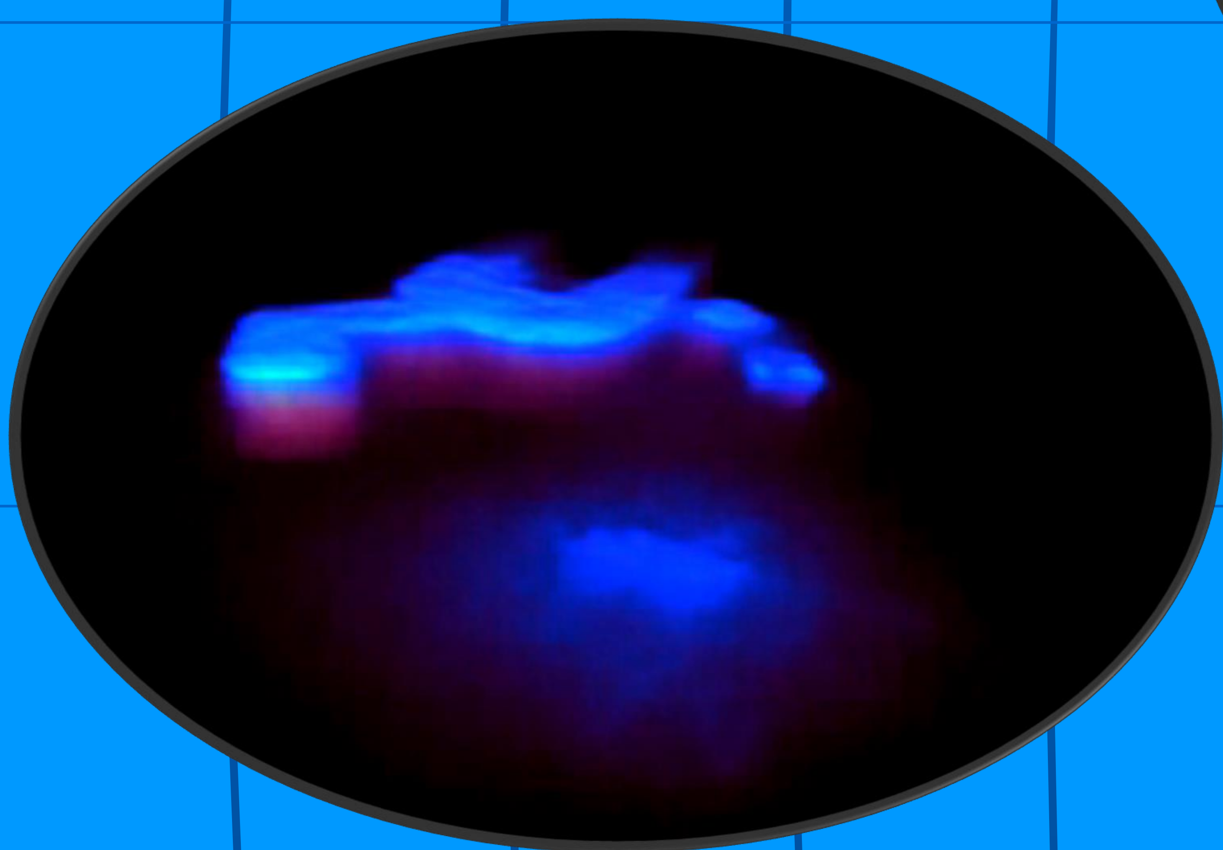
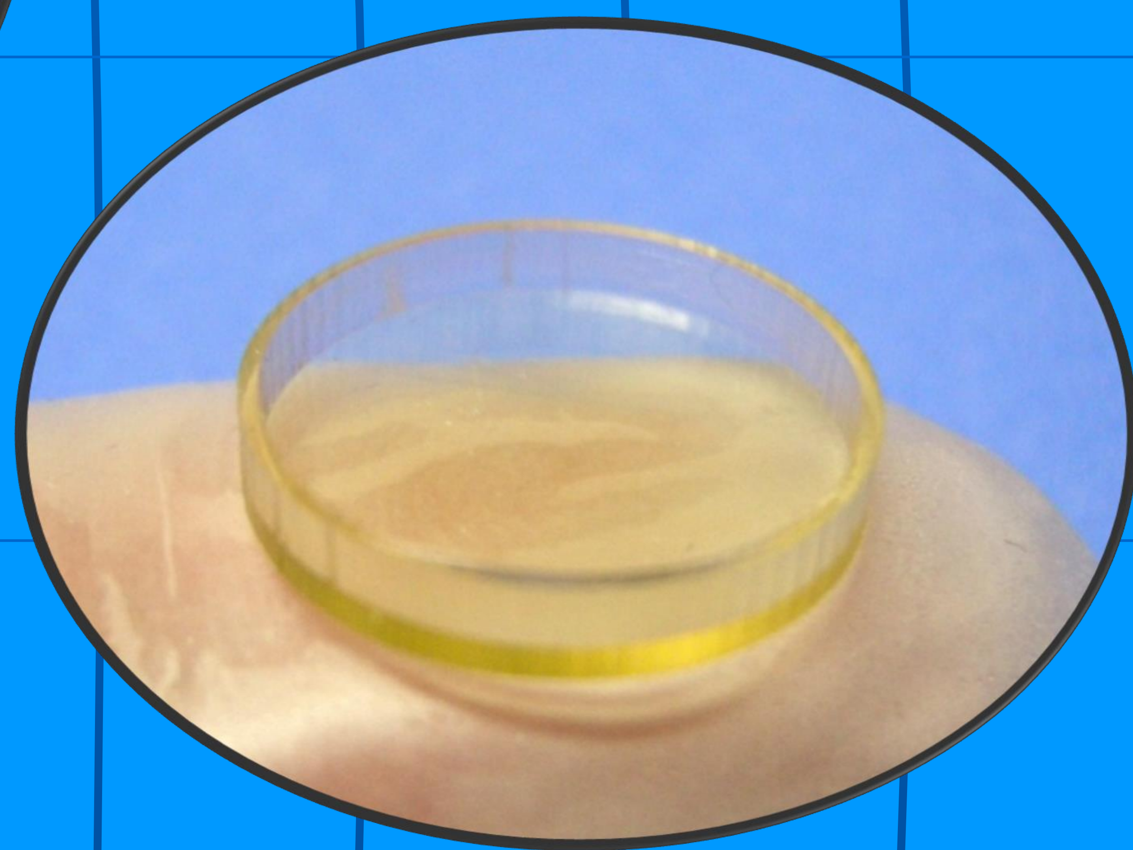
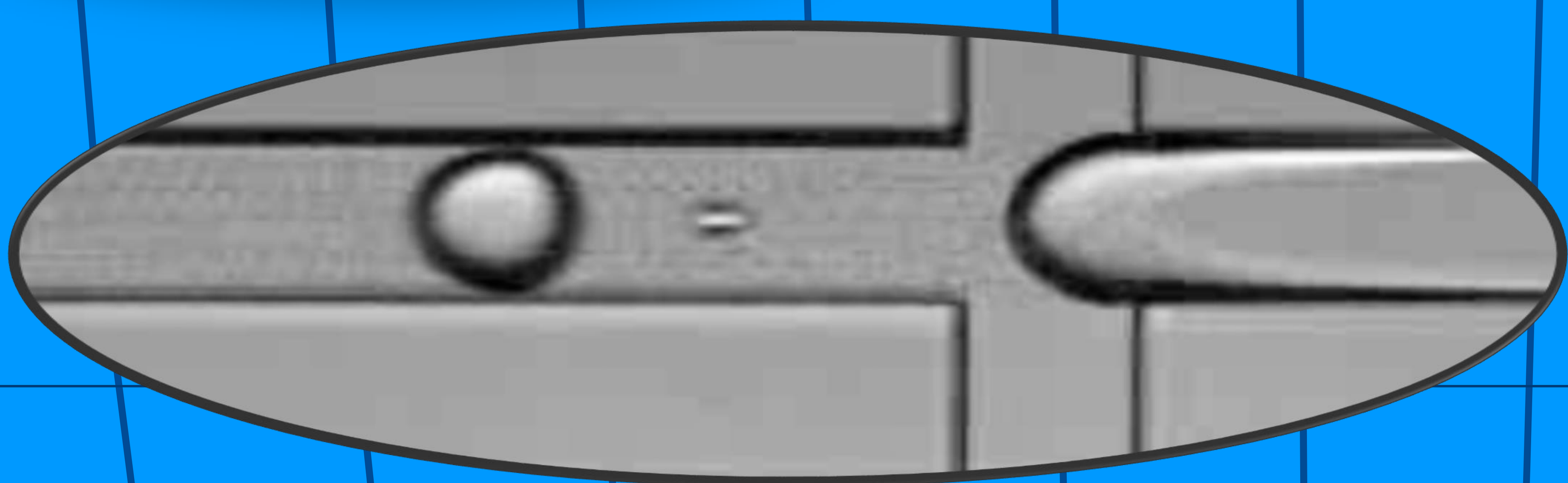
Selected Novel Technologies for Licensing

2017 MRS Fall

Innovative Technologies for Your Products







Japan Science and Technology Agency

Mass Production of Micro Droplet

High Throughput Production of Single and Compound Emulsions

Prof. Takasi NISISAKO (Tokyo Institute of Technology), et al.

1. Background

- **Microdroplet technology** has been attracting attentions not only in the fields of **Medical/Scientific Analysis** but also in the fields of **Electronics/Food/Pharmaceutical industries**.
- The **"Emulsion Method"** ("water-in-oil emulsion droplet technology") for producing Microdroplet has been widely accepted in the market.
- The **"Scale Up/Mass Production"** for the "Emulsion Method" is eagerly awaited for use in several rapidly expanding market.

2. An Innovative "Simple & Easy" Micro Droplet Production Method

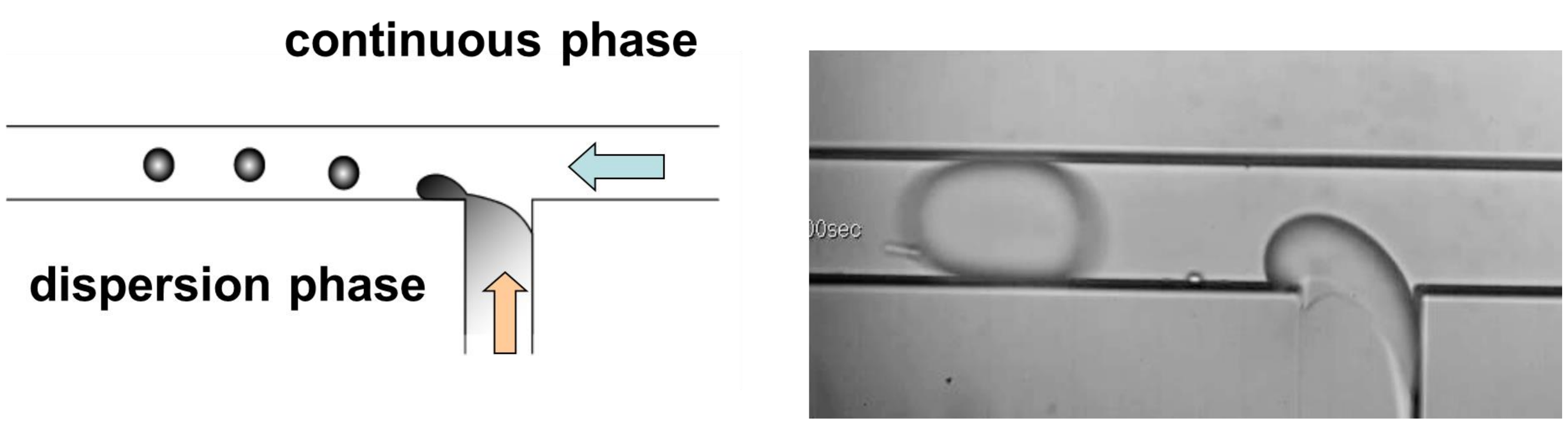


Fig.1 Micro droplets formation in the T intersection

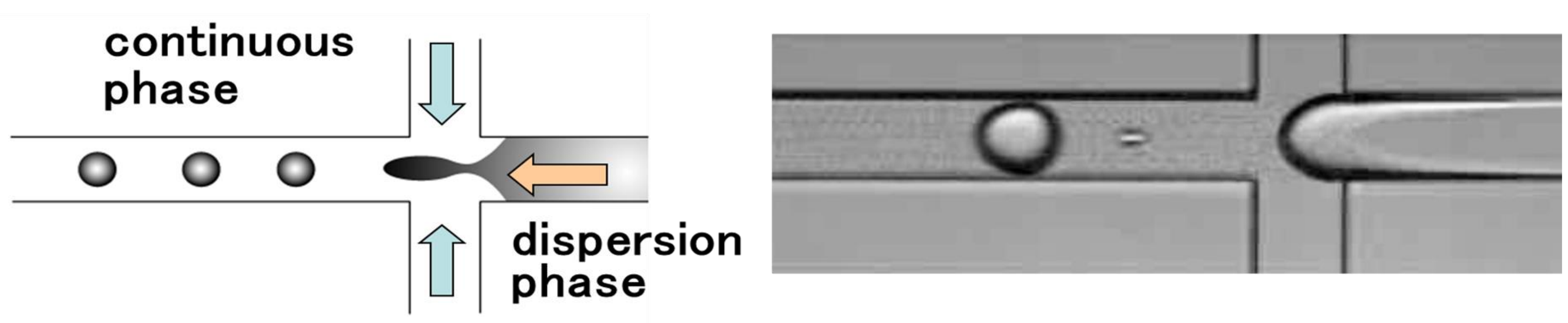


Fig.2 Micro droplets formation in the + intersection

- The Microdroplet formation by using "Micro-channel" ("**Emulsion Method"**: both simple **T intersection structure** and **cross intersection structure**) has been recognized as a standard method for producing Microdroplets.
- The technology has already been adopted in the various market fields in the world.

3. High Throughput Mass Production Method

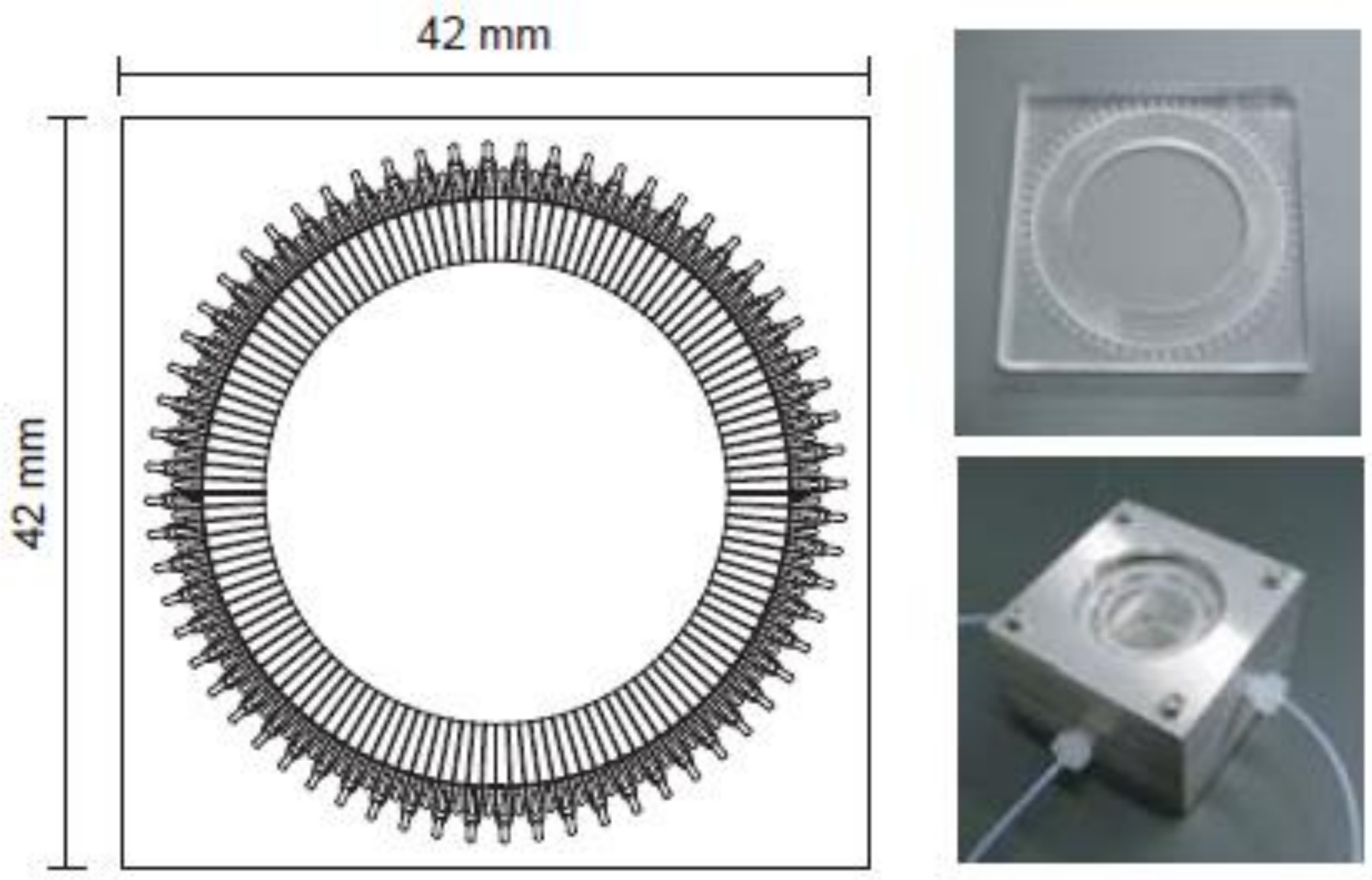


Fig.1 A microfluidic module with 256 Microfluidic Droplet Generators(MFDGs)

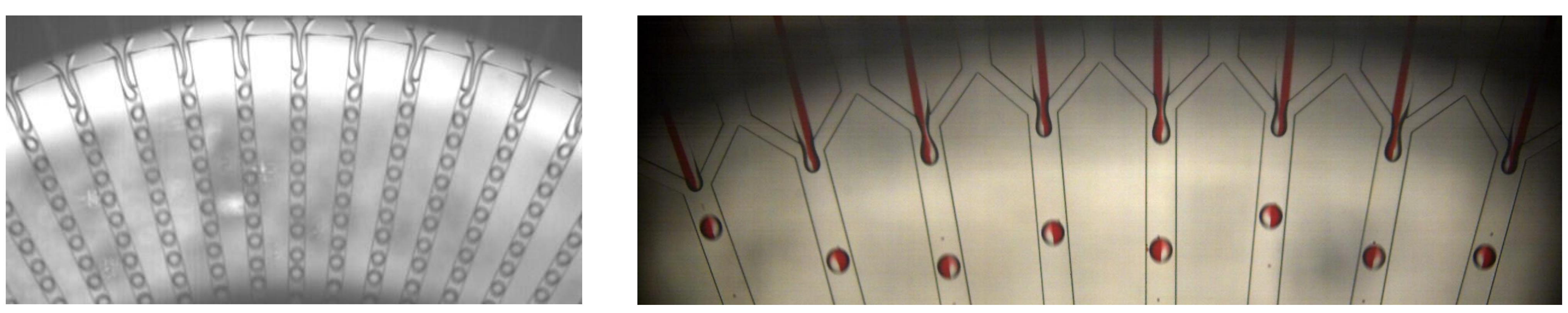


Fig.2 High Throughput Emulsification (left: single droplet and right: Janus droplet)

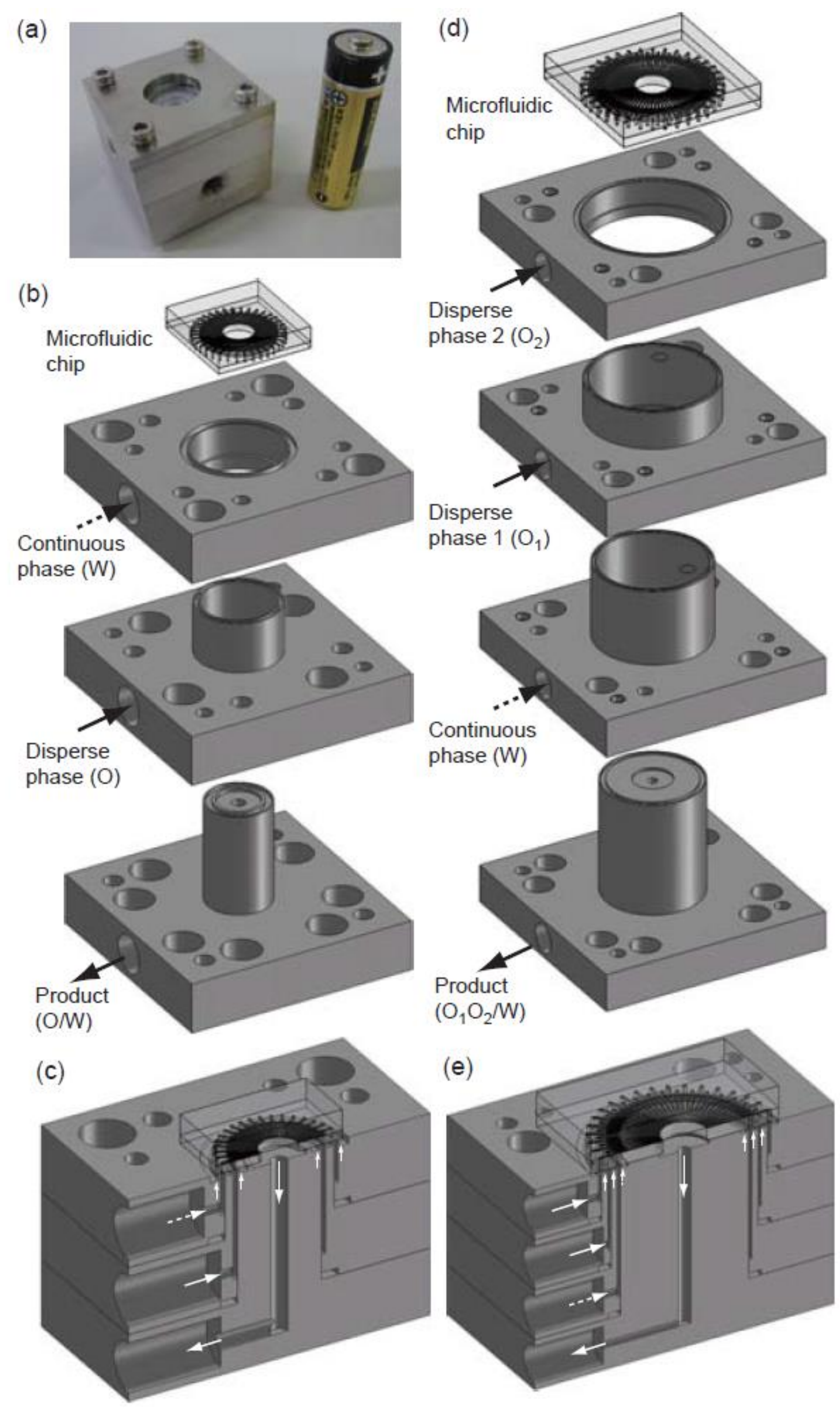


Fig.3 Simple coaxial multiple annular interfacing modules are coupled with circularly arranged MFDGs.
By using the coupled modules, Micro Droplet can be mass-produced.

4. Patent Licensing Available

Patent No.: WO2002/068104 , WO2012/008497 Patent Family

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Ozon Water Etching

Method for Etching Metal/Metal Oxide by OZONE Water

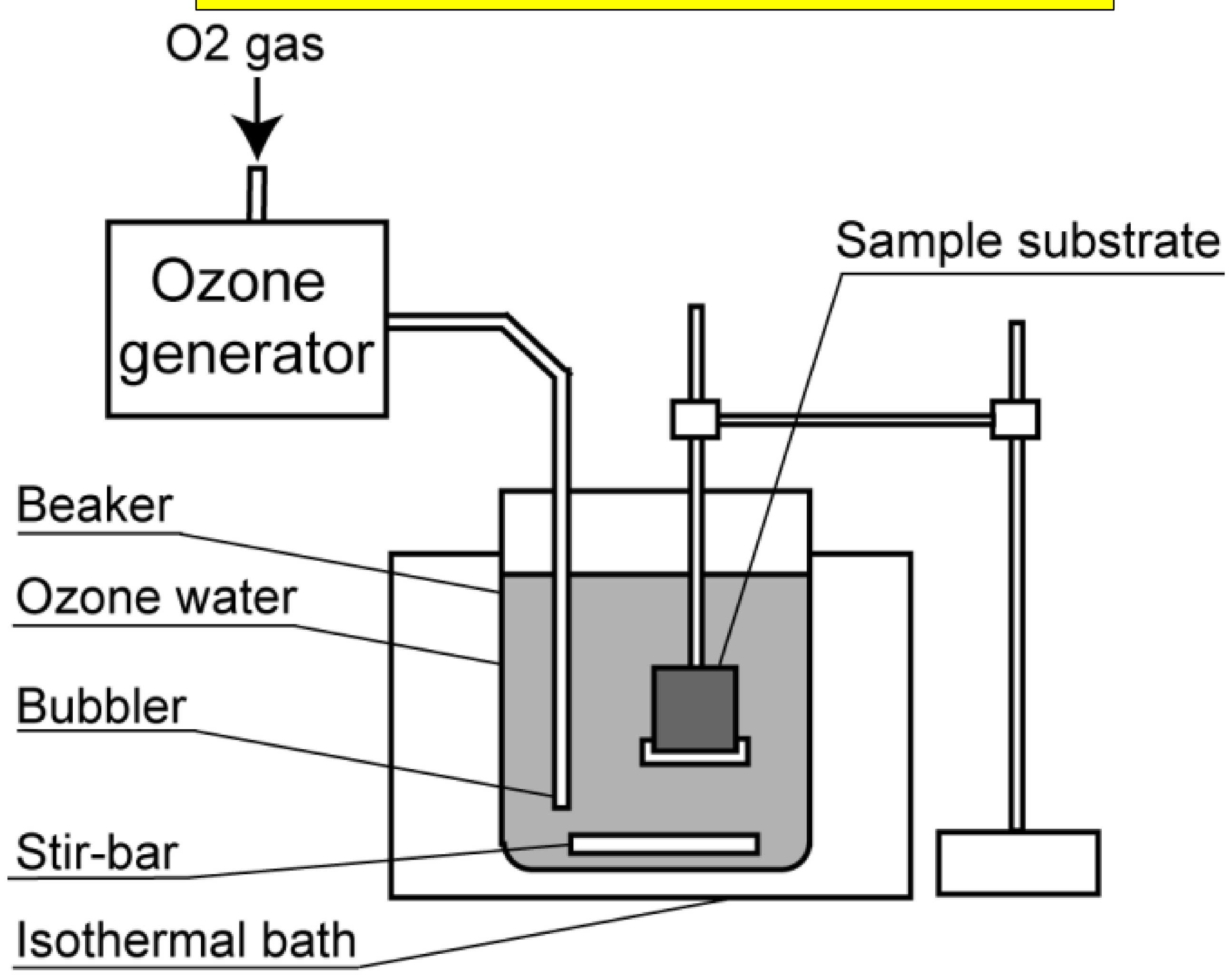
Prof. Takatoki YAMAMOTO et al. (Tokyo Institute of Technology)

1. Background

(Market Requirements)	(New Solutions)
a. Environmentally friendly	a. Realized by using only Air and Water
b. Implemented by a Simple Apparatus	b. No need for waste liquid treatment, vacuum facilities
c. Realize Ultimate Smoothing Surface	c. Realize Atomic Level Surface Smoothness
d. Applied to various metals	d. Can be applied to wide variety of Metal/Metal Oxide

2. New Method for Etching Metal/Metal Oxide by Ozone Water

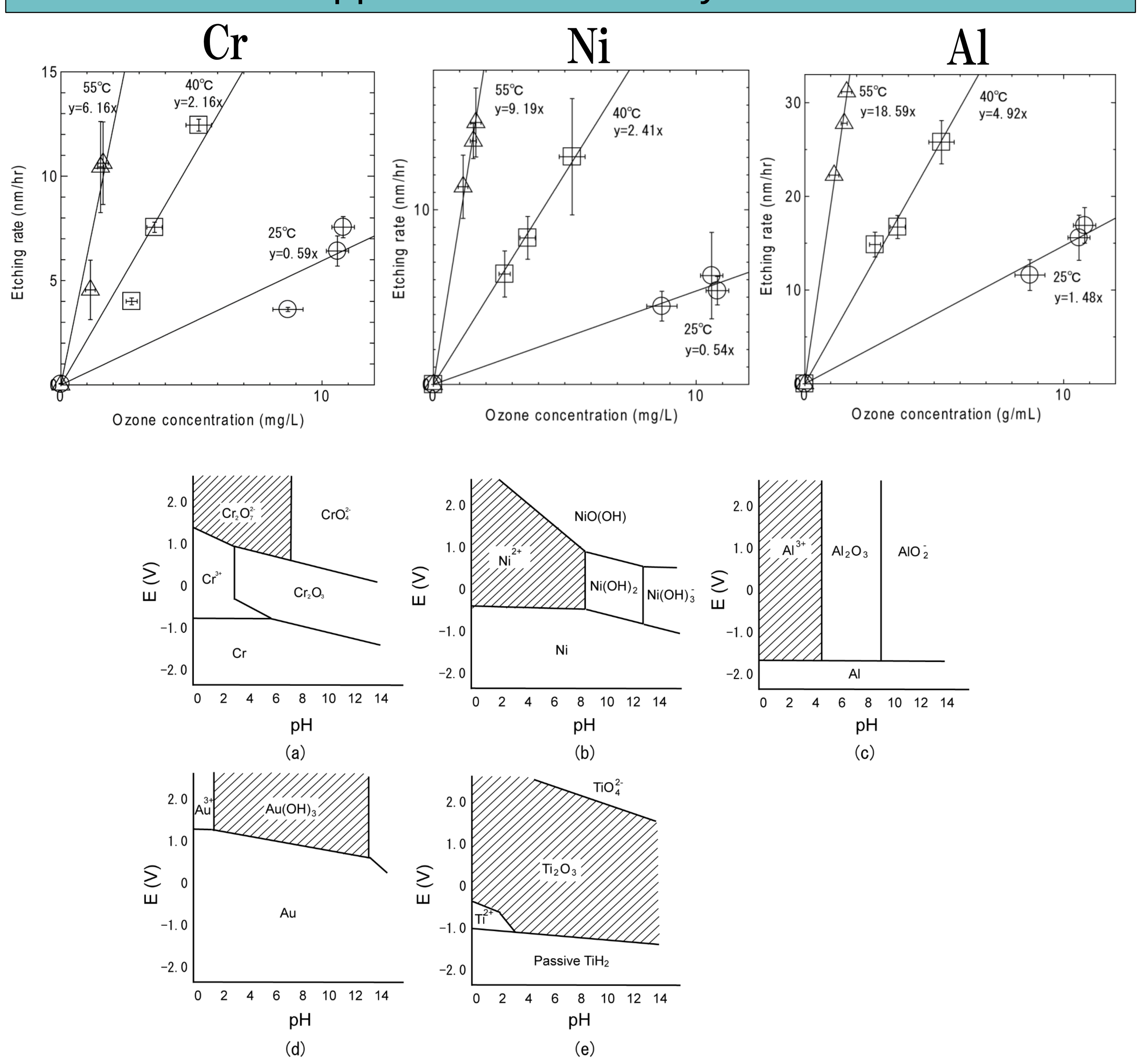
Ozone Water Etching set up



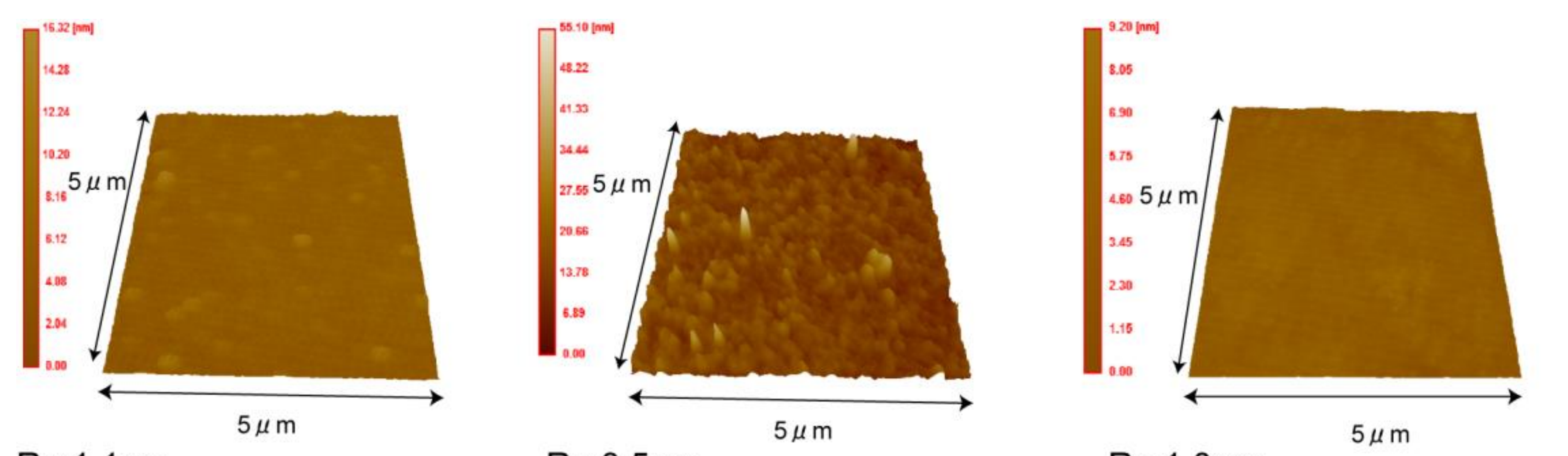
Surface Roughness measured by AFM

Metal	Before etching	After conventional etching	After ozone-water etching
Cr	1.32±0.39	3.61±1.12	1.17±0.22
Ni	0.87±0.37	1.71±0.34	1.69±0.79
Al	4.10±0.49	4.29±1.07	3.17±0.72
Au	1.11±0.28	3.86±0.44	1.06±0.28
Ti	1.19±0.32	———	4.37±2.43

Method can be applied to wide variety of Metal/Metal Oxide



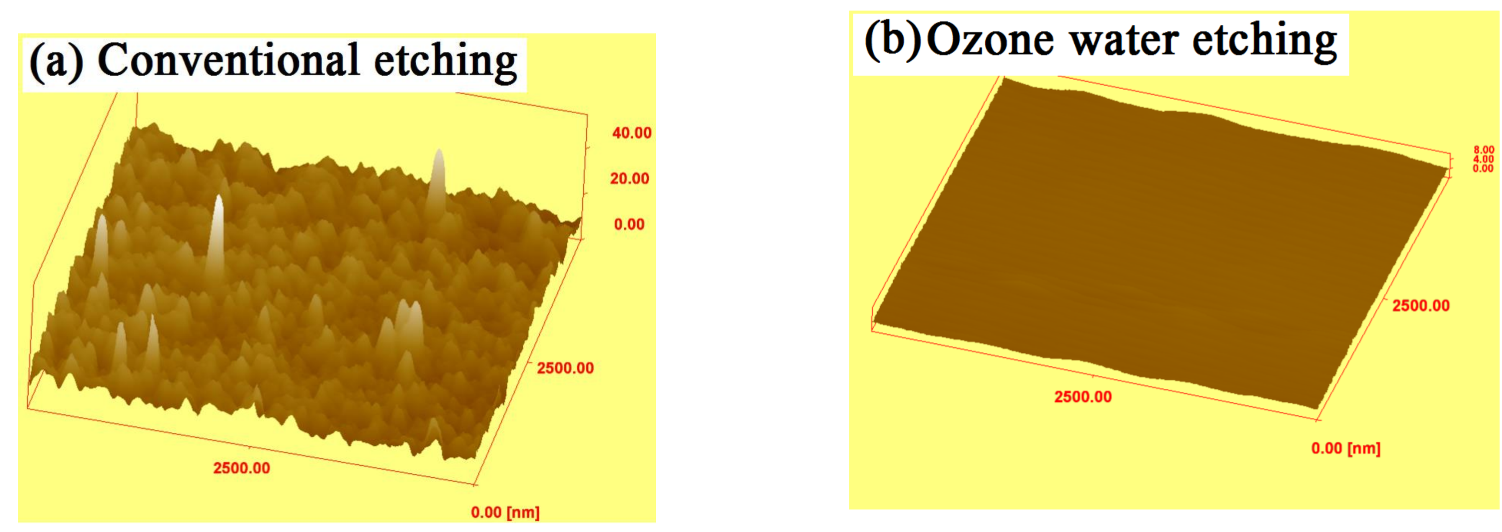
Atomic Level Surface Smoothness can be realized (example data by using Cr)



Rq:1.1nm (a) Before etching

Rq:3.5nm (b) Conventional etching

Rq:1.0nm (c) Ozone water etching



	Surface roughness Ra (nm)
Before etching	0.94 ± 0.24
After conventional etching	2.61 ± 0.77
After ozone water etching	0.94 ± 0.19

3. Prospective Applications

- For the manufacturing process of Nano Device, which is required the thickness control at the Atomic scale
- For the final polishing process of the Metal/Metal Oxide, which requires the ultimate surface smoothness
- To promote effective utilization and recycle of the residual ozone from various ozone-based systems
- As new technology of Atomic Level process by precise controlling of etching speed

4. Patent Licensing Available

Patent No.: WO2013/161959 Patent Family

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3D Imaging System

New Realtime 3D Imaging System combined with Confocal Microscope and Optical Tweezers

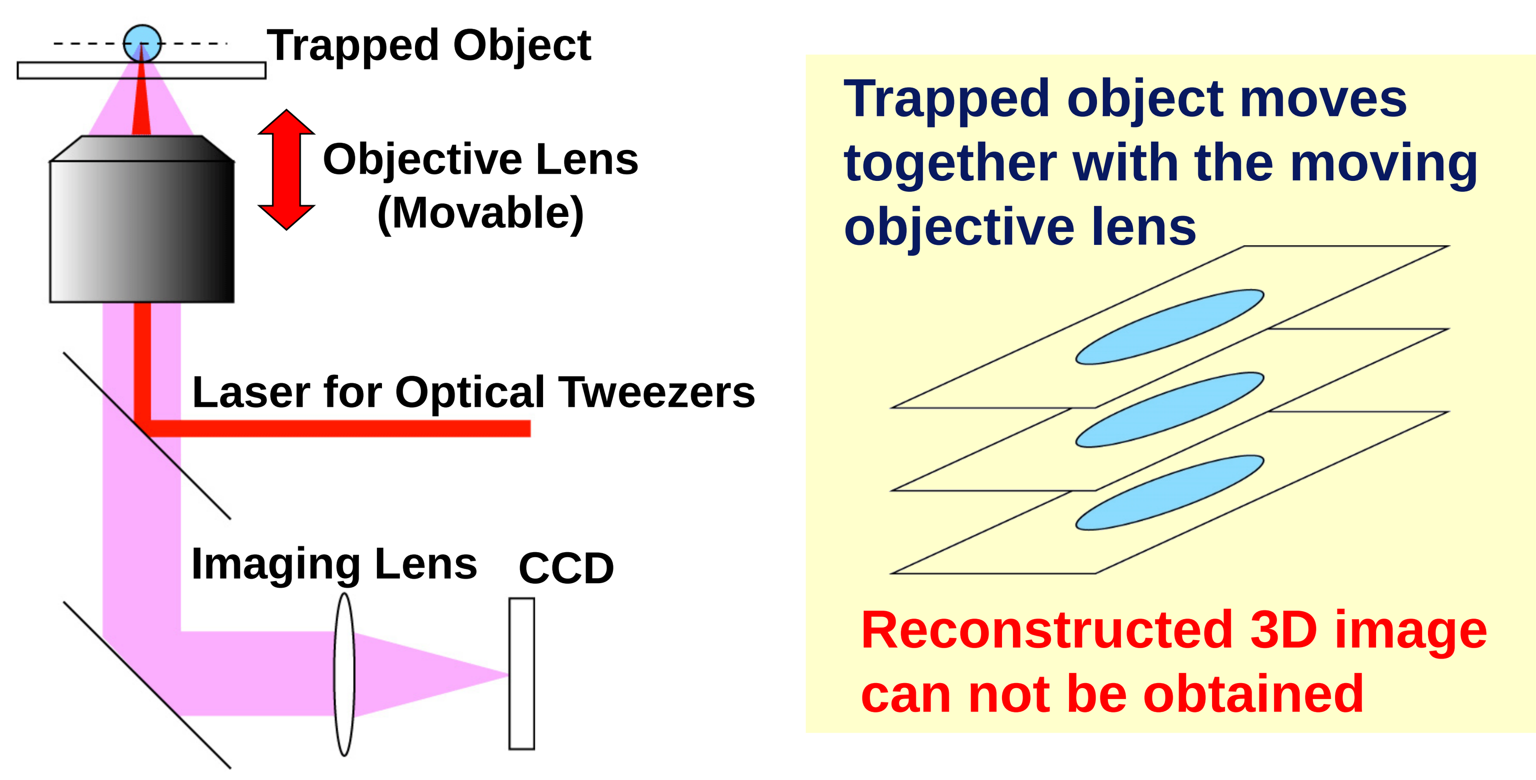
Prof. Koji IKUTA (The University of Tokyo)

1. Introduction

Realtime 3D imaging system combined with a confocal microscope and optical tweezers has been newly developed. It is possible to provide a 3D confocal microscope which can acquire a 3D image of a specimen during a manipulation of the specimen using optical tweezers without affecting an optical trap.

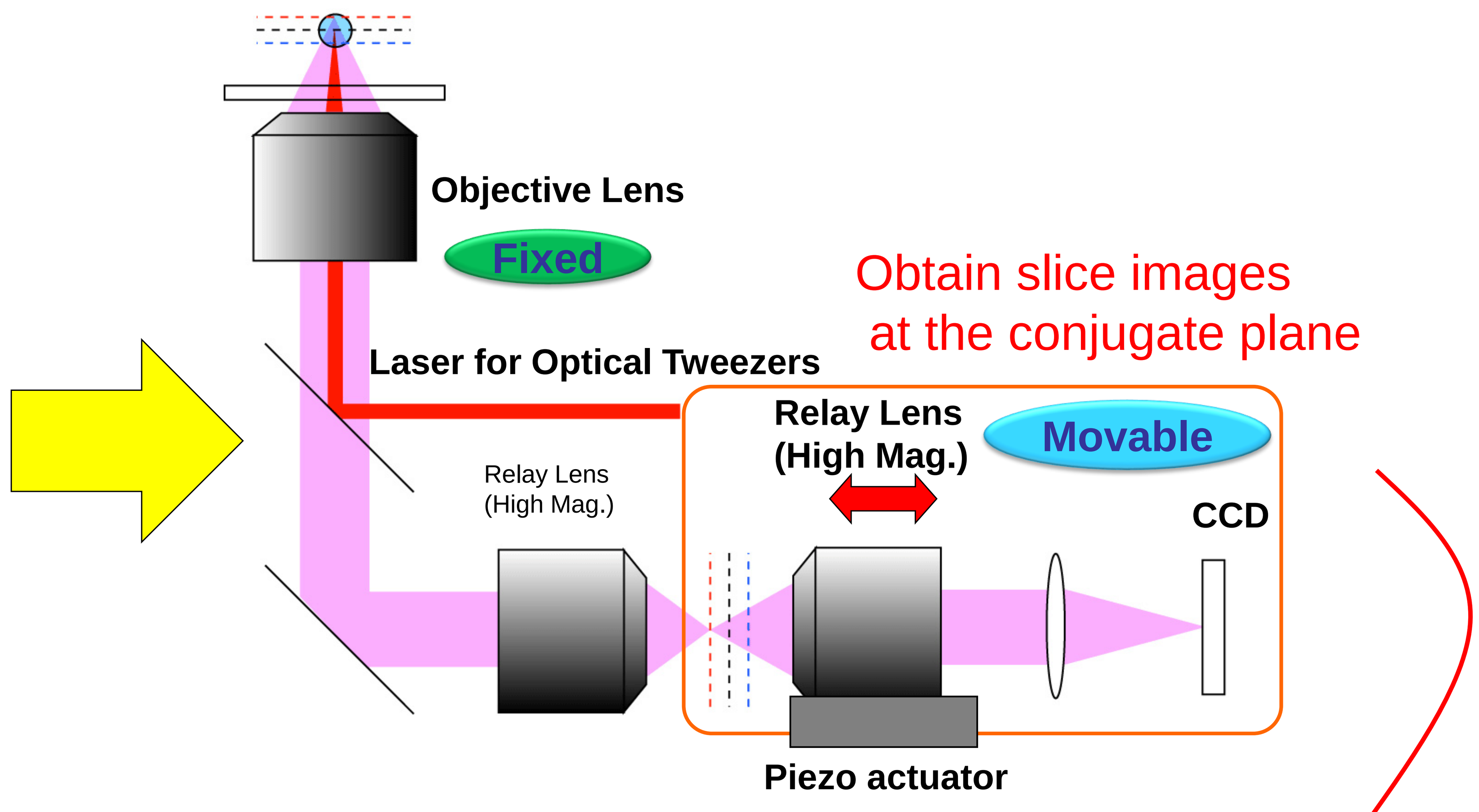
2. Key Features, Principle of the Invention

Issue of conventional 3D microscopy combined with optical tweezers



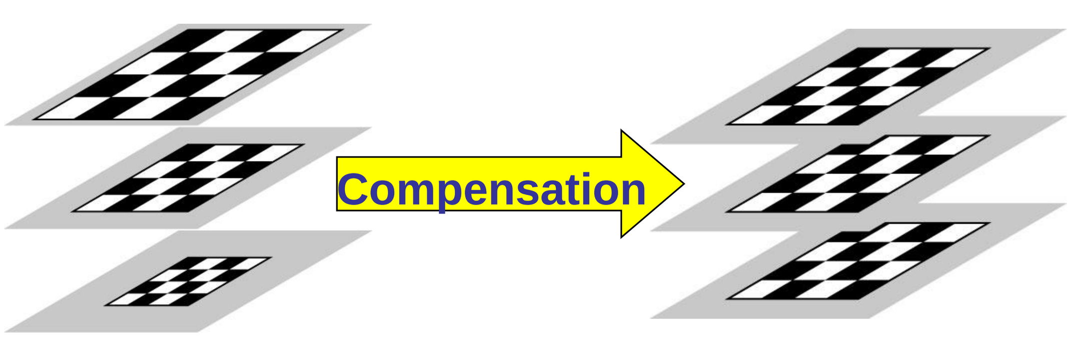
➔ Needs for 3D imaging system compatible with optical tweezers

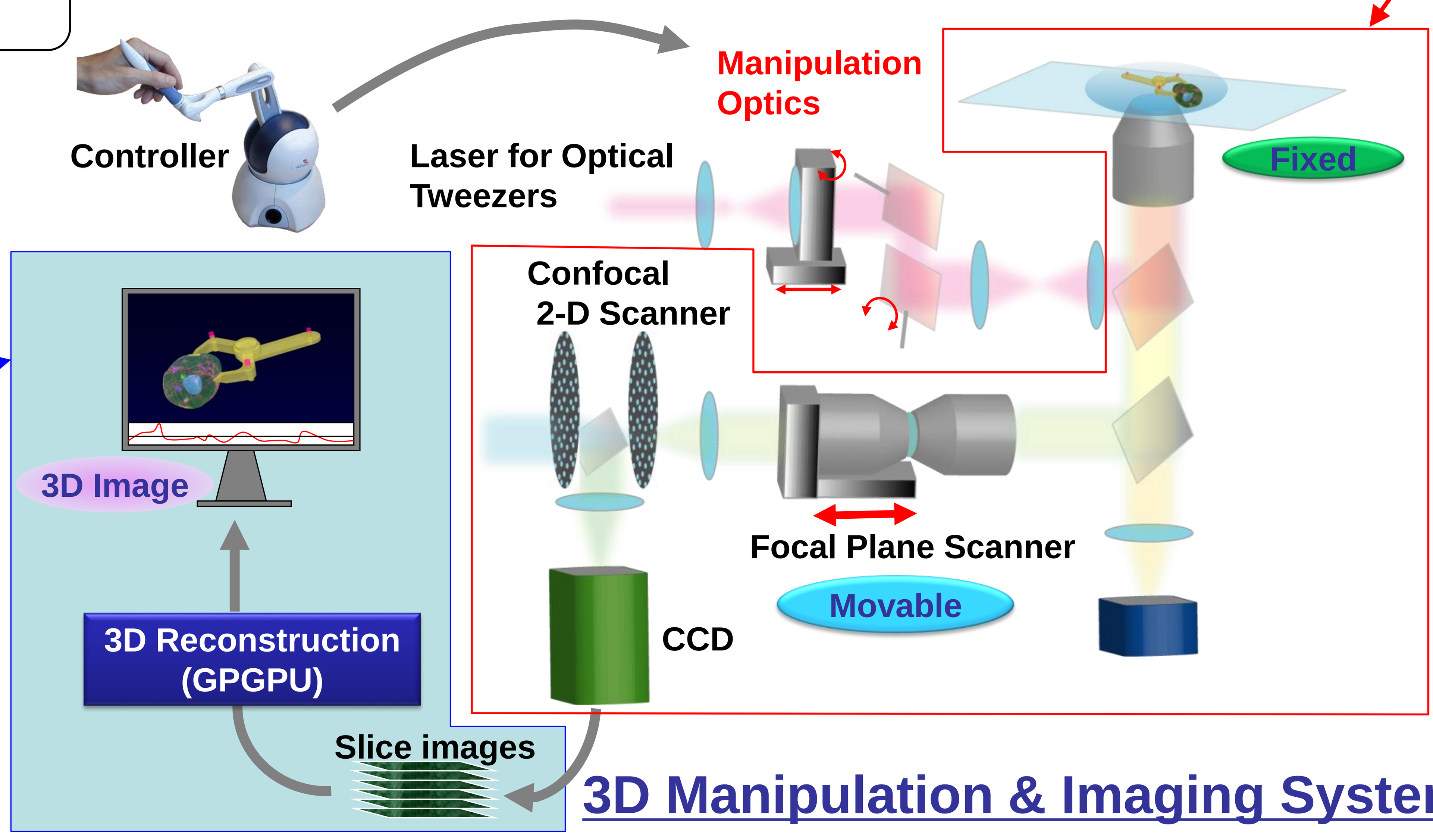
New 3D Imaging System for Optical Tweezers



Compensation of the Magnification Shift

Based on a relationship between the magnification and the position of the focal plane, GPU normalize the slice images, then reconstruct 3D images





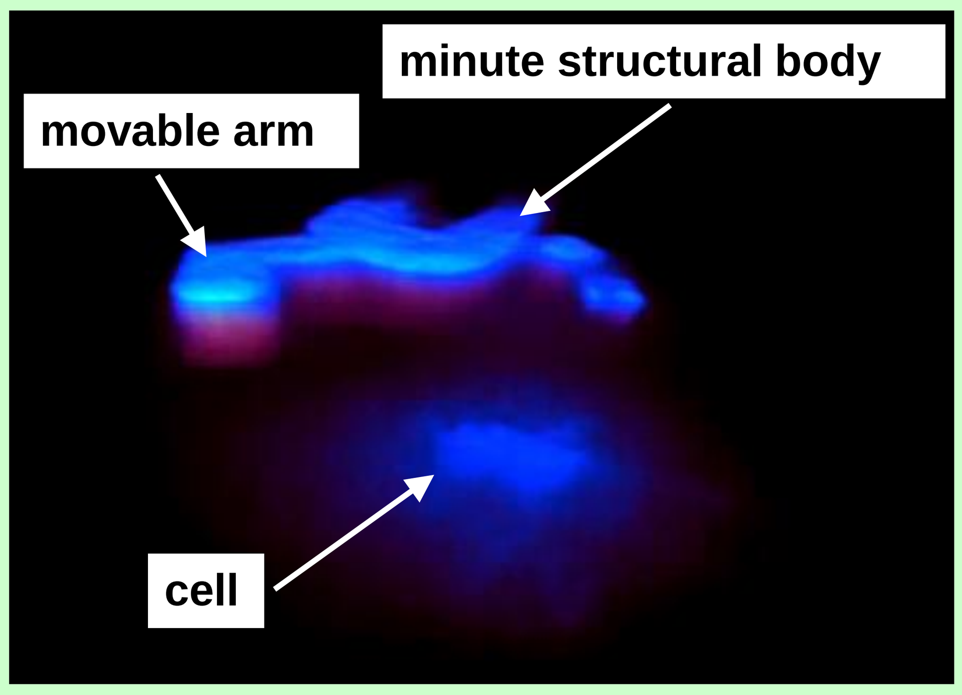
3D Manipulation & Imaging System

3. Example of Realtime 3D Imaging during Cell Manipulation

2D Image by Conventional System

➔Hard to grasp vertical positions

3D Image by this New 3D System



➔ 3D manipulation of cell by optical tweezers and 3D observation by confocal microscope are compatible

4. Application Examples

-Three-dimensional observation and manipulation of cells, DNA in life science field

5. Patent Licensing Available

Patent No.: WO2012/035903 Patent Family

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Micro-Stereolithography

Cytocompatible 3D Structure Fabrication Process for Micro-Stereolithography

Prof. Koji IKUTA (The University of Tokyo)

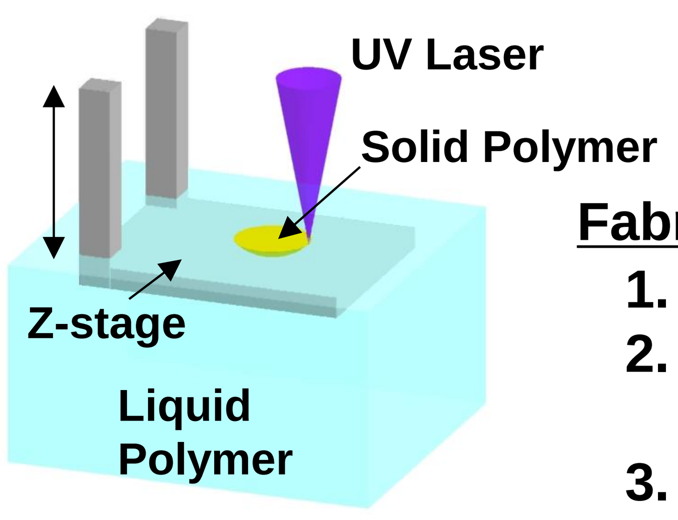
1. Introduction

A post-cure process applied for microstreolithography has been newly developed. The post-cure process realize to detoxify 3D structures made of a commercial photocurable polymer fabricated by microstreolithography.

This technology can be applied to the design of tailor-made implant devices, three-dimensionally configured cell devices and micro-chemical devices using microstereolithopraphy.

2. Application of 3D microstructure by Micro-Stereolithography to Biomedical Field

Microstreolithography



Fabrication process

1. Designed 3D objects by CAD
2. Converted X-Y planes scanning data
3. Scanned a X-Y plane of a 3D structure by UV laser
4. Layer by layer fabricated by Z-axis

Advantages:

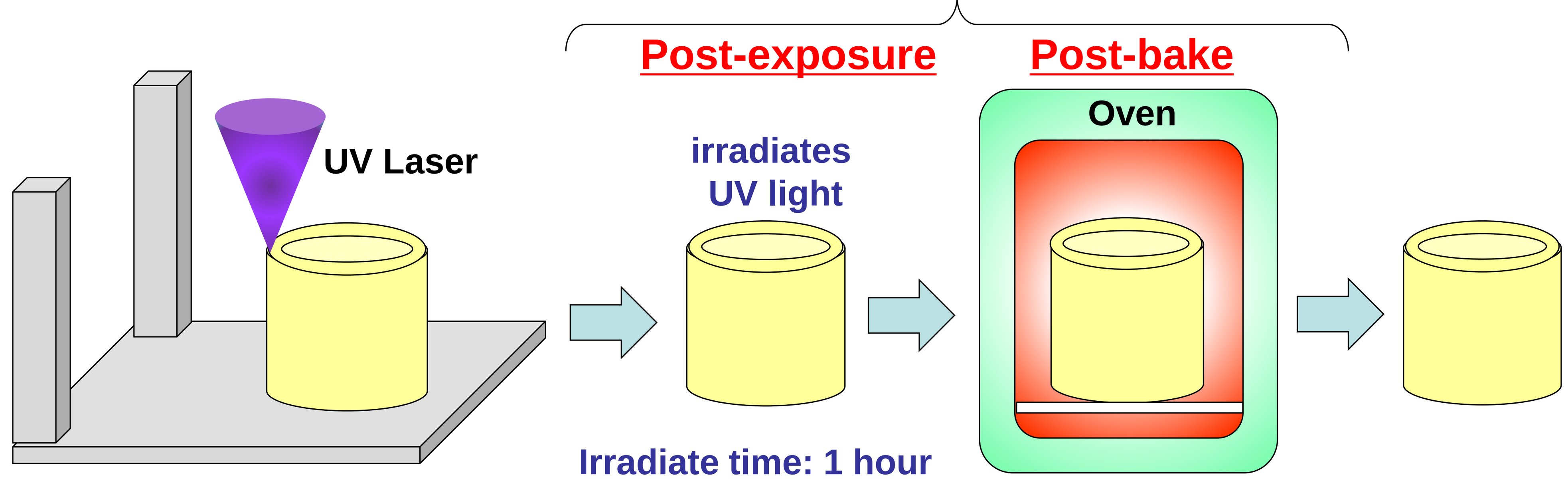
- -Real 3D-micro-fabrication
- -Fast fabrication
- -Manuacturing variety of products in small lots
- -sub-micron resolution

Problems:

Photocurable polymer used in conventional microstereolithography are not cytocompatible.

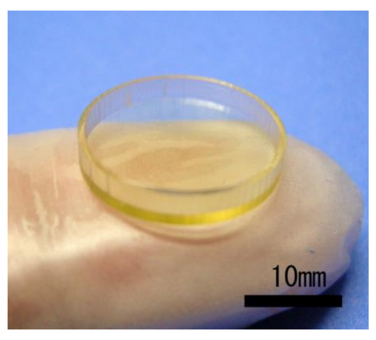
Post-cure process

We have developed new post-cure process to provide cytocompatibility to conventional photocurable polymer



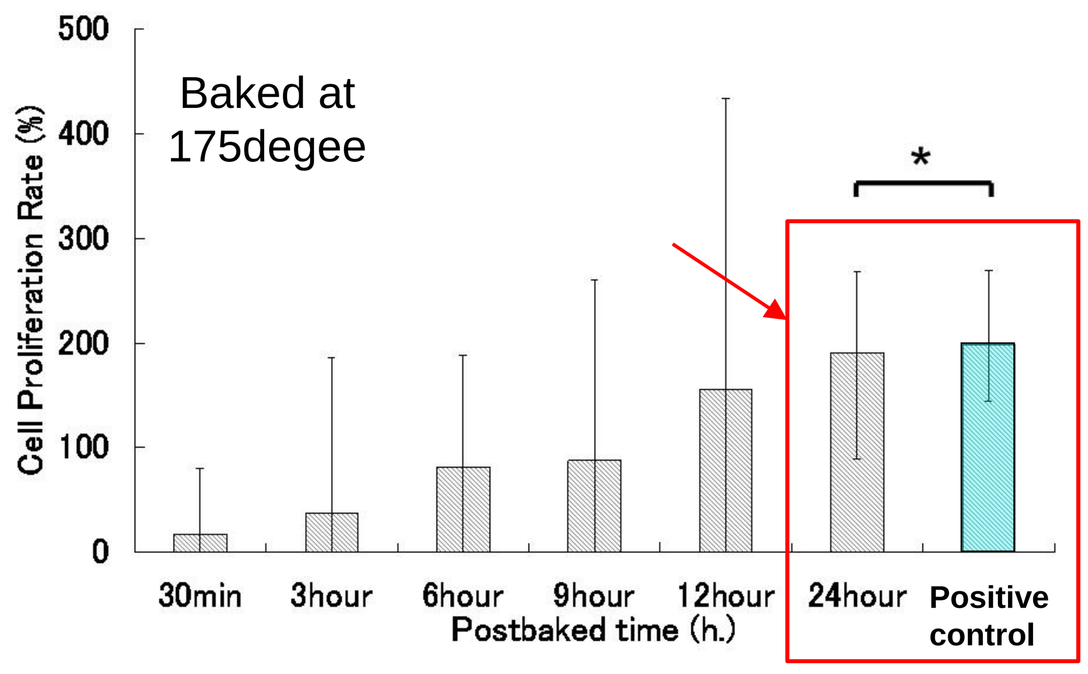
Promote polymerization after streolithography

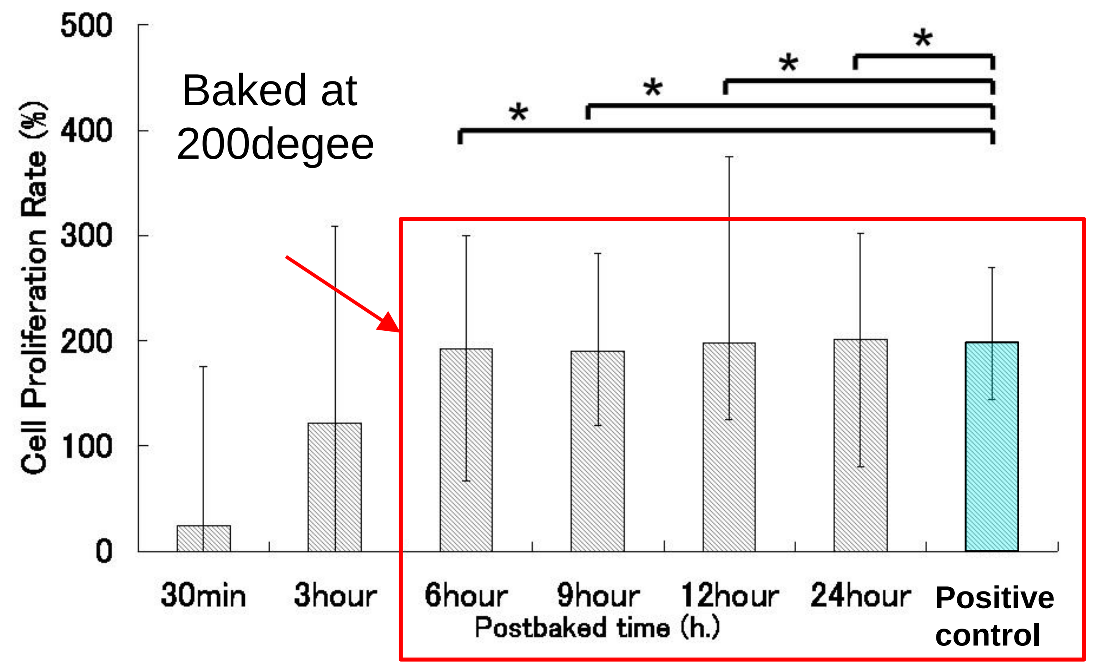
3. Post-bake Conditions and Evaluation



Outer diameter	15.0mm
Internal diameer	14.0mm
Height of wall	2.0mm
Bottom thickness	0.8mm

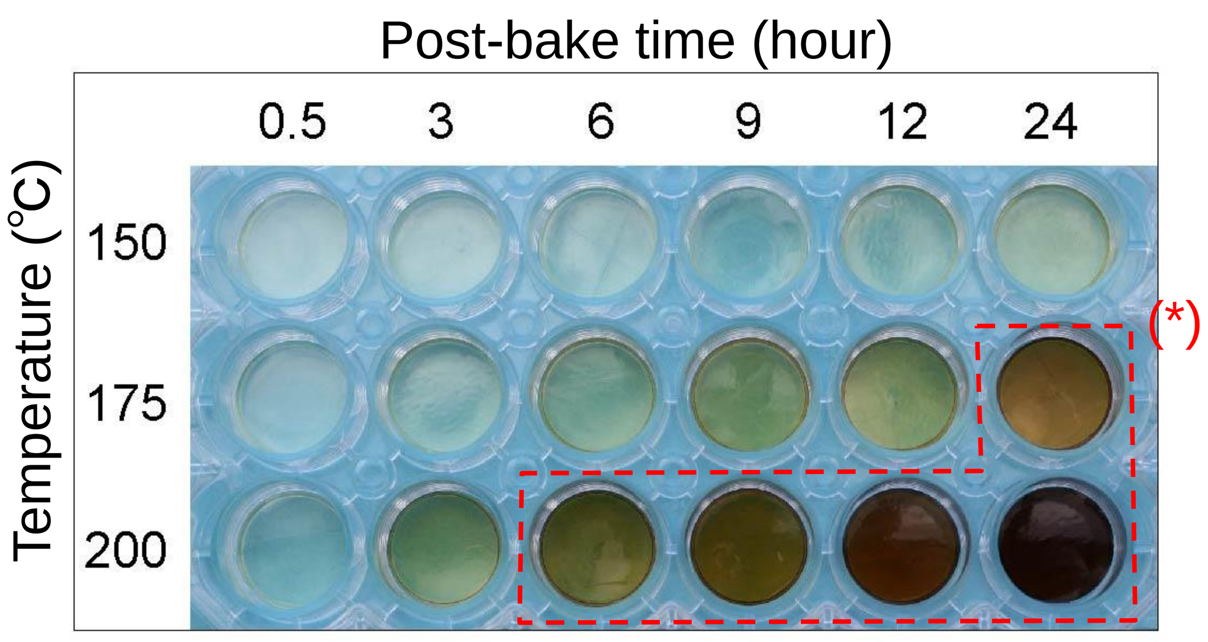
Cell culture dishes for Cytotoxic test





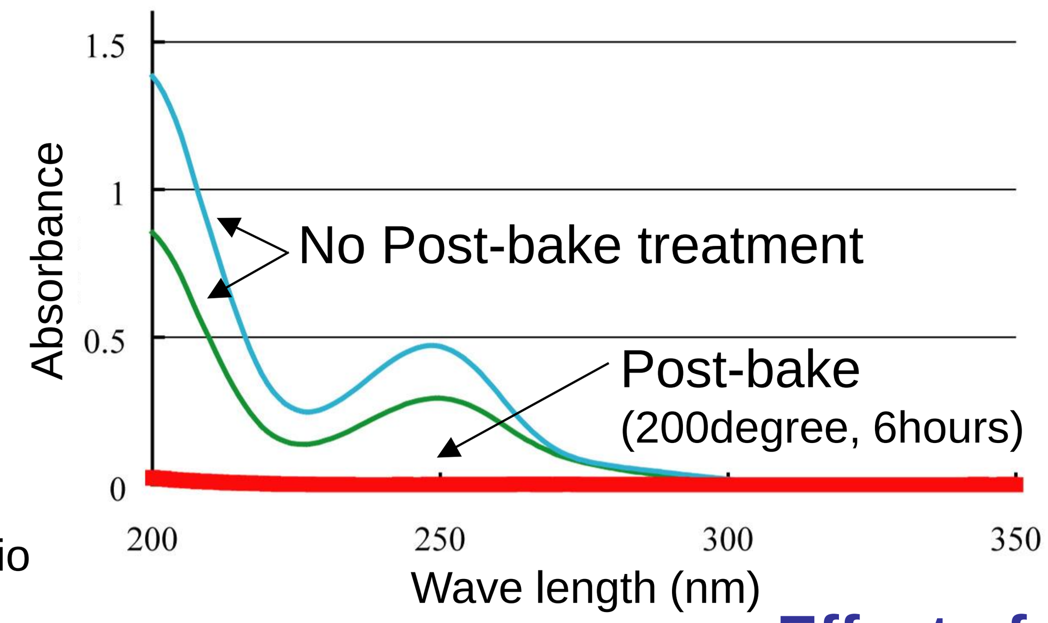
Cell culture test result

After "24h(at 175degree)" and "6h or more(at 200 degree)" of post-bake time made photo curable polymer cytocompatible were confirmed.



Cell culture dish after post-bake

(*) Though color of the cell culture dish gradually changed brown, it was keeping transparency required for observatio



Non-post-bake microstereolithographic objects:
-Two peaks of the spectra were found.
These peaks were of eluted substances.

The post-bake microstereolithographic objects:
-Eluted substance was not detected.

Effect of the post-bake treatment

4. Application Examples

- -Tailor-made implant devices
- -Three-dimensionally configured cell devices
- -Microchemical devices for cell application

5. Patent Licensing Available

Patent No.: WO2010/050604 Patent Family

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High-Temperature Superalloys

Cobalt-based High-Temperature Superalloys

Prof. Emeritus Kiyohito ISHIDA, Prof. Ryosuke KAINUMA
Prof. Toshihiro OMORI et al.(Tohoku University)

1. Background

- At power plants and aircraft industry, the thermal efficiency increases with increasing operation temperature. Therefore, the superalloys, which can resist high-temperatures, are strongly required.
- Both high manufacturability and high workability are demanded at the same time.
- In some applications, the wear resistance at high temperatures is also required.

2. Enhanced Creep Resistance of a New Co-Al-W Alloy

● Co-based alloys' properties as superalloys candidate (compared to Ni-based superalloys)

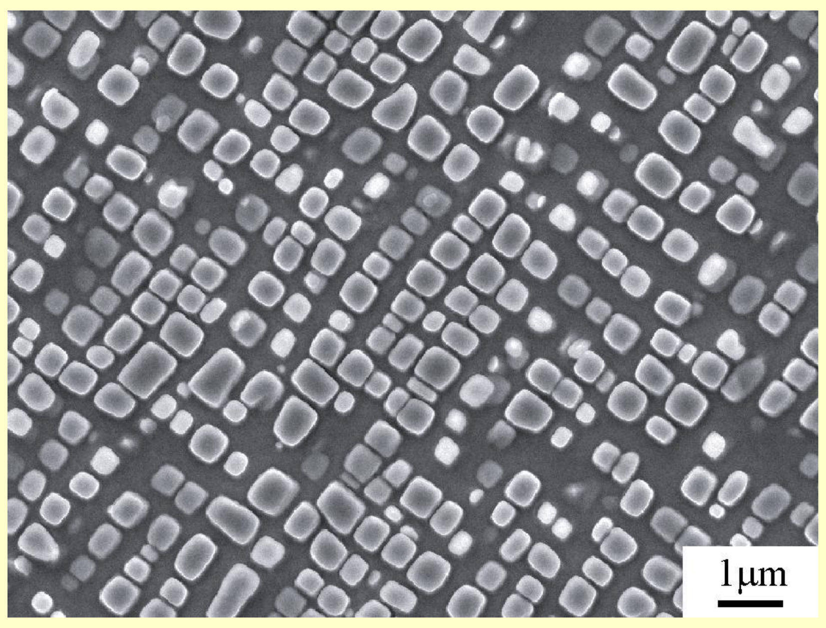
1) Higher melting point ･･･favorable
2) Lower strength ････ ･･･unfavorable

Precipitation hardening of matrix by ordered phase as in the case of Ni-based superalloys is necessary.

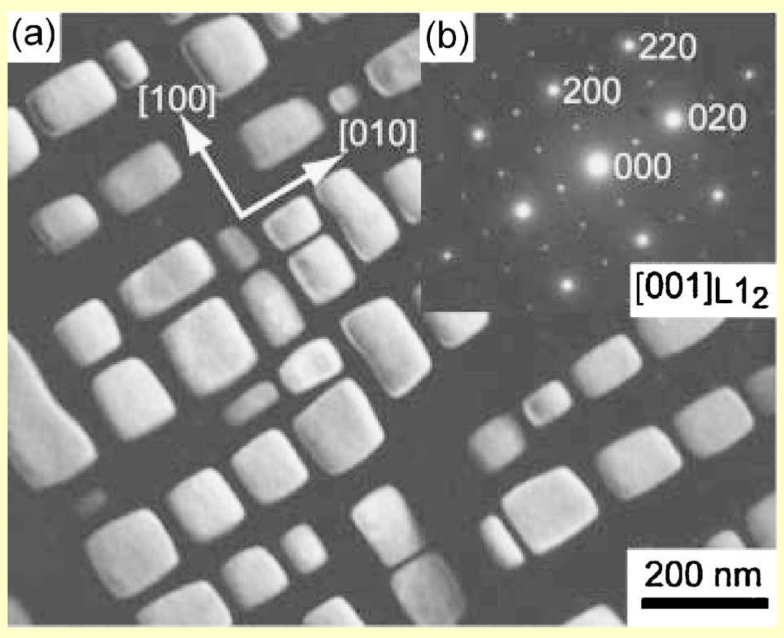
● γ+γ' phase in Co-Al-W was discovered

Base Element	Melting Point (K)	Superalloys	Crystal Structure of Superalloys	
Nickel (Ni)	1,728	Ni-Al-Ti	matrix	γ(FCC)
			Ordered phase	γ'(Ni_3(Al,Ti)) with $L1_2$ structure)
Cobalt (Co)	1,768	Co-Al-W (this study)	matrix	γ(FCC)
			Ordered phase	γ'(Co_3(Al,W) with $L1_2$ structure)

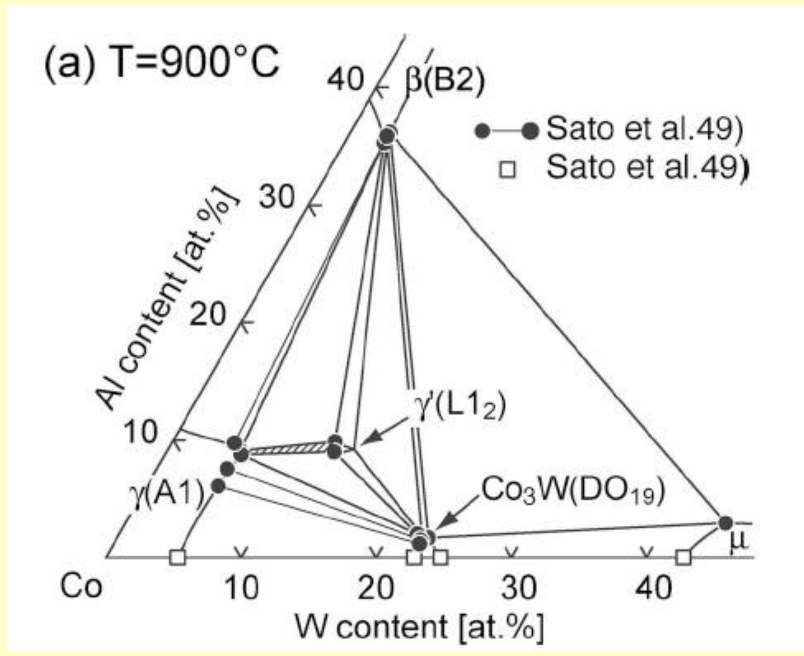
Co-Al-W superalloys



Phase of Newly developed Co-Al-W alloys

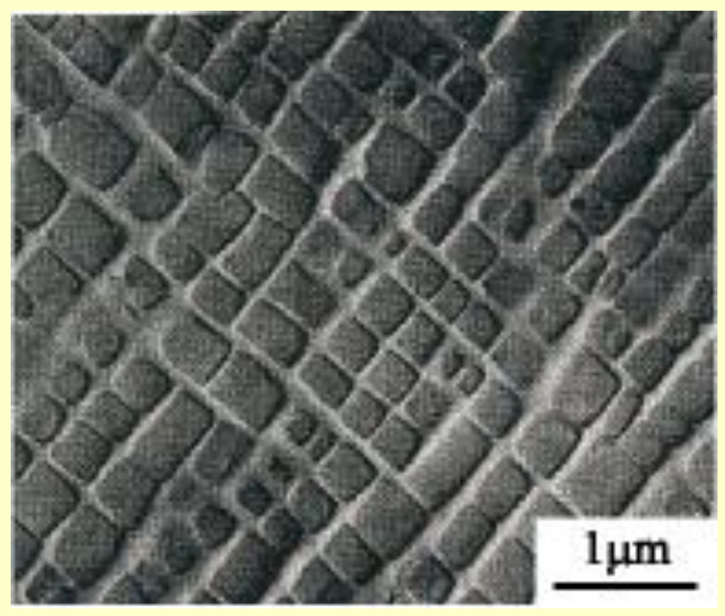


Precipitated phase was confirmed as γ' phase



Phase diagrams of the Co-Al-W ternary system

Ni-based superalloys



γ+γ' phase in Ni-based superalloys for comparison

3. Prospective Applications

- The **Wrought Alloys** by this technology, which has high creep resistance, are expected to be used widely i.e. turbine engine components, auto parts.
- The **Cast Alloys** by this technology, which also resist abrasions, are expected to be used at several machining fields i.e. FSW tool.

Wrought Alloys: application examples

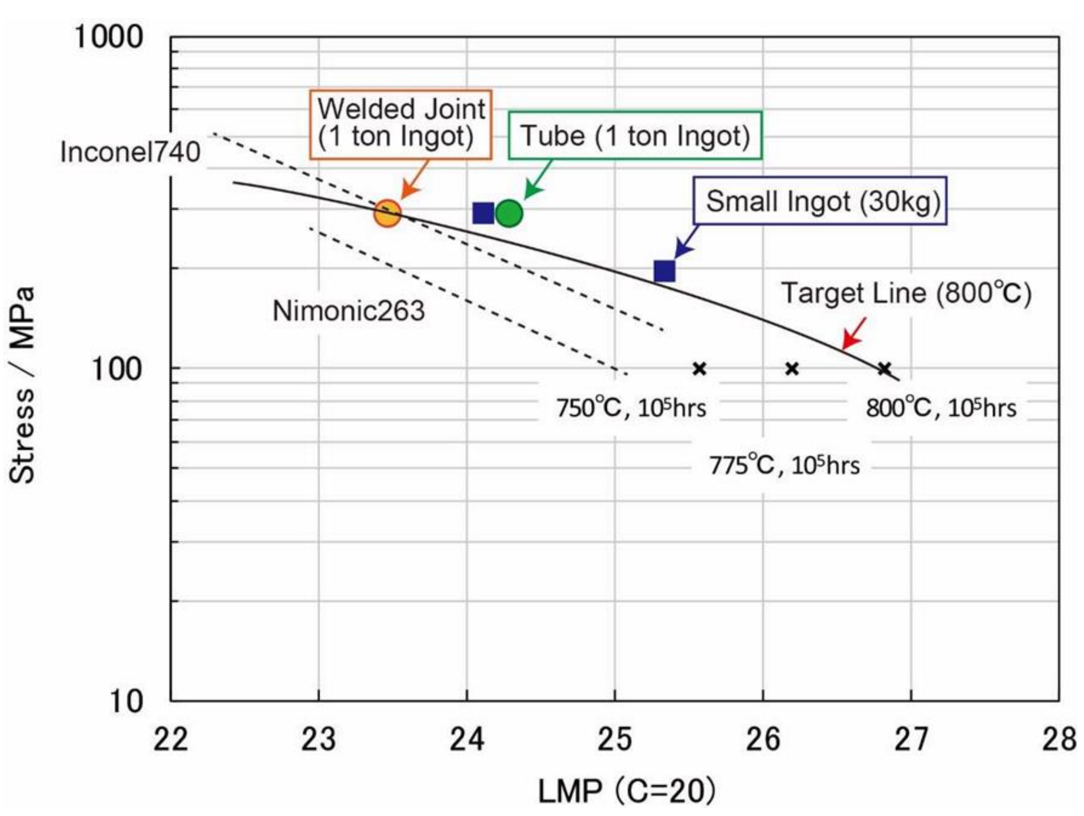


Fig.1 Creep Resistance Characteristics of A-USC(Advanced Ultra Super Critical) power generation material

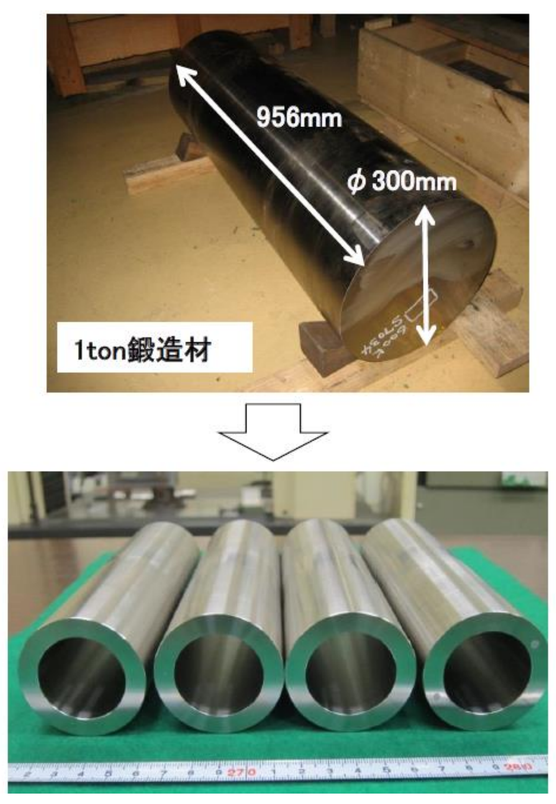


Fig.2 Boiler Tube made of A-USC power generation material

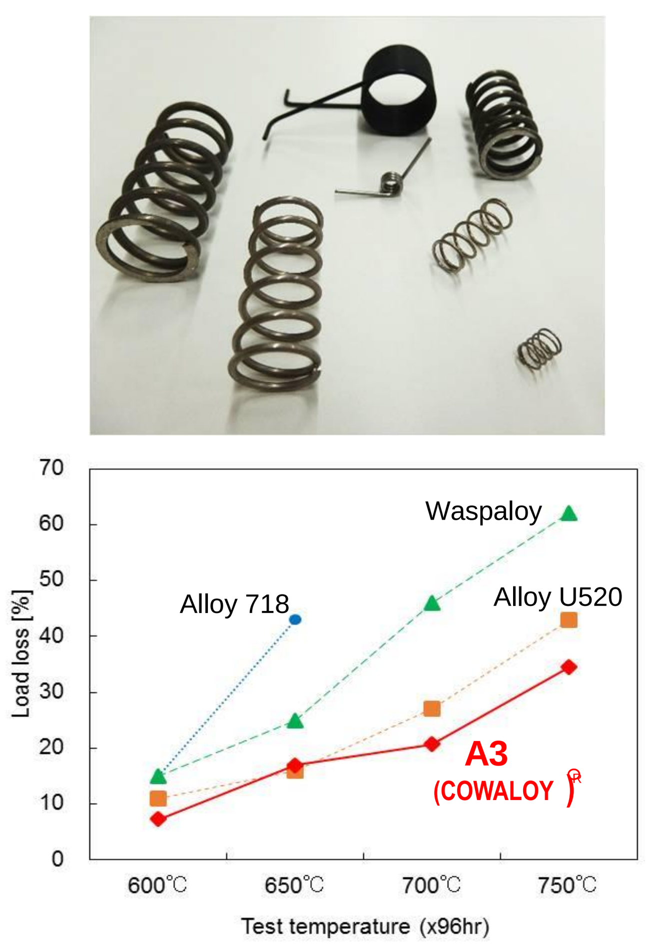


Fig.3 COWALOY® springs

Cast Alloys: application examples

Fig.4 Welded Sample (Two Ti plates are welded)

4. Patent Licensing Available

Patent No.: WO2007/032293, WO2007/091576 Patent Family

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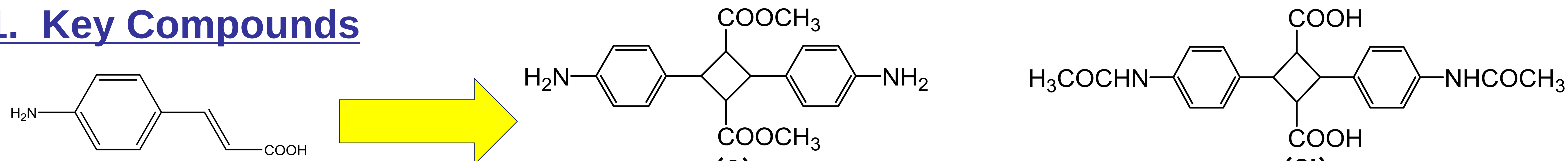
Superstrong & Transparent Films

Novel Polymer Films with Excellent Transparency, High Tensility, Good Heat Resistance

Prof. Tatsuo KANEKO (Japan Advanced Institute of Science and Technology)

1. Key Compounds



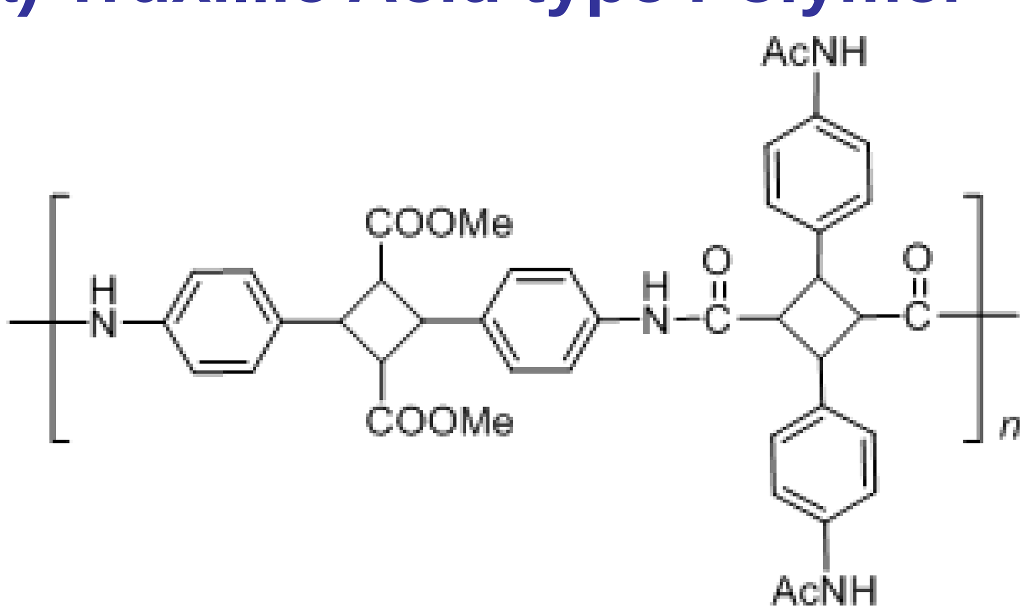
(1) (2) Truxillic Acid type monomers (2')

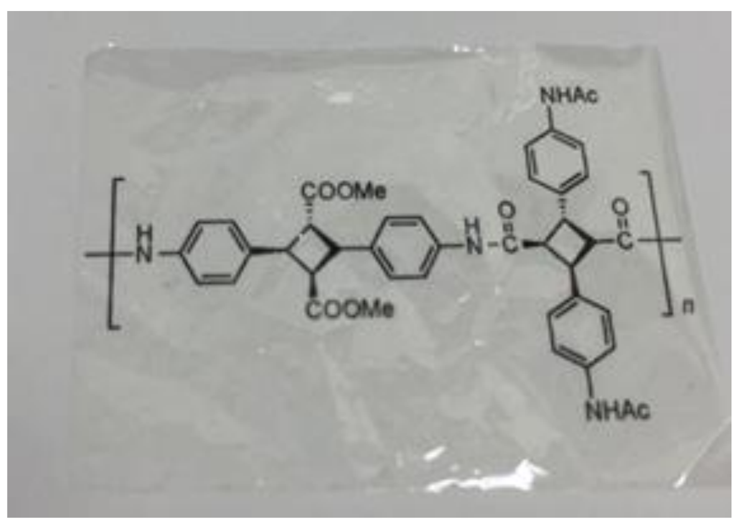
Superstrong and transparent bioplastics are generated from fermented microbial monomers.

— 4-aminocinnamic acid (1) was prepared from a biomass using recombinant bacteria.
— Diacid and diamino monomers that were both characterized by a rigid α-truxillate structure (2) (2') were generated by photochemical reaction.

2. Our Polymer Films —Excellent Transparency, High Tensility, Good heat resistance

(a) Truxillic Acid type Polymer

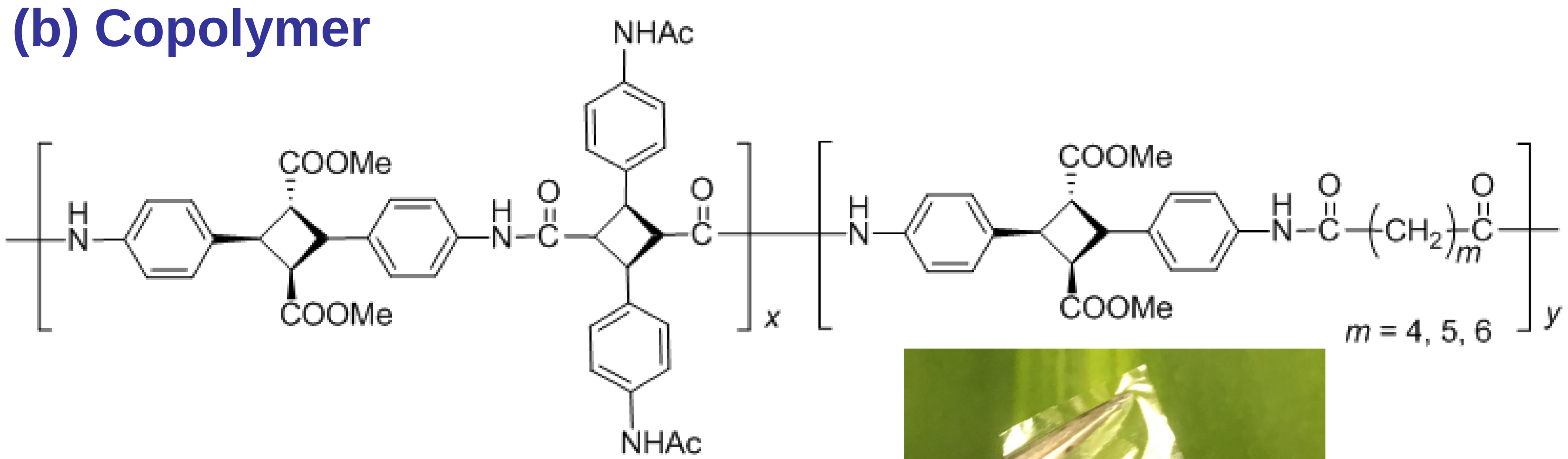




Glass transition temp	Tg = 273 ℃
10% weight loss temp	Td = 370 ℃
Young's modulus	*E* = 11.6 GPa
Maximum stress	σ = 356 Mpa
Transparency	93% (336nm)

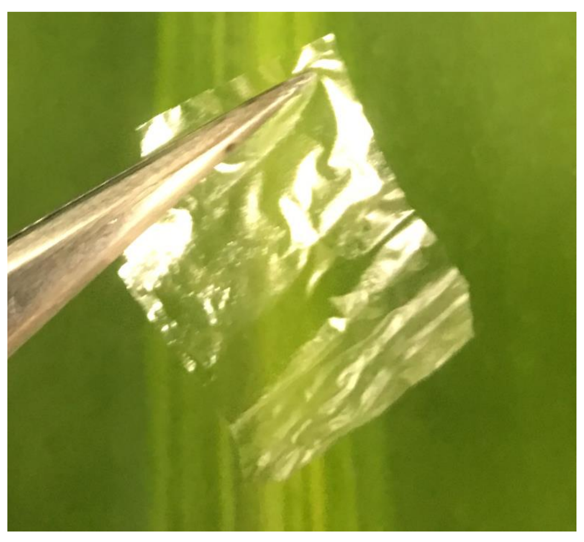
Highest thermomechanical properties as amorphous films

(b) Copolymer



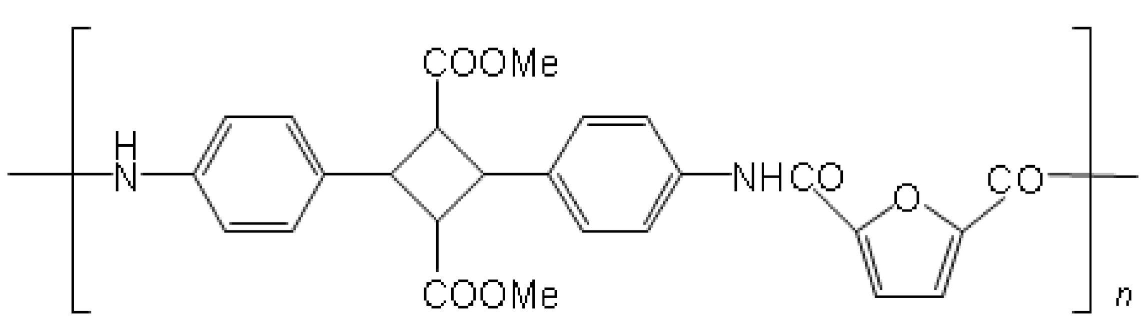
Glass transition temp	Tg = 243℃
10% weight loss temp	Td = 359 ℃
Young's modulus	*E* = 12.1 GPa
Maximum stress	σ = 407 Mpa
Transparency	87% (373nm)

＊High-tensil steel (σ ≒ 400 Mpa)
＊Pure iron (σ ≒ 250 Mpa)



Equivalent strength as high-tensil steel

(c) Furan diacid type polymer



Glass transition temp	Tg = 198℃
10% weight loss temp	Td = 355 ℃
Young's modulus	*E* = 8.0 GPa
Maximum stress	σ = 163 Mpa
Transparency	81% (391nm)

3. Prospective Applications

Our excellent transparent, high tensile, good heat resistance polymers use as…
・glass substitute material
・body materials of automobile and aircraft

4. Patent Licensing Available

Patent No.: WO2013/073519 Patent Family

(Contact) JST/ IP Management and Licensing Group
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Novel Alloy replaces "rhodium(Rh)"

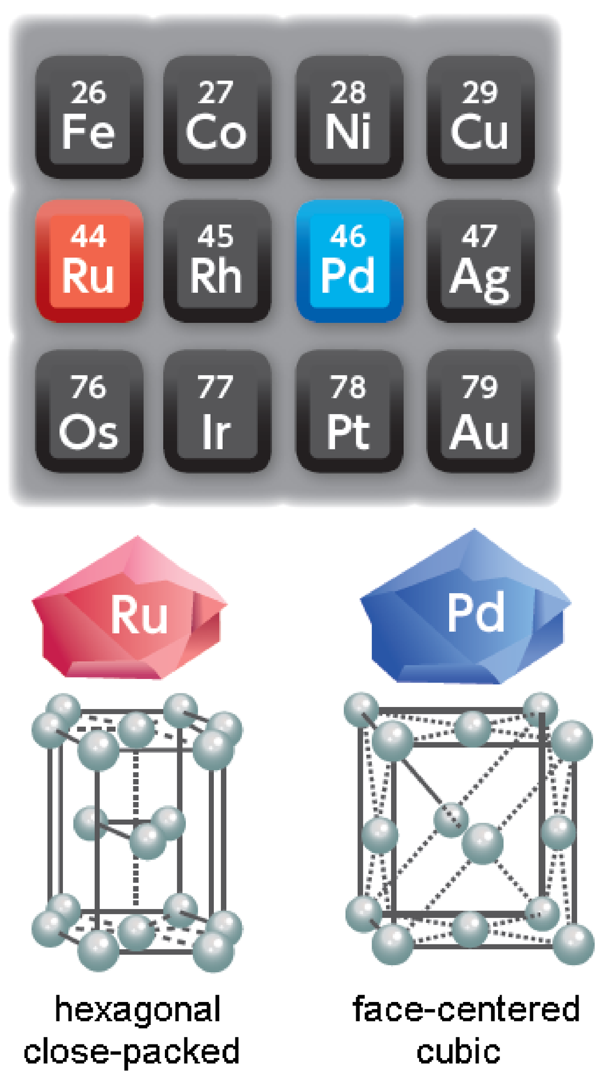
New "PdRu Nano-Alloy Material" created by Inter-Element-Fusion technology

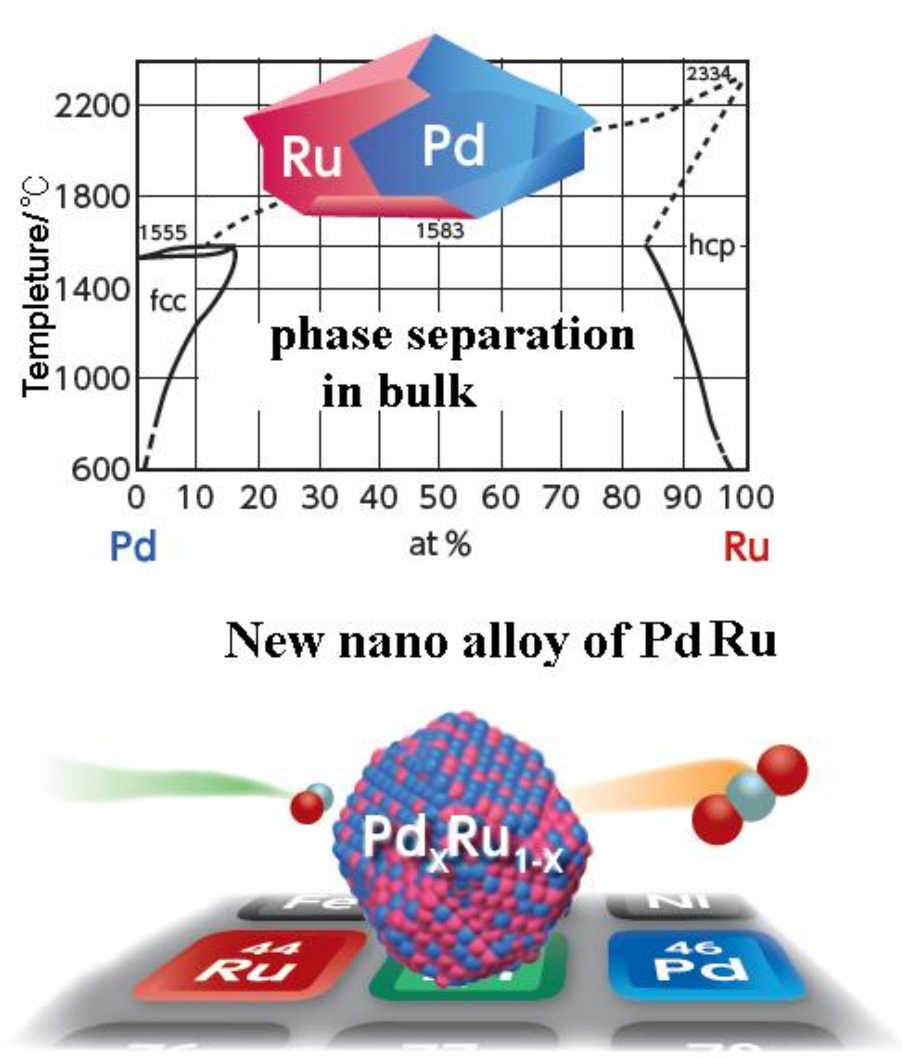
Prof. Hiroshi KITAGAWA (Kyoto University)

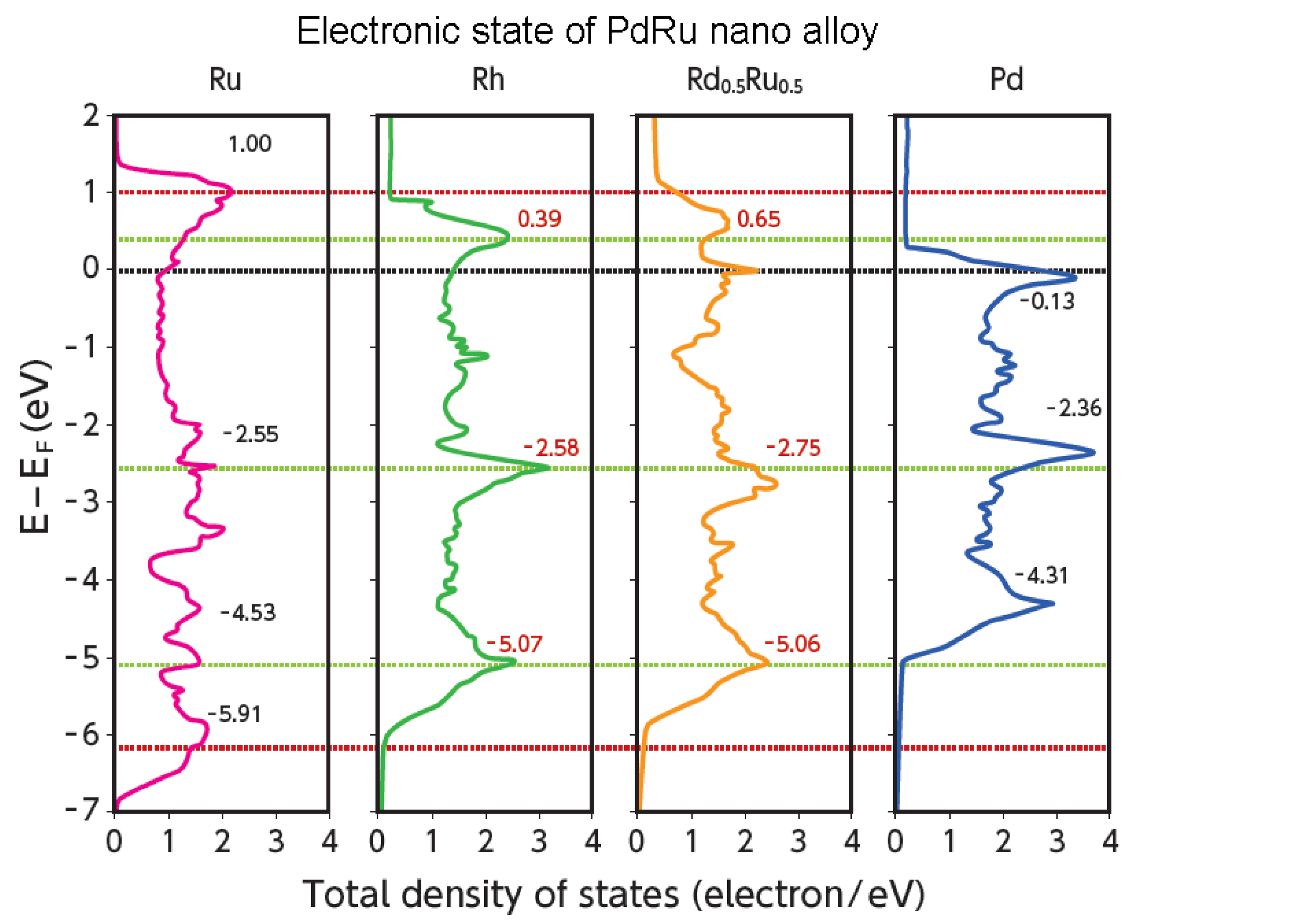
1. New "PdRu Nano-Alloy Material" having the "Rh" properties

◆The Nano-Alloy Material is created by the "Inter-Element-Fusion technology" to mix at the atomic level palladium (Pd) and ruthenium (Ru).

◆The Nano-Alloy Material has superior properties than natural rhodium (Rh). i.e. catalytic activities, lower reaction proceeding temperatures





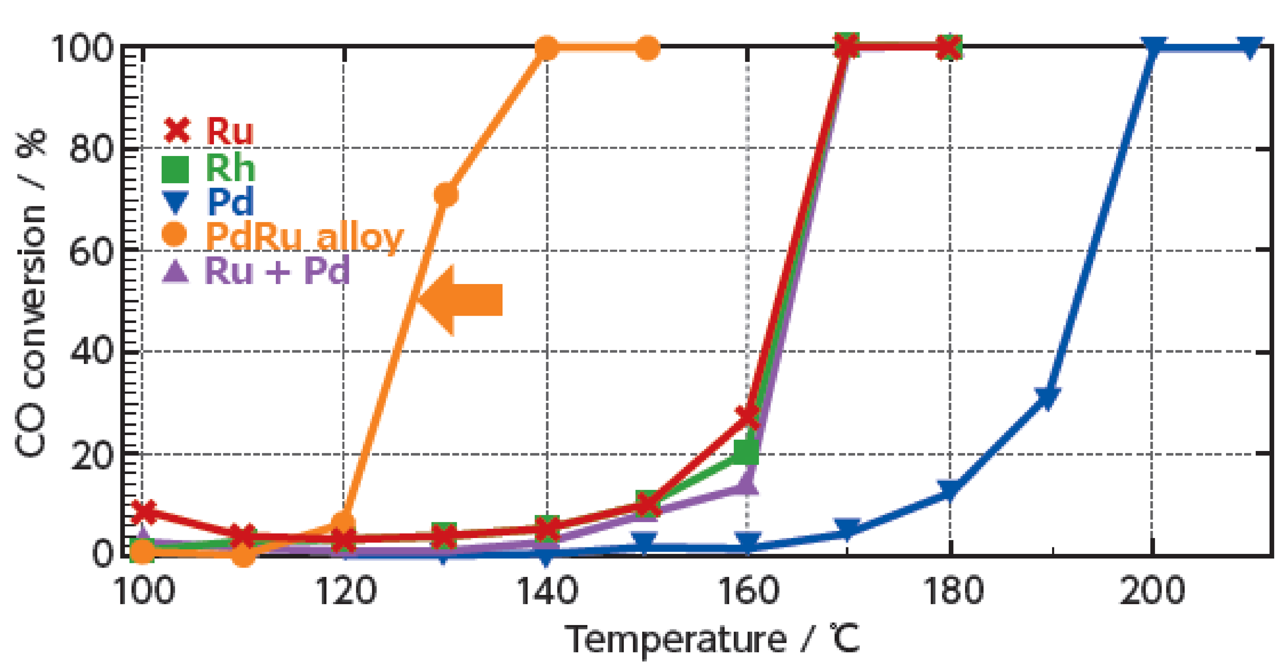


The tables show the electronic state patterns of Ru, Rh, the new "PdRu Nano-Alloy Material" and Pd (from the left to the right).

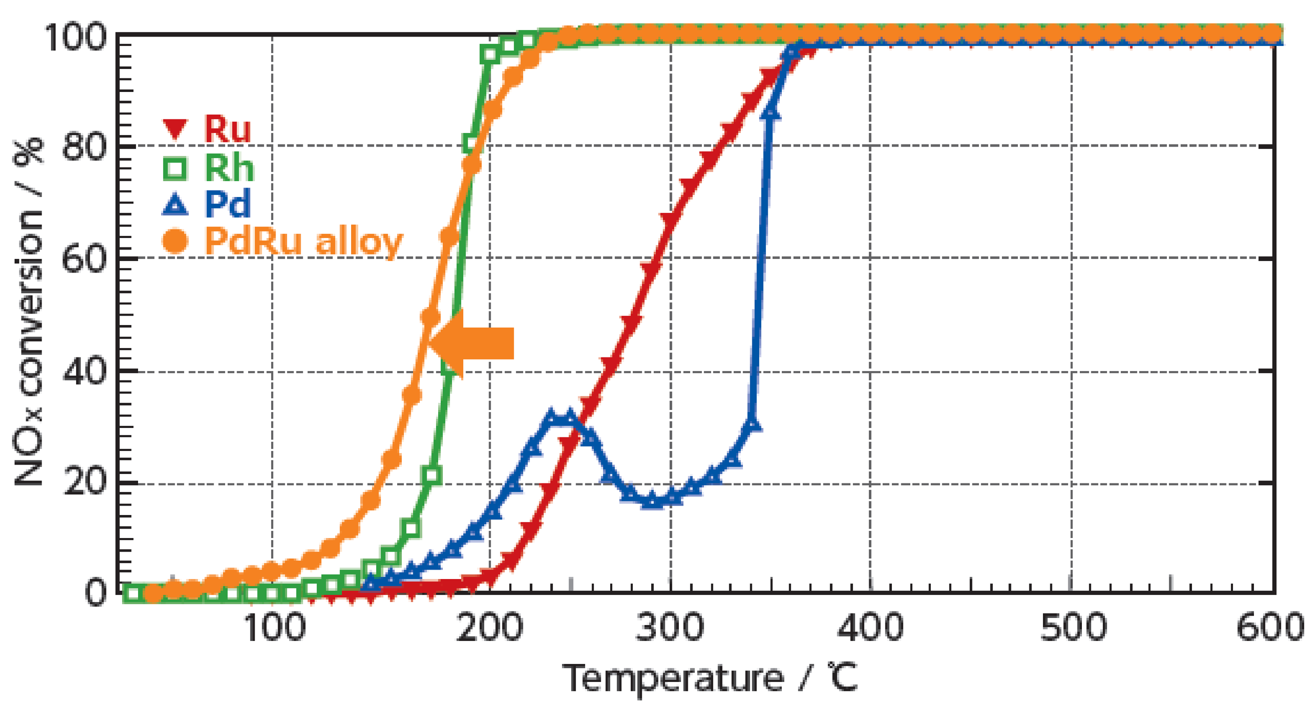
The electronic state pattern of the new "PdRu Nano-Alloy Material" is very much similar to the pattern of Rh.

2. New "PdRu Nano-Alloy Material" used for Exhaust Gas Catalyst

◆CO oxidation reaction

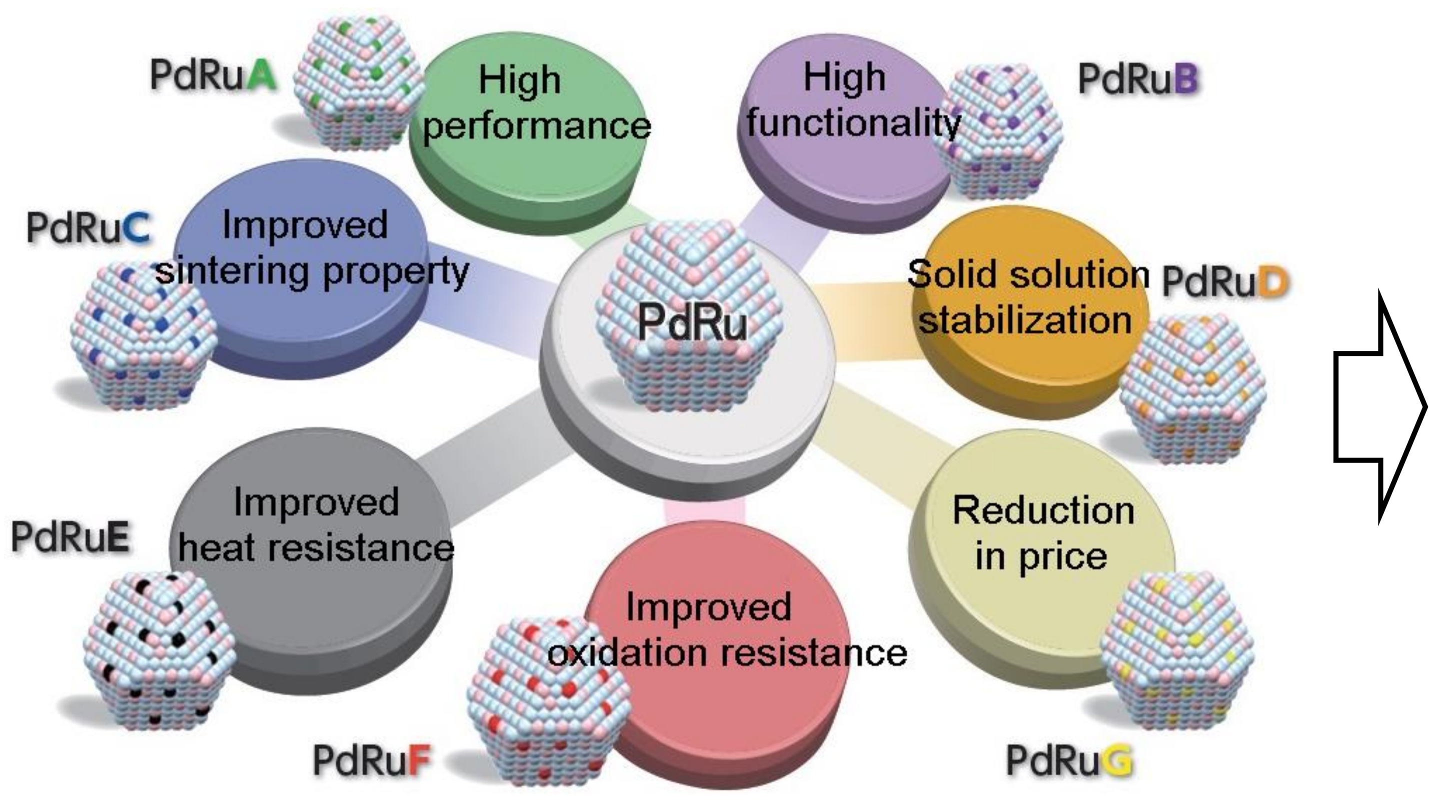


◆NOx reduction reaction

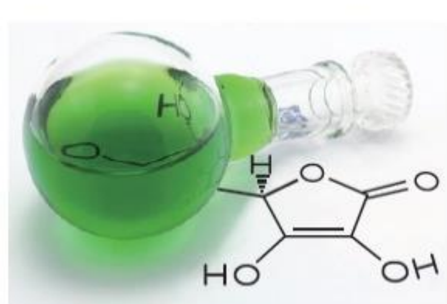


The New "PdRu" Nano-Alloy Material is now available to the market by Furuya Metal Co., LTD.

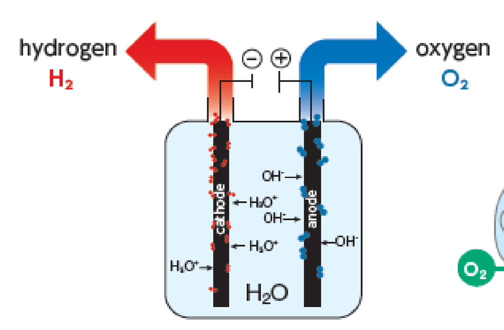
3. Great Potential of various new materials and their applications



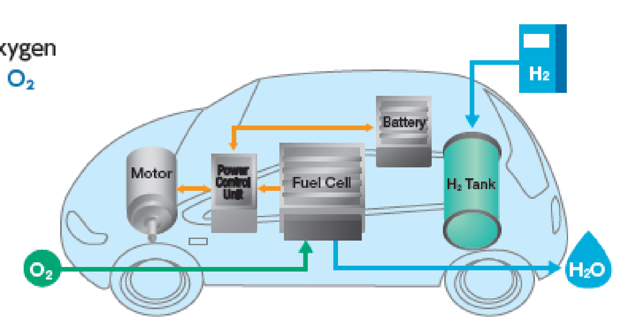
◆Chemical catalyst



◆Water electrolysis catalyst



◆FC catalyst



4. Patent Licensing Available

Patent No.: WO2014/045570 Patent Family

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About JST

The Japan Science and Technology Agency (JST) is one of the core institutions responsible for the implementation of science and technology policy in Japan, including the government's Science and Technology Basic Plan. From knowledge creation—the wellspring of innovation—to ensuring that the fruits of research are shared with society and Japan's citizens, JST undertakes its mission in a comprehensive manner. JST also works to provide a sound infrastructure of science and technology information and raise awareness and understanding of science and technology-related issues in Japan.

Mission :
We contribute to the creation of innovation in science and technology as the core implementing agency of the fourth phase of the Science and Technology Basic Plan.

Visions :
1. To achieve innovation in science and technology through creative research and development.
2. To maximize research outcomes by managing research resources on the virtual network.
3. To develop the nation's infrastructure for science and technology to accelerate innovation in science and technology.

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