



Collaboration of NANOTECH/NSTDA and Kyoto University under JASTIP

**Dr. Kajornsak Faungnawakij and team
National Nanotechnology Center (NANOTECH), NSTDA**

**Assoc.Prof. Noriaki Sano and team
Dept of Chemical Engineering, Kyoto University**



Joint Project Title

Innovations in Biomass Application for Catalytic Material Synthesis and Energy Devices

Members

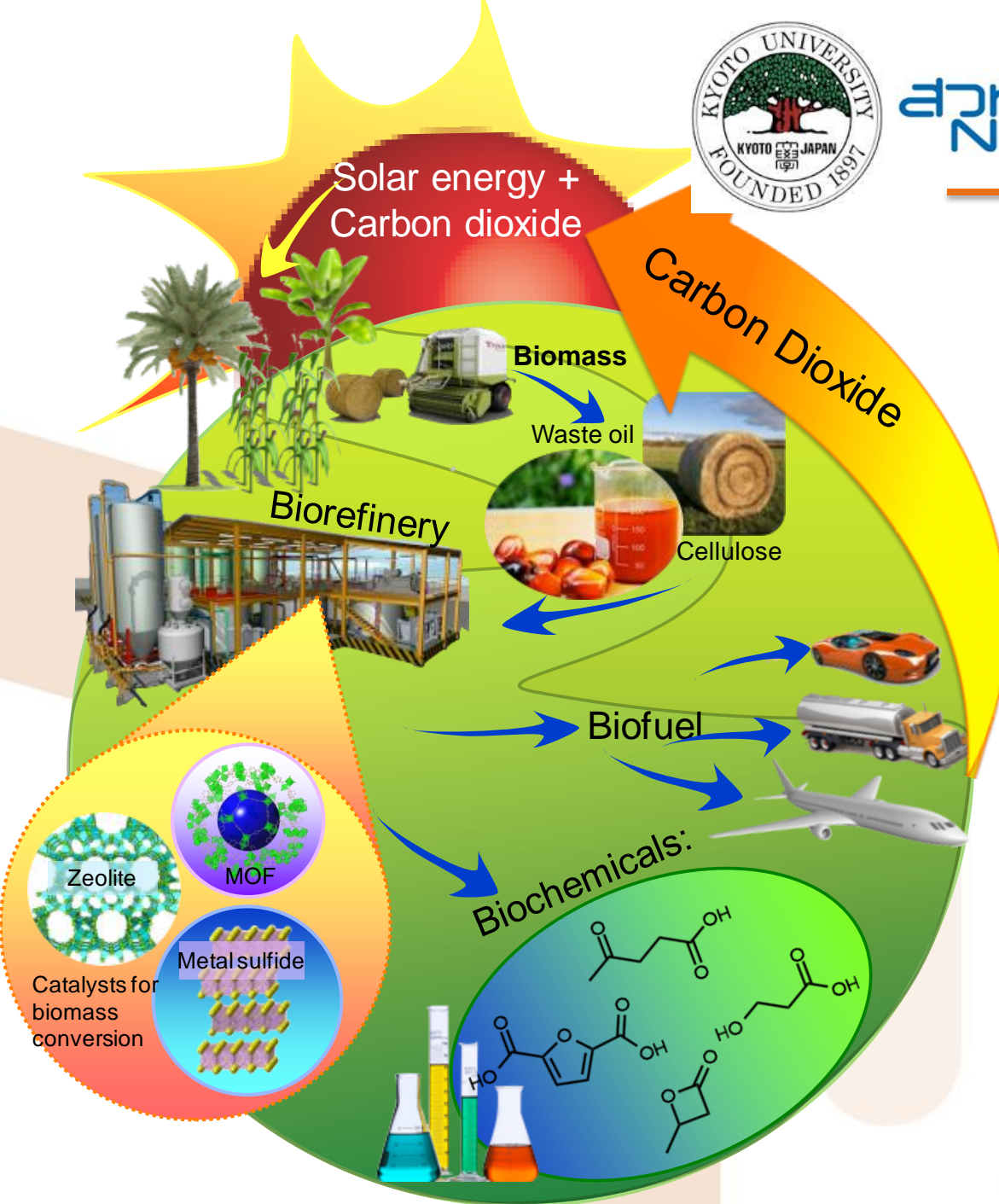
Period: 5 years

Thailand

Dr. Kajornsak Faungnawakij (NANOTEC, NSTDA) (PI)
Dr. Vorranutth Itthibenchapong (NANOTEC, NSTDA)
Dr. Pongtanawat Khemthong (NANOTEC, NSTDA)
Dr. Pussana Hirunsit (NANOTEC, NSTDA)
Dr. Supawadee Namuangruk (NANOTEC, NSTDA)
Dr. Chompoonut Rungnim (NANOTEC, NSTDA)
Ms. Chuleeporn Luadthong (NANOTEC, NSTDA)
Ms. Rungnapa Kaewmeesri (NANOTEC, NSTDA)
Assoc.Prof.Tawatchai Charinpanitkul (Chulalongkorn Univ.)
Asst.Dr.Thongthai Witoon (Kasetsart Univ.)
Dr.Weerawut Chaiwat (Div of Engineering, Mahidol University)
Assoc.Prof.Dr. Prasert Pavasant (School of Energy Science and Engineering, VISTEC)

Japan

Assoc.Prof. Noriaki Sano (Kyoto University) (PI)
Research team from Dept of Chem Eng.



Nanocatalysis for Green Biorefinery towards Materials, Biochemicals, and Biofuels



Objectives

To realize a sustainable systems for energy and material synthesis

- **New synthesis methods of carbon-based nanomaterials and multifunctional catalysts using the hydro/thermo chemical conversion of biomass, reducing algae, and arc discharge technique.**
- **Development of non-precious metal or hybrid nanocatalysts for catalytic conversion of biomass to biochemicals such as furans, organic acids, fuel-like alkanes, biodiesel and fuel additives**
- **Development of carbon nanohorn-based catalysts for biodiesel production**
- **Development of electrodes for glucose fuel cell**
- **Development of hydrogen storage medium using nanoparticles**
- **Study the reaction behaviors and mechanisms via combined experimental and theoretical investigation**



Expected Outcomes

Advancement of science and technology in the field of renewable energy and environment via strong and sustain international networking between NSTDA and Kyoto University

Expected Outputs

- **Research articles in international-peer reviewed journals (at least 5 papers in 5 years)**
- **Researcher exchanges between Thailand and Japan**
- **Research Exchange Seminar/Workshop for international networking and knowledge sharing**

Overview R&D of the joint project



Material development



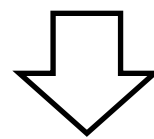
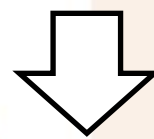
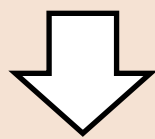
Active carbons from biomass

Nanostructured Multifunction catalysts

Carbon nanohorns

Metal Nanoparticle

Carbon nanotubes on electrode



Catalysts for production of biochemicals from biomass

Catalysts for production of biofuels from oils and fats

Novel electrode for glucose fuel cell

Hydrogen storage



SANO's team

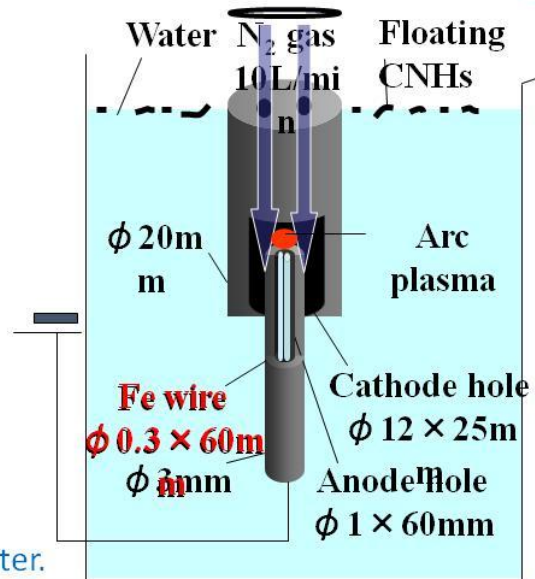


'Arc discharge in water' method to synthesize carbon nanohorns (CNH) used for catalyst materials

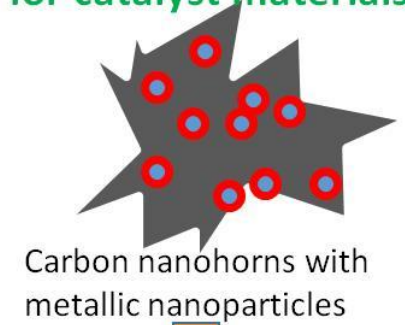
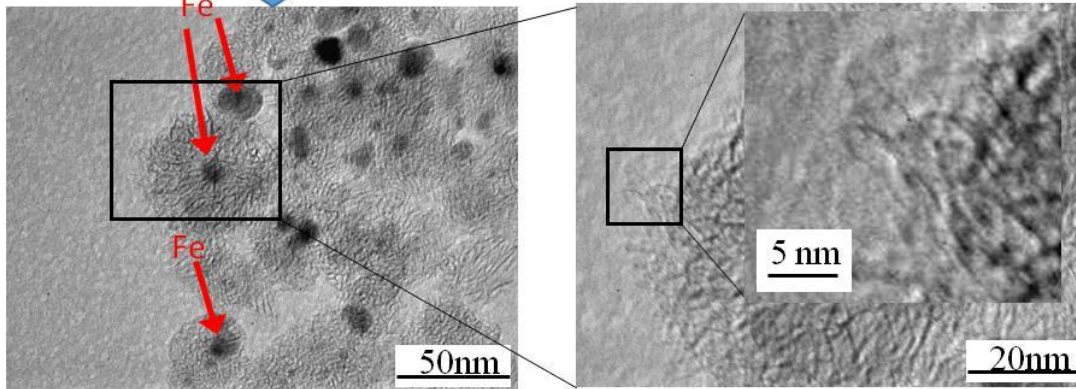
Synthesis of CNH including Fe nanoparticles for catalyst to produce biodiesel



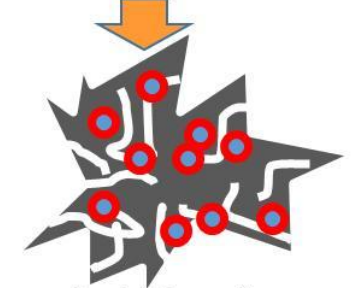
Carbon and metal are vaporized by arc discharge.



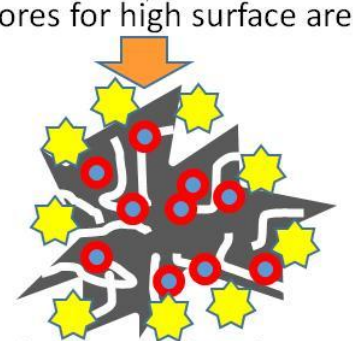
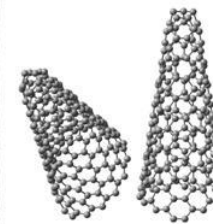
Vapors are cooled in water.



Carbon nanohorns with metallic nanoparticles



Open pores for high surface area

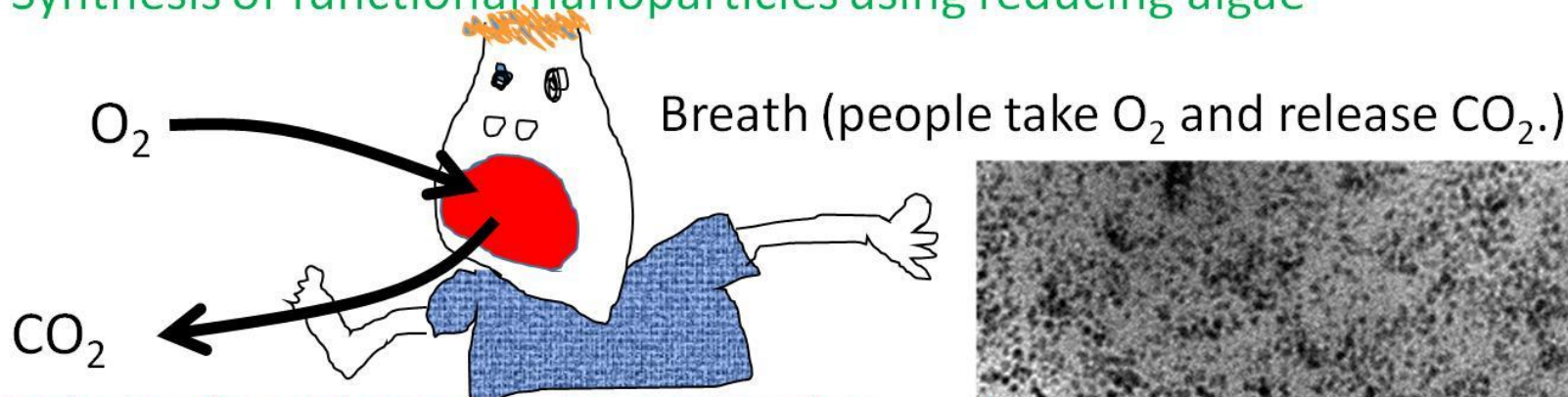


Functionalize material surface
=> catalysts for many applications

SANO's team

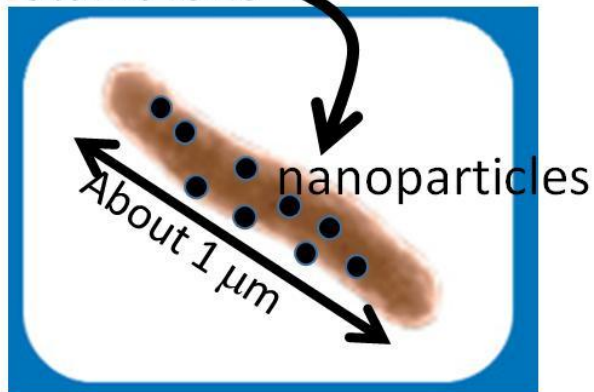


Synthesis of functional nanoparticles using reducing algae

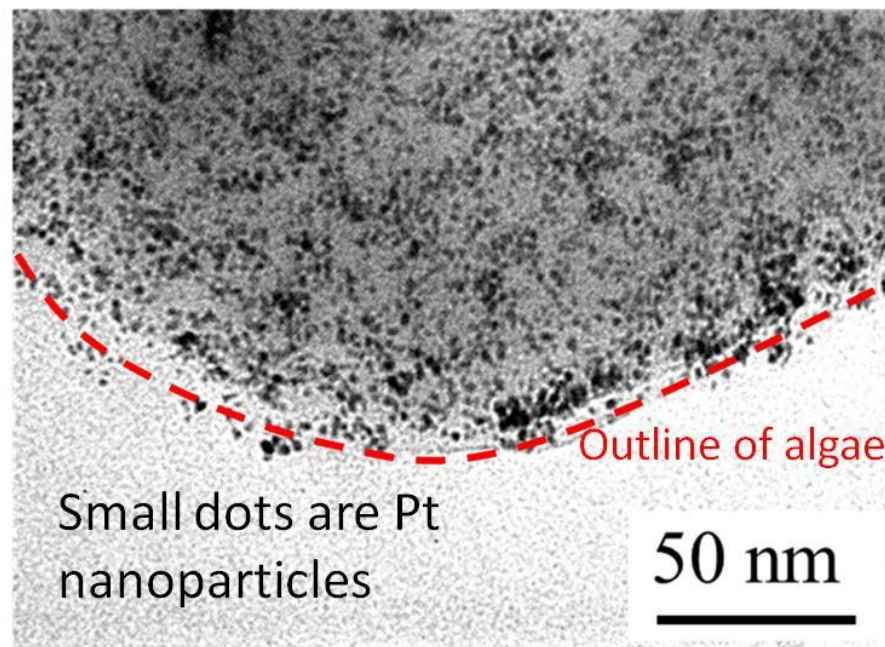


Reducing algae take metallic ions and produce nanoparticles for breathing.

Metallic ions



Shewanella algae



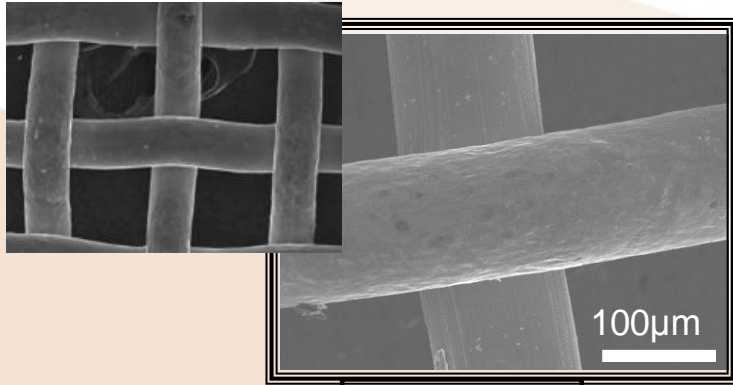
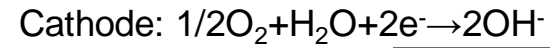
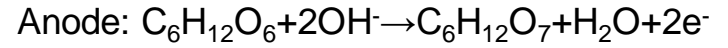
Pt nanoparticles synthesized by bioreduction of *Shewanella* algae

=> Useful to make catalysts

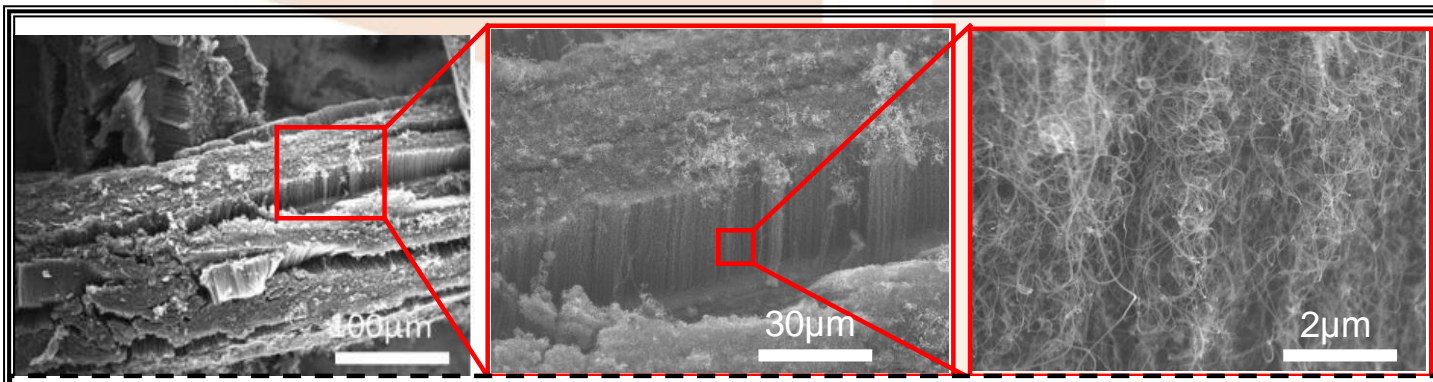
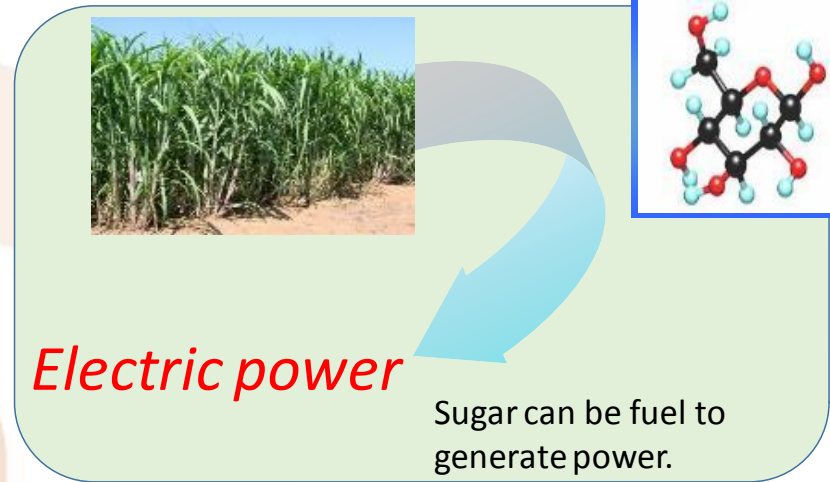
SANO's team



Synthesis of carbon nanotubes on electrode for catalyst support for glucose fuel cell



Carbon nanotube synthesis

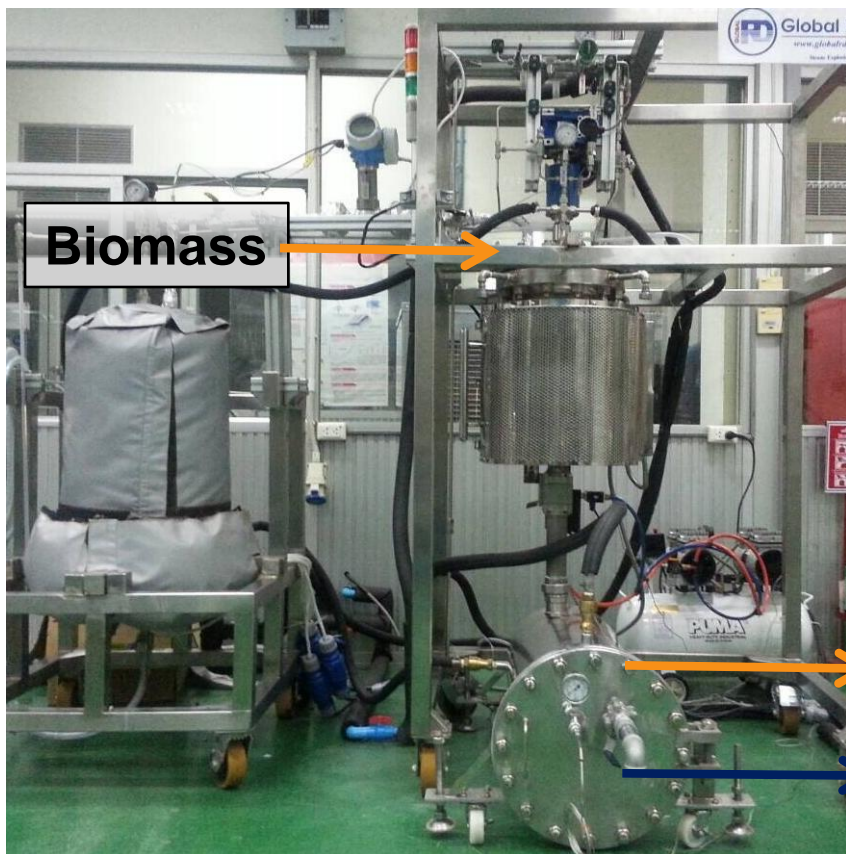


CNTs on stainless steel mesh => stable and high surface area electrodes can be made



Catalyst support for many applications.

NANOTEC's team



Biomass

Pre-pilot biomass processing

**Cellulose
(40-50%)**

Glucose

**Hemicellulose
(25-35%)**

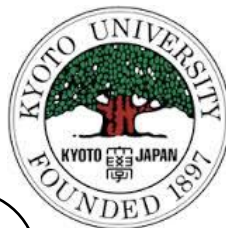
Xylose

**Lignin
(15-20%)**

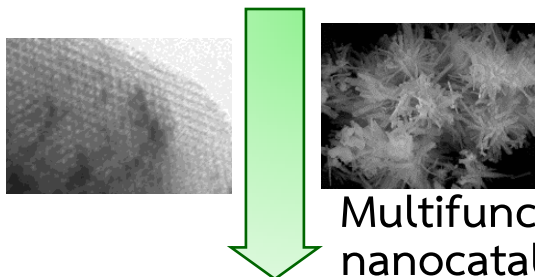
**Biochemicals,
Biofuels,
Biopolymers,
Bioactives,
etc.**

**Carbon
Nanomaterials**

NANOTEC's team



Palm oil/Animal fat/Biomass derivatives



Multifunctional nanocatalysts



BioDiesel

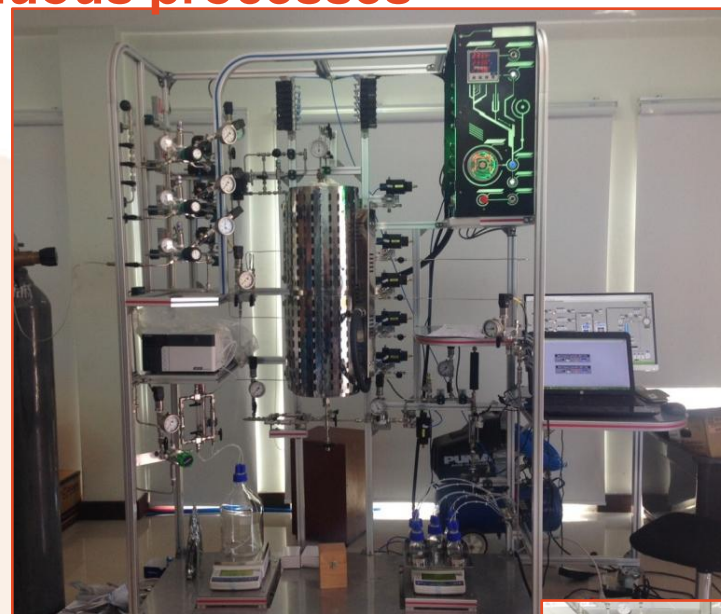


Biochemicals



Carbon materials

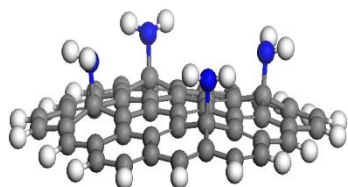
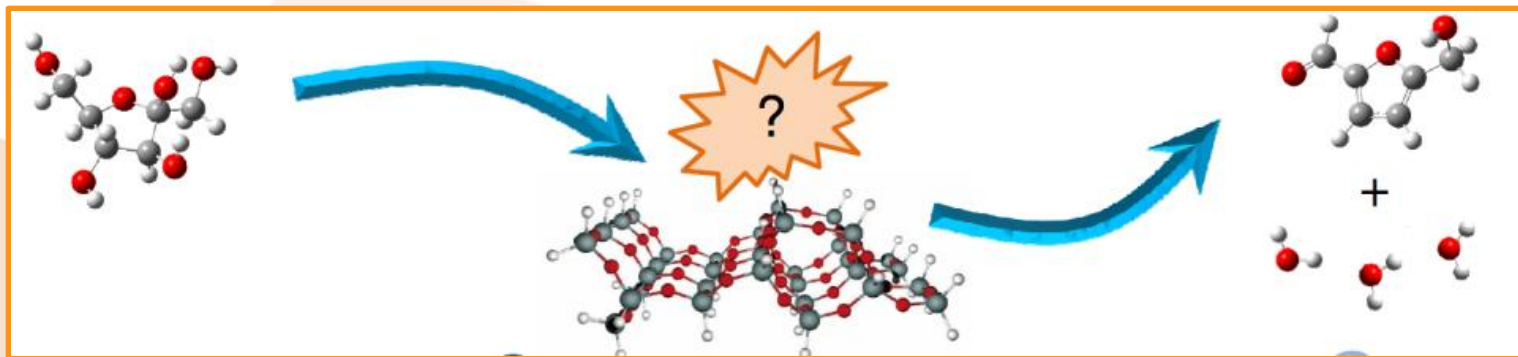
Packs of high-pressure and low-pressure continuous processes



NANOTEC's team

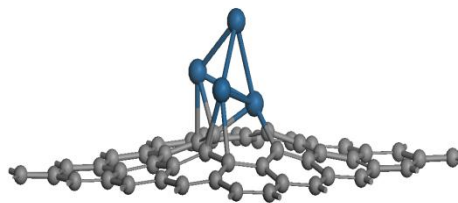


Materials design and reaction/sorption mechanism study by simulation



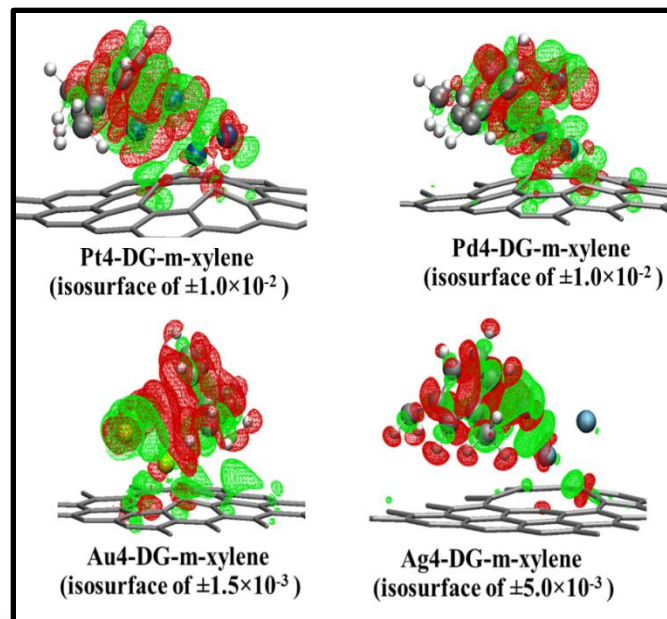
NH₂-Graphene

Functionalized Graphene

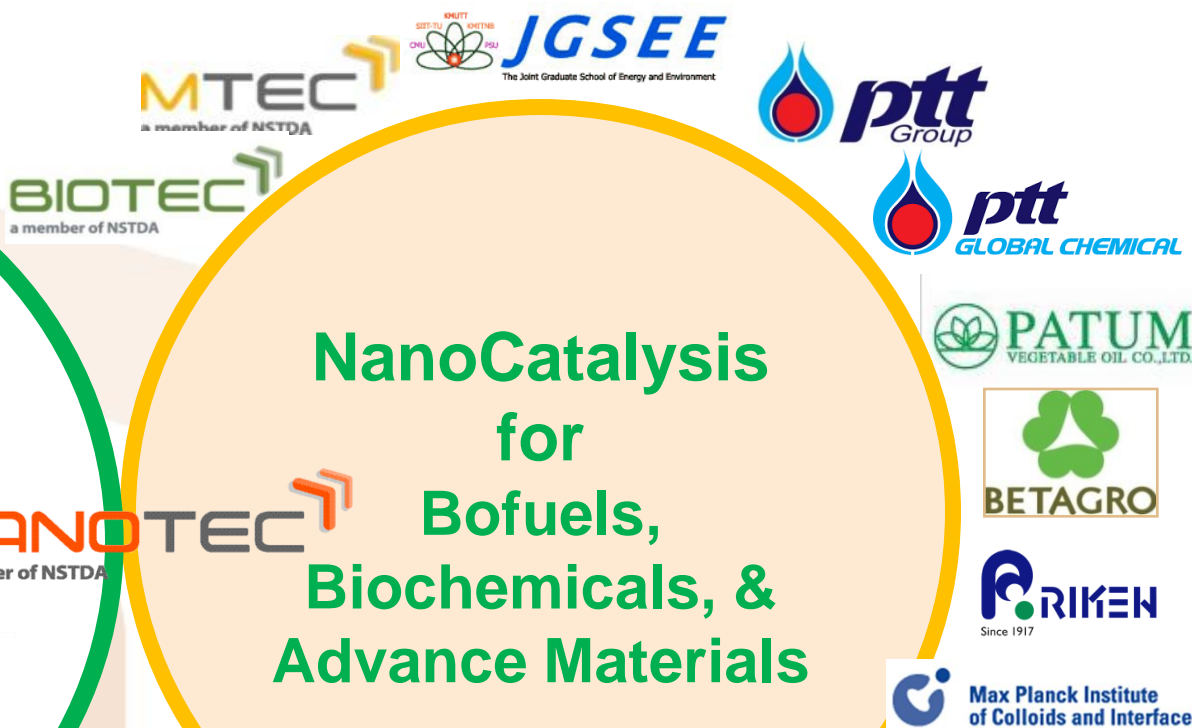


Pd₄-Graphene

Metal doped Graphene



Strong networking



More partners are very welcome!!!

Research Plan



	Faungnawakij's group (NANOTECH/NSTDA)	Sano's group (Kyoto University)
1 st year	<p>Phase 1: Explore conditions and apparatus set-up for synthesis of nanocatalysts for catalytic conversion of biomass and biomass derivatives to materials and biochemicals</p> <p>Study the reaction behaviors and mechanisms via combined experimental and theoretical investigation</p> <p>Visit Kyoto University for joint seminar</p>	<p>Explore conditions for synthesis of nano particles for fuel cell electrodes, biodiesel production catalysts, hydrogen storage.</p> <p>Explore conditions for measurement of hydrogen storage</p> <p>Receive PhD student from Faungnawakij's group to support biomass conversion experiment</p> <p>Host NANOTECH team for joint seminar</p>
2 nd year	<p>Phase 1: Development of catalysts/adsorbent and process for catalytic conversion of biomass and waste to carbon-based materials</p> <p>Development of metal nanocatalysts for catalytic conversion of biomass to biochemicals, including sugar, furans, and organic acids</p> <p>Testing of the catalysts from Sano'Group for continuous biodiesel production process</p> <p>Study the reaction behaviors and mechanisms via combined experimental and theoretical investigation</p>	<p>Explore conditions for synthesis of nano particles for fuel cell electrodes, biodiesel production, hydrogen storage.</p> <p>Conduct experiment for hydrogen storage, electric power generation by fuel cells</p> <p>Receive PhD student from Faungnawakij's group to support biomass conversion experiment (till July)</p> <p>Synthesis of catalyst for sending to Faungnawakij's group for continuous biodiesel production process, and detail structural analysis on this catalyst</p>
3 rd year	<p>Phase 1: Optimization of the catalytic conversion of biomass and waste to carbon-based materials</p> <p>Optimization of the catalytic conversion of biomass to biochemicals, including sugar, furans, and organic acids</p> <p>Testing of the catalysts from Sano'Group for continuous biodiesel production process</p> <p>Testing of the catalysts from the PhD student working in Sano'Group for continuous biomass conversion process</p> <p>Study the reaction behaviors and mechanisms via combined experimental and theoretical investigation</p> <p>Receive PhD/Master student/Researcher from Sano's group to support biomass conversion experiment</p> <p>Host Kyoto Univ team for joint seminar</p>	<p>Explore conditions for synthesis of nano particles for fuel cell electrodes, biodiesel production, hydrogen storage.</p> <p>Conduct experiment for hydrogen storage, electric power generation by fuel cells</p> <p>Synthesis of catalyst for sending to Faungnawakij's group for continuous biodiesel production process, and detail structural analysis on this catalyst</p> <p>Synthesis of catalyst for sending to Faungnawakij's group for continuous biomass conversion process and detail structural analysis on this catalyst</p> <p>Receive PhD/Master student/Researcher from Faungnawakij's group to support biomass conversion experiment</p>

Research Plan



	Faungnawakij's group (NANOTECH/NSTDA)	Sano's group (Kyoto University)
4 th year	<p>Phase 2: Development of catalysts and process for catalytic conversion of biomass and waste to biofuels and fuel additives Study the reaction behaviors and mechanisms via combined experimental and theoretical investigation</p>	<p>Optimization of alloy components for hydrogen storage, fuel cell catalyst, and biofuel synthesis catalyst. Development of mass production methods for synthesizing the catalyst for continuous biodiesel production Receive PhD/Master student /Researcher from Faungnawakij's group to support biomass conversion experiment</p>
5 th year	<p>Phase 2: Optimization of the catalysts and process for catalytic conversion of biomass and waste to biofuels and fuel additives Study the reaction behaviors and mechanisms via combined experimental and theoretical investigation Receive PhD/Master student /Researcher from Sano's group to support biomass conversion experiment Host Kyoto Univ team for joint seminar</p>	<p>Optimization of alloy components for hydrogen storage, fuel cell catalyst, and biofuel synthesis catalyst. Development of mass production methods for synthesizing the catalyst for continuous biomass conversion</p>
Propose a sustainable system for materials synthesis and energy using biomass and bio activities		

Thank you for your attention
ขอบคุณครับ

ยินดีต้อนรับ

