring was conducted at continuous ponded rice paddy in Ibaraki Prefecture, Japan. Four different treatments were set: rice paddies with/without rice plant and with/without straw application. Methane emissions was measured using a closed-chamber method with a portable spectroscopic gas analyzer. High methane ebullition was observed during heading(HD) stage. The application of rice straws increased both methane fluxes via rice plant and by ebullition during panicle formation(PF) and booting (BT) stages. There was a positive correlation between plant-mediated methane emission and bubble volume during PF and BT. Increase in bubble volume indicates enhanced methane production in PF and BT and enhanced diffusive uptake of methane by the rice root, causing increase in methane emissions via rice plant. Conference Presentation: Kobayakawa et al., Seasonal variations in methane emissions via plant and ebullition from rice paddies, A-GE30 Japan Geoscience Union Meeting 2022, May 24, Makuhari, Japan. (2022)

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Effects of cation exchange on colloid transport in saturated porous media

Rikutaro Higashi

GL

The University of Tokyo

Since colloidal particles in soils are known to act as carrier of contaminants, understanding the transport behavior of colloidal particles in soil is an important issue. This study investigates the transport behavior of colloidal particles during the cation exchange reaction between Ca2+ and Na+ at the surface of porous media. One-dimensional column experiments were conducted using Toyoura sand as the repacked porous media and carboxyl latex particles as the model colloid, respectively. It was found that colloidal particles deposited on the surface of the Toyoura sand during the cation exchange reaction, regardless of the amount of exchanged cation and the particle size of the applied colloids. The deposited colloidal particles were released when the ionic strength of the pore water decreased after the cation exchange reaction. The interaction energies between the latex particles and the sand surface were calculated based on the DLVO theory, suggesting the contribution of the attraction in the secondary minimum to the colloid deposition during cation exchange reaction. On going research about measurements on interaction force between colloids and solid surface under variable solution chemistry using Atomic Force Microscopy (AFM), and direct observations about colloid deposition and release on the grain surface using microfluidic channel, are also introduced. Article: Higashi et al., Effect of cation exchange on colloid transport in saturated porous media, J. Japanese Society of Soil Physics, 150: 105-113. (2022)

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Utilization of Adsorbent from Organic Matter in Reducing Heavy Metal Levels

***Oviyanti Mulyani*[1], *Dikdik Kurnia*[1], *Benny Joy*[1], *Yasuhisa Adachi*[2]**

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[2] University of Tsukuba, Japan

The ecosystem of the rice field can be harmed by industrial waste pollution, which can also impact farming sustainability and the growth of the agricultural sector. One example of this, occurs in Indonesia. The utilization of two forms of organic matter, such as soil and animal manure, is extensively researched because of their significant roles and advantages for environmental health. It is aimed to get an efficient adsorbent in reducing the amounts of heavy metals by increasing the potential of organic matter as an adsorbent by altering the shape of organic matter to a form that may maximize its role as an adsorbent, such as humic acid. Several adsorption parameters were investigated in order to understand the characteristics of the mechanism that occurs, particularly for the three heavy metals Cr, Cd, and Pb. The results showed that the properties of organic matter will influence its potential as an adsorbent to reduce heavy metal content. This ability as an adsorbent also be compared with other forms, such as compost and biochart, which can offer more information on other sources of materials, particularly in terms of the availability of raw materials, ease of production methods, low cost and the effectiveness in reducing the content of heavy metals.

Short introduction “Lignocellulose Biomass Utilization as Soil Conditioners”

Nadia N. Kamaluddin

Alumni of Biomaterial Chemistry Laboratory

Lignocellulose is one of the most abundant renewable biomasses on earth. It was estimated that agriculture residues contributed to 0.7% of lignocellulose annual availability. Management of lignocellulose waste in agriculture is crucial to avoid agroindustry adverse effect towards the environment. One of the ways to utilize lignocellulose biomass from agricultural residues is through soil application. Lignocellulose biomass is a rich carbon and can be used as an organic carbon source or soil conditioners in agricultural practice. Reapplication of lignocellulose biomass in soil requires prior conversion in order to break the polymers into simple and available nutrients for plants and other soil organisms. One of the methods of lignocellulose biomass conversion is through microorganism-mediated decomposition. Soil inhabiting microorganisms such as bacteria and fungi are known for their ability to change lignocellulose materials into soil organic matter. It is well known that soil basidiomycetes and actinomycetes produces ligninolytic and cellulolytic enzymes, but these enzymes production were not limited to organisms from kingdom fungi. Continuous exploration is still performed to find more efficient and environmentally resilient microorganism that can simplify lignocellulose materials in order to utilize it as soil conditioners and nutrient for plant in agricultural process.

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BIO-MEDIATED FLOCCULATION OF COHESIVE SEDIMENT AND MICROALGA IN DIFFERENT GROWTH PHASES

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Interaction between microalgae and clay minerals enhances biologically mediated flocculation, therefore affecting the sedimentation and transportation of suspended particulate matter (SPM) in the aquatic system. This interaction forms larger flocs with a higher settling velocity and controls the fate of SPM. In this research, we investigated the flocculation kinetics of microalgae and cohesive sediment to elucidate the associated mechanism in such kinds of interactions. A flocculation jar test was applied to various mixtures of kaolinite and microalgae samples from batch culture (Chlorella vulgaris) to estimate the biologically mediated flocculation kinetics. The organic matter (OM) composition, secreted from the microalgae, was characterized by a liquid chromatography-organic carbon detection system, and quantitative analysis on transparent exopolymer particles was led separately. A two-class flocculation kinetic model, based on the interaction between flocculi and flocs, was also adopted to quantitatively analyze the experimental data from the flocculation. Results from the flocculation kinetic tests and OM analyses, in association with other data analyses (i.e., floc size distribution, flocculation kinetic model), showed that flocculation increased with OM concentration during the growth phase. However, on the day of the early stationary phase, flocculation kinetics started decreasing and substantially declined as time went even though the amount of OM was still increasing. Our results indicate that an adequate quantity of biopolymers produced by the microalgae cells in the growth phase enhanced floc-to-floc attachment, and hence flocculation kinetics. In contrast, an excessive quantity of biopolymers and humic substances in the stationary phase enhanced the formation of polymeric backbone structures and flocculation via scavenging particles, but it simultaneously increased steric stabilization with the production of many fragmented particles.

Keywords:
flocculation, microalgae, clay, floc size distribution, Bayesian calibration

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Struvite Recovery from Industrial Wastewater via Coagulation and Flocculation Mechanism

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Struvite crystal is a slow-release fertilizer that can be potentially recovered from agro-industrial and municipal wastewater treatment due to its richness of phosphate and ammonia content. This material is an essential fertilizer that may improve soil quality. However, many factors such as pH, different types of coagulant, and organic content (dissolve, particulate, or colloidal), inhibit the potential of nutrient recovery. This research investigated the effect of pH and the molar ratio $[Mg^{2+}]$:$[NH^{4+}]$:$[PO4_4{}^{3-}]$ on the struvite precipitation method for industrial wastewater treatment. Struvite precipitation was conducted in batch reactors, $MgCl_2$ as a coagulant, and mechanically agitated for 158 rpm. Results show that the pH optimum is pH 9, and the molar ratio $[Mg2+]$:$[NH^{4+}]$:$[PO_4{}^{3-}]$ optimum is the molar ratio of 3:1:1 with a removal efficiency of ammonium and phosphate reaching 99%. Some organic compounds and impurities ion contained in precipitates such as calcium, fluoride, sodium, chloride, and silicate should be further investigated since it damages the struvite surface. This research reveals the potential of magnesium chloride as a coagulant that can be used to recover struvite from the wastewater, thus, reducing the amount of phosphate and ammonia released into the environment.

Keywords:
Coagulant; flocculation; magnesium chloride; struvite crystallization

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Performance of a novel biochar-clamshell composite for real acid mine drainage treatment

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Composites from clamshell (CS) and low-cost biochar (BC) that was derived from coconut shell (CoS) were successfully produced. The BC-CS composites were prepared under two conditions, namely, solid–solid and solid–liquid, in ratios of 1:1 and 7:3. The metal sorption abilities of Al, Ca, and Mg were characterized using ICP and tested under batch conditions at pH values of 2.7, 6.8, and 8. The obtained XRD patterns showed that CoS and BC had crystalline and amorphous structures. XRF analysis showed that CoS and BC had high CaO and K2O contents while CS and BC-CS contained no K2O. The ICP analysis showed that the examined acid mine drainage sample had high Al, Ca, and Mg concentrations. BC and BC-CS successfully removed Al. According to the results of this study, low-cost-modified pyrolysis of BC-CS is a promising and inexpensive sorbent material for removing Al ions from acid mine drainage.

Keywords:
Acid mine drainage; Biochar (BC); Clamshell (CS); Low-cost-modified pyrolysis; Metal ions

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Rate of flocculation of positively charged monodisperse spheres induced by the addition of montmorillonite dispersion in the standardized mixing

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(1) Introduction
Controlling pollution of water from waste of various industries and domestic activities has become a worldwide challenge. Flocculation is one of the most convenient technique employed to separate the suspended particles in multi-phase fluid [1]. This process is induced by the addition of flocculant resulting in aggregation of particles to form flocs for easier separation from water. Recently, research is focused on the possibility to use natural substances as flocculants because of their advantages including safety to human and natural environment with acceptable removal performances.

(2) Methods
Earlier, a novel standardized mixing method was established by Adachi et al to study the kinetics of salt-induced rapid coagulation of colloidal particles of various sizes in terms of collision frequency [2]. This method involves simple mixing of particles and flocculant in an end-over-end mixing device. Temporal evolution of the number of flocculating colloid particle is described by the following equation.

$$\ln \frac{N(t)}{N(0)} = -K\alpha a_0^2 t \tag{0.1}$$

Where, N_t, K, α and a_0 denotes Number concentration at time t, a constant determined by mechanical condition of apparatus, capture efficiency and the radius of colloidal particle. The significant point is that the rate in the mixing is largely influenced by the size of particles. On the basis of Eq.(0.1), the mixing flow can be normalized by the collision frequency between colloid particles

(3) Addition of flocculants with considerable size
As a sequel to our continued studies on flocculation, we studied the role of natural colloid material such as clay particle. In the present study, we tested montmorillonite as a type of natural flocculant. The presence is detected as an effective increase of collision radius by the protruding length, d_1, formed on the particles by the following equation of the enhancement factor,β.

$$\beta = \frac{(a_0+d_1)^3}{\alpha \times a_0^3} \tag{0.2}$$

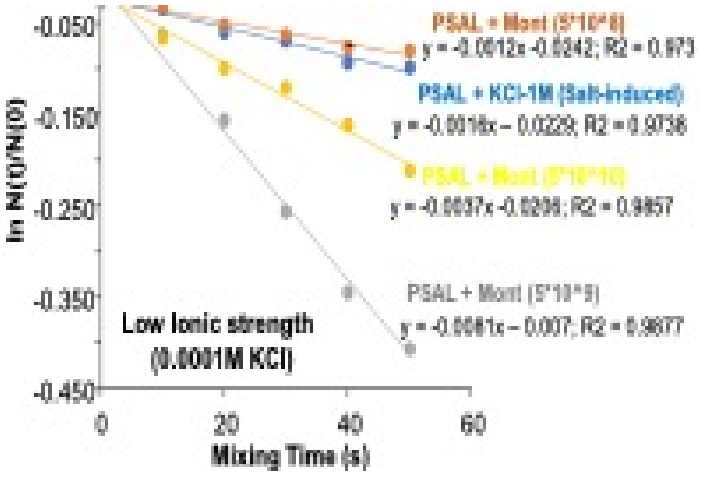

Fig. 1: Effect of concentration of montmorillonite on the bare particle

The diffusion constant of the positively charged particle (PSAL) with the montmoril-

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lonite, D, was analyzed by measuring the adsorbed hydrodynamic layer thickness,δ, using the Stokes-Einstein's equation.

$$D = \frac{KT}{6\pi(a_0+\delta)\mu} \tag{0.3}$$

Fig.1 demonstrates the progress of flocculation of Polystyrene Amidine Latex (PSAL) induced by salt and montmorillonite of different concentrations. The slope denotes the rate of flocculation. It was found that the rate is remarkably enhanced by the application of Montmorillonite. It is confirmed that the rate goes through the maximum with an increase of Montmorillonite concentration. flocculation efficiency at an optimum concentration of 5×10^9. The adsorbed hydrodynamic layer thickness on the basis of Eq(0.3) showed the tendency to increase when pH value shifted from 3.5 to 7.5.

Ackowledgement
This work is implemented under the supervise of Prof.Y.Adachi.

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Useful Information

On behalf of TGSW2022 Session 3-2 Bio-flocculation and Smart Sludge toward Soil Improvement, we would like to express our sincere thanks for your contribution and or participation in our session.

We are excited to welcome you to our session soon ! https://tgsw.tsukuba.ac.jp/sessions/32

Please note that **Talks** will be held at the **ZOOM** meeting. Hopefully the meeting link is already sent to your email box. However, for your kind purpose, the meeting link is attached hereafter.

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On the basis of this background, we decided to collaborate with the session "Bio-flocculation and Smart Sludge for Soil Improvement (BSSI)" at TGSW2022 held by the University of Tsukuba and to publish a Special Issue of Gels (an open access journal from MDPI). BSSI is an important issue in agriculture and water treatment, but this Special Issue is open to manuscripts on topics ranging from basic to applied flocculation and electrokinetics in bioresources and the environment. We welcome submissions from authors who did present at the TGSW2022 session, as long as they agree with the objectives of the activities of the ELKINJP and RUCEB. The deadline for submission of manuscripts is August 31, 2023. Ten papers will be selected from the submissions as invited papers, and the Article Processing Charges for these submissions will be waived. Other papers will be treated as general papers in accordance with MDPI rules. For the latter, Article Processing Charges (1600 CHF, https://www.mdpi.com/apc#journal-apcs) will be required. Invited papers will be selected by the Editorial Board at the end of March 2023.

Dr. Kazuyoshi Ogawa
Prof. Dr. Yasuhisa Adachi
Prof. Dr. Hiroyuki Ohshima
Guest Editors

If you have any questions related to book of abstract please contact following persons by email.

- SAHA Santanu (Email: sahasantanu.math@gmail.com)
- Yang Yuhan (Email: yyhanjuly@gmail.com)
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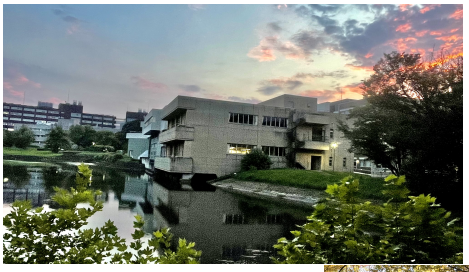
Go To the Schedule Day: 1 or Day: 2

Photos: Univeristy of Tsukuba



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