

# Financial Results Q2 FY24/3

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Microwave **Chemical**

**Make Wave,  
Make World.**

世界が知らない世界をつくれ

# Executive Summary

1

FY24/3 Q2 results are on track to FY target

- FY24/3 Q2, **Sales JPY238MM ((30.3)% YoY)**
- 12.9% progress rate for FY24/3 plan (JPY1,846MM). As our **revenue recognition would be biased toward the second half, we expect to achieve FY target.**
- **Progress rate on contract basis is 88.6% (JPY1,636MM).**

2

Steady progress made in KPI:

- (1) # of new contracts
- (2) # of total contracts
- (3) sales by phase

- Acquired 16 new contracts, **57.1% progress** of FY24/3 target (28 contracts).
- Total 44 contracts signed, **67.7% progress** of FY24/3 target (65 contracts).
- **Sales from Phase 2 contracts exceeded JPY1.2Bn.**

3

Advancement in green market business

- Launched joint development of innovative naphtha cracking technology, "M-Cracker", using microwave heating (Partner: **Chiyoda Corporation** and **Mitsui Chemicals, Inc.**)
- Launched joint development of microwave process application in elastomer manufacturing (Partner: **Zeon Corporation**)
- Launched joint development of nickel smelting and refining technology using microwaves (Partner: **Pacific Metals Co., Ltd.**)



# Agenda

1. Company Overview
2. Financial Results and KPI Highlights
3. Topics
4. Appendix



**【Mission】**

**Make Wave, Make World**

**【Vision】**

**Innovate chemical industry, which has been left unchanged for more than a century,  
and revolutionize the world of manufacturing**

**-Making the microwave process a global standard-**



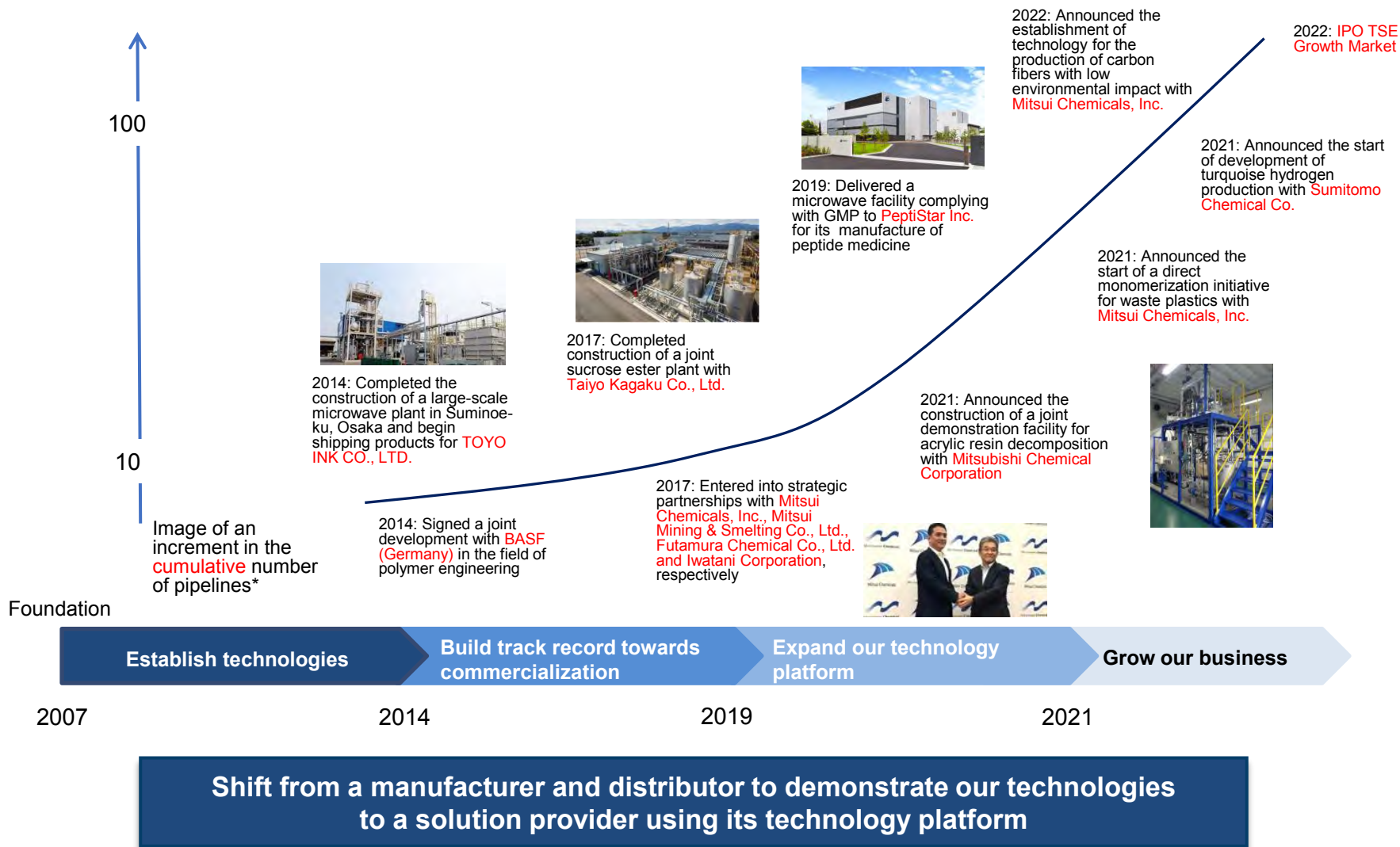
# Company Overview



<b>Name</b>	Microwave Chemical Co., Ltd.
<b>Founded</b>	August 15, 2007
<b>Representative</b>	Iwao Yoshino, CEO
<b># of Employees</b>	64 (including 13 Ph.D.)(1)
<b>Head Office</b>	Photonics Center 5F, 2-1 Yamadaoka, Suita, 565-0871 Osaka
<b>Business</b>	Provide R&D and engineering solutions for clients based on our microwave technology platform

(1) As of March 31, 2023

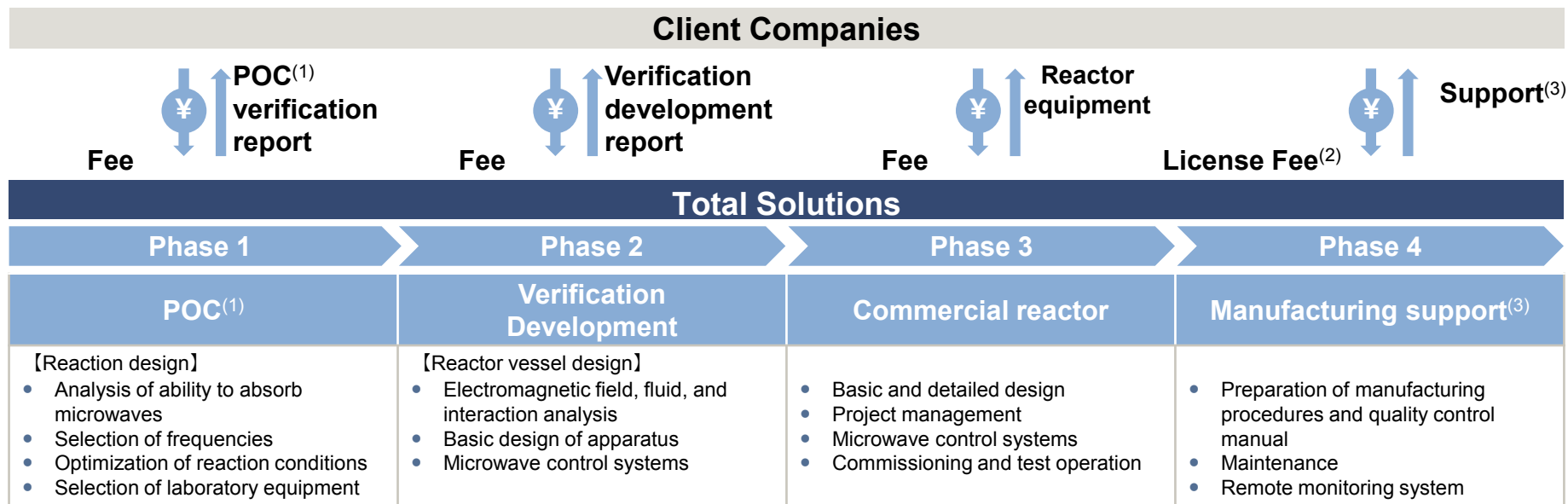
# Corporate History



\* The Pipelines refer to development projects in Phase 1 (lab development), Phase 2 (demonstration development), Phase 3 (commercial reactor introduction), or Phase 4 (manufacturing support)

# Business Model

- (1) Provide total solutions from R&D to engineering
- (2) Realize profit on each phase and license fee when commercialized by our clients



**Notes:**

- (1) POC: Proof of Concept. The process of testing the feasibility and effectiveness of new concept or idea before actual development
- (2) License: Share the client value earned by introduction of microwave process as license fees. Specifically, receive as upfront payment and recurring royalties
- (3) Manufacturing support and maintenance: Support clients who have installed microwave reactors in their manufacturing process. In addition, provide maintenance of microwave reactors and other facilities



# Growth Strategy

Focus and advance investment for growth from FY25/3 onwards.

## Business Model



## Focus Areas

# of  
Contracts



Unit Price



Project Phase  
Development



Packaged  
Solution

### 1 Acquisition of high-quality contracts

- Targeting # of new contracts to be comparable to that in FY23/3.
- Rather than simply pursuing quantity, will **focus on high-quality inquiries that lead to large-scale projects.**

### 2 Enhance certainty of project phase development by strengthening technology platform

- **Improvement of efficiency and profitability** by strengthening our technology platforms focusing on areas with technological superiority and market demand.

### 3 Standardization

- Acceleration of existing standardization procedures (e.g. chemical recycling, freeze-drying) and launch of new standardized business

### 4 Focus on growth areas

- Form projects on green business area.
- Accelerate growth by **active investments in the carbon-neutral field.**

Green business

Healthcare  
(drug, food, etc.)

Electronics  
(electronic materials)



# 4 Our Vision toward Carbon Neutral

We will expand our business by committing to carbon neutrality of various industries.

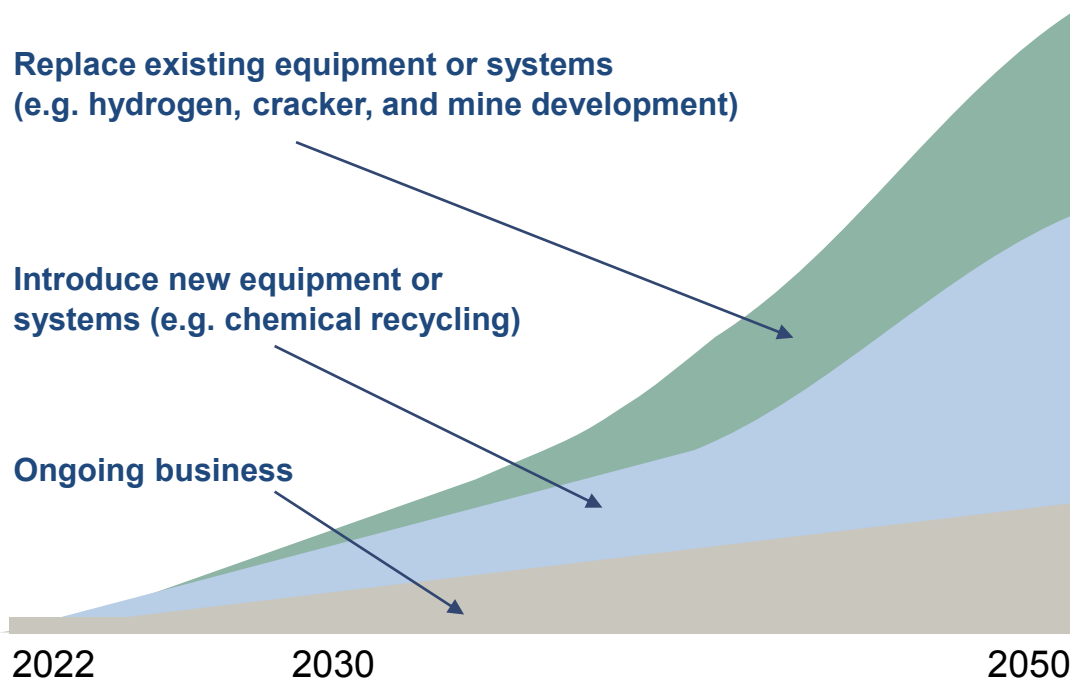
## Our Growth Image

- For heavy industries, average lifetimes of plant equipment is around 40 years, and 30% of existing assets are expected to be renovated within the next 10 years.<sup>(1)</sup>
- Generally, it takes c.10 years for new technologies to become commercially viable. In order to achieve carbon neutral, we need to start development "now".

Replace existing equipment or systems  
(e.g. hydrogen, cracker, and mine development)

Introduce new equipment or  
systems (e.g. chemical recycling)

Ongoing business



(1) Net Zero by 2050 A Road Map for the Global Energy Sector IEA May 2021

## Active Solutions for Decarbonization

- **Electrification of the chemical industry**
  - Electrification of crackers
  - Other processes
- **Energy**
  - Turquoise hydrogen
  - Ammonia
  - Nuclear fusion
- **Raw materials**
  - Chemical recycling
  - Biomass
- **Carbon Fixation**
  - CCUS
- **Mobility**
  - Battery-related material (cathode, etc.)
  - Carbon Fiber/CFRP
  - Lithium and rare earth (mining process)



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# FY24/3 Budget & FY23/3 Results

Net sales target JPY1,846MM, operating profit JPY40MM.

(JPYMM)

		FY23/3 Full-year (result)	FY24/3 Full-year (budget)	YoY comparison	
Net sales		1,215	1,846	+631	+51.9%
	Phase 1	567	559	(8)	(1.4)%
	Phase 2	593	1,284	+690	+116.3%
	Phase 3	35	—	(35)	(100)%
	Phase 4	—	—	—	-
	Others	19	3	(16)	(84.4)%
Operating profit		59	40	(19)	(32)%
Ordinary profit		26	33	+7	+27.8%
Net Profit		75	89	+14	+18.9%

\*The estimated amount of corporate tax adjustment is zero yen.



# Financial Results for FY24/3 Q2

YoY sales comparison (30.3)%.

(Unit : JPYMM)

	FY23/3 Q2 total	FY24/3 Q2 total	YoY comparison	
Net sales	342	238	(103)	(30.3)%
Phase 1	139	148	+9	+6.5%
Phase 2	167	90	(77)	(46.3)%
Phase 3	35	—	(35)	(100)%
Phase 4	—	—	—	-
Others	0	—	(0)	(100)%
Operating profit	(72)	(262)	(190)	-
Ordinary profit	(103)	(263)	(159)	-
Net Profit	(105)	(288)	(183)	-

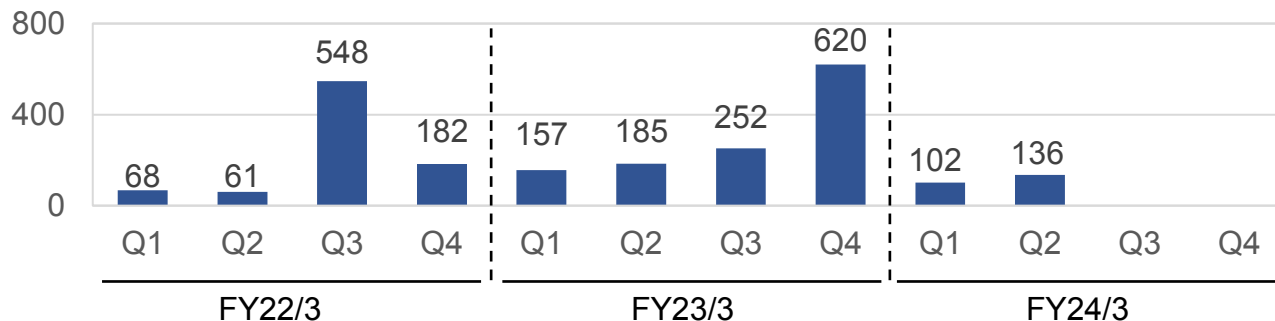


# Seasonal Fluctuations / Revenue Recognition

## Seasonal Fluctuations

- Our major clients, chemical companies, finalize budgets by March, just before the start of the new fiscal year, so projects with MWCC often begin in the first or second quarter. As a result, the completion of the contracts, in which **our company's revenues are recorded, tends to be biased toward the second half of the year.** There is also an impact from the completion timing of large-scale projects.
- In addition, as the majority of SG&A expenses are fixed costs, the proportion of profits also tends to be weighted toward the second half of the year, which would affect investors' decisions.

## Quarterly Net Sales (JPYMM)



## Revenue Recognition

The following is a description of the main performance obligations in the Company's main business related to revenues arising from contracts with clients and the usual time at which such performance obligations are met. Payment is made generally within one month after obligation is fulfilled and does not include financial component.

### (1) Joint development agreement(JDA)

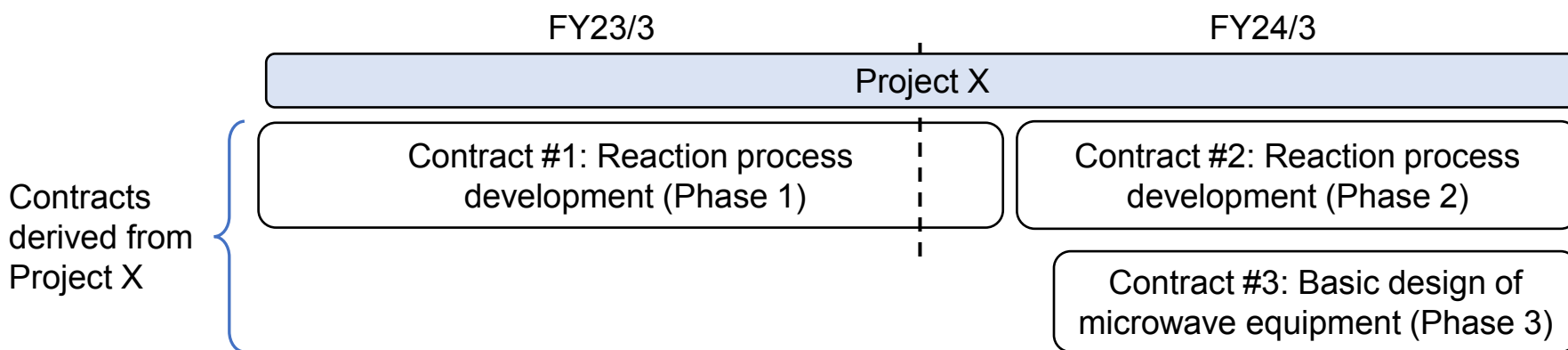
The Company submits reports, samples, etc. stipulated in the JDA and receives payment. Under such agreements, **revenue is booked upon acceptance of the report, samples, etc. by the client.**

### (2) License agreement

Under license agreements, the Company licenses its intellectual property to clients and receives upfront payments and running royalties as compensation. The upfront payment is booked as revenue at the time the intellectual property is licensed. Running royalties are based on the sales revenue of the licensee company, and revenue is recognized when the product is sold by the licensee company.

# KPI (Key Performance Indicator)

- Important KPIs for our business are **(1) number of new contracts**, **(2) total number of contracts**, and **(3) Sales by Phase**.
  - Contracts are executed with clients based on our solutions and service per phase.
  - Multiple contracts would be executed with one project as indicated below.
- (3) Sales by phase shows progress of the contracts by sales in each phase (1~4).
- Contracts are basis of our sales. We disclose number of contracts which are expected to be completed and book sales within this FY.



(Reference)

- **Number of projects:** Project consists of a team with tasks to provide “total solution” to clients. It is also referred as a pipeline and categorized in two types:
  - Revenue-related projects, where we provide solutions to clients
  - Revenue-unrelated projects, where we invest our own resources for internal R&D

# FY24/3 Q2 KPI Highlights

## 1 Number of New Contracts

- Acquired 16 contracts out of 28 annual target.

## 2 Total Number of Contracts

- 44 contracts were executed and 21 delivered (FY24/3 target is 65 contracts).

## 3 Sales by Phase

- JPY1,636MM (88.6%) achieved on contract basis (FY24/3 target JPY1,846MM).

## 4 (Ref.) Number of Projects

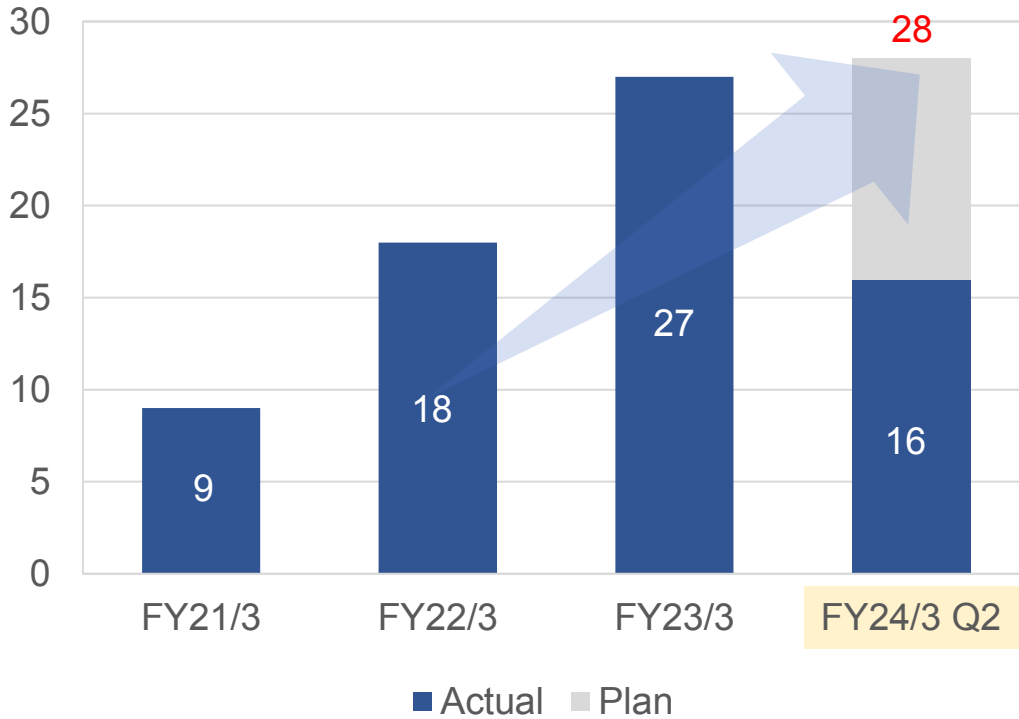
- 41 Solution provide projects and 3 R&D projects are ongoing.



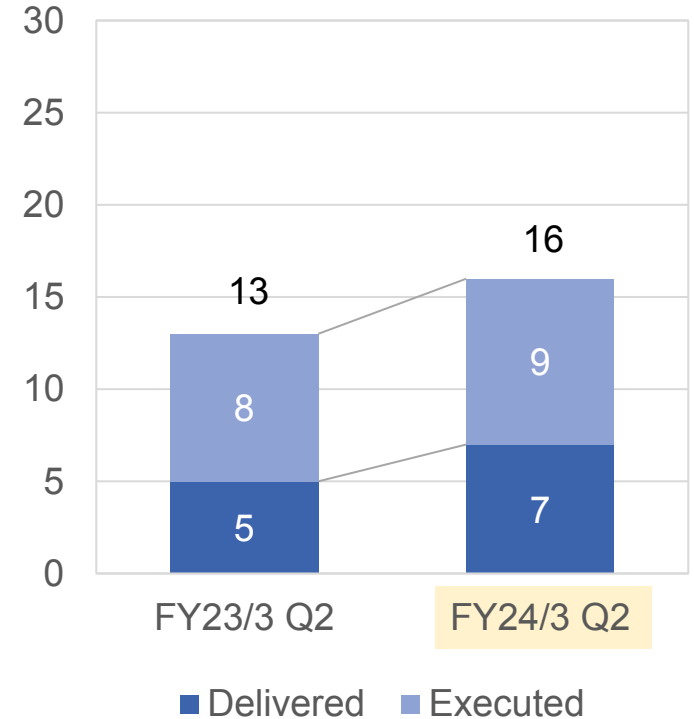
# KPI (1) Number of New Contracts

Acquired 16 new contracts in Q2, out of 28 annual target (13 contracts in FY23/3Q2).

## # of New Contracts



## YoY Comparison



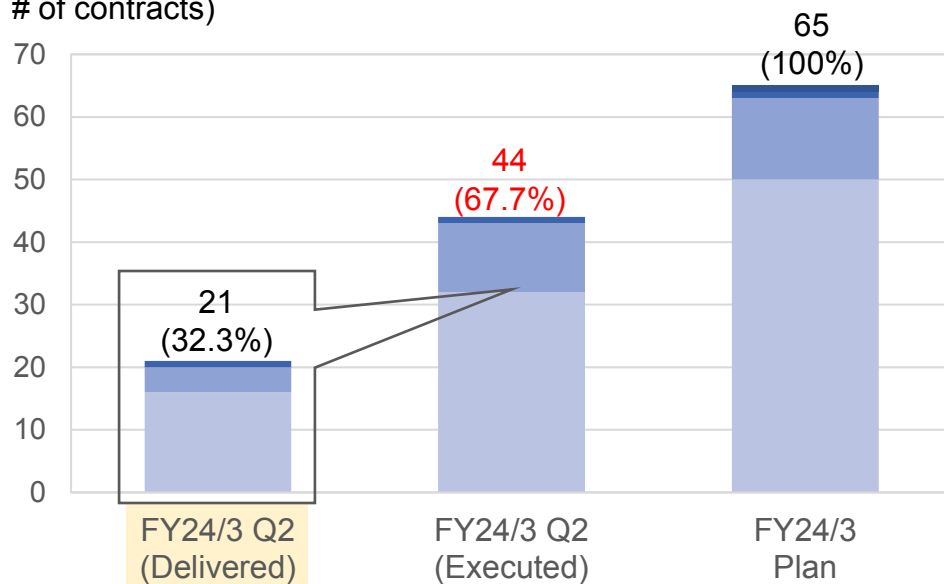


# KPI (2) Total Number of Contracts

67.7% progress for FY24/3 target.

## Progress vs. Full-year plan

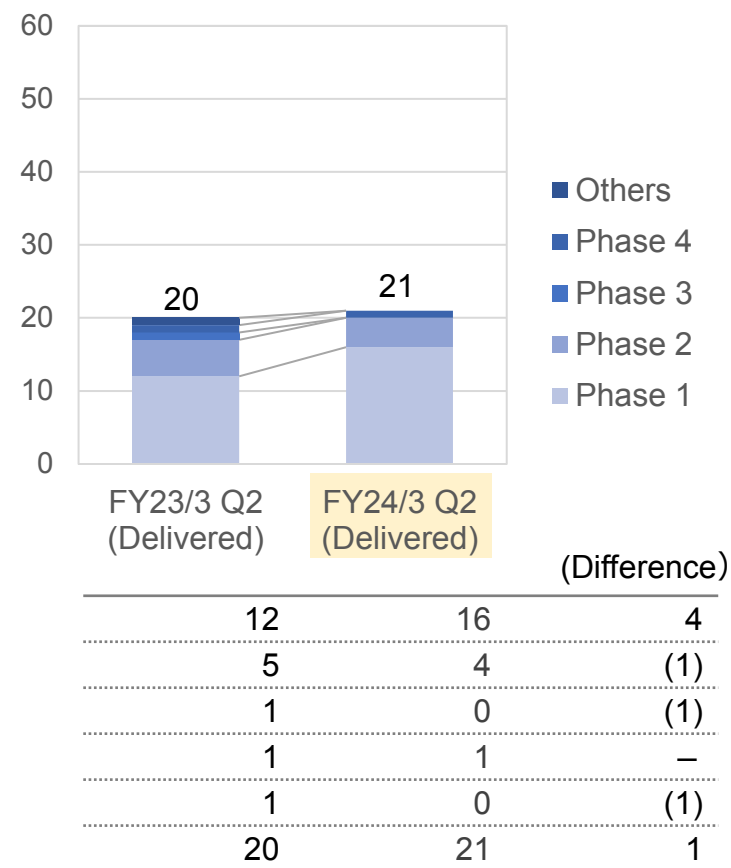
(Unit : # of contracts)



Phase 1	16	32	50
Phase 2	4	11	13
Phase 3	0	0	0
Phase 4	1	1	1
Others	0	0	1
<b>Total</b>	<b>21</b>	<b>44</b>	<b>65</b>

## YoY Comparison

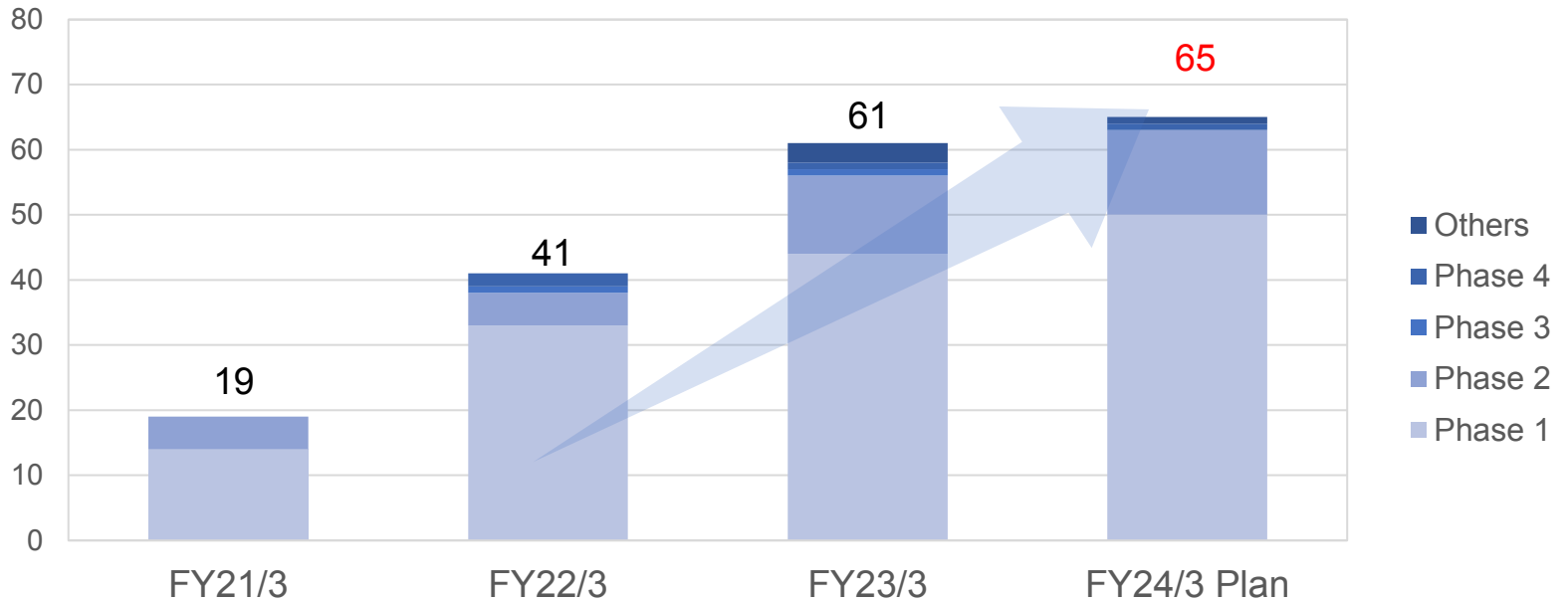
(Accumulated, Unit : # of contracts)



			(Difference)
	12	16	4
	5	4	(1)
	1	0	(1)
	1	1	-
	1	0	(1)
	20	21	1

# (Ref) Total Number of Contracts: Past Figures & FY24/3 Plan

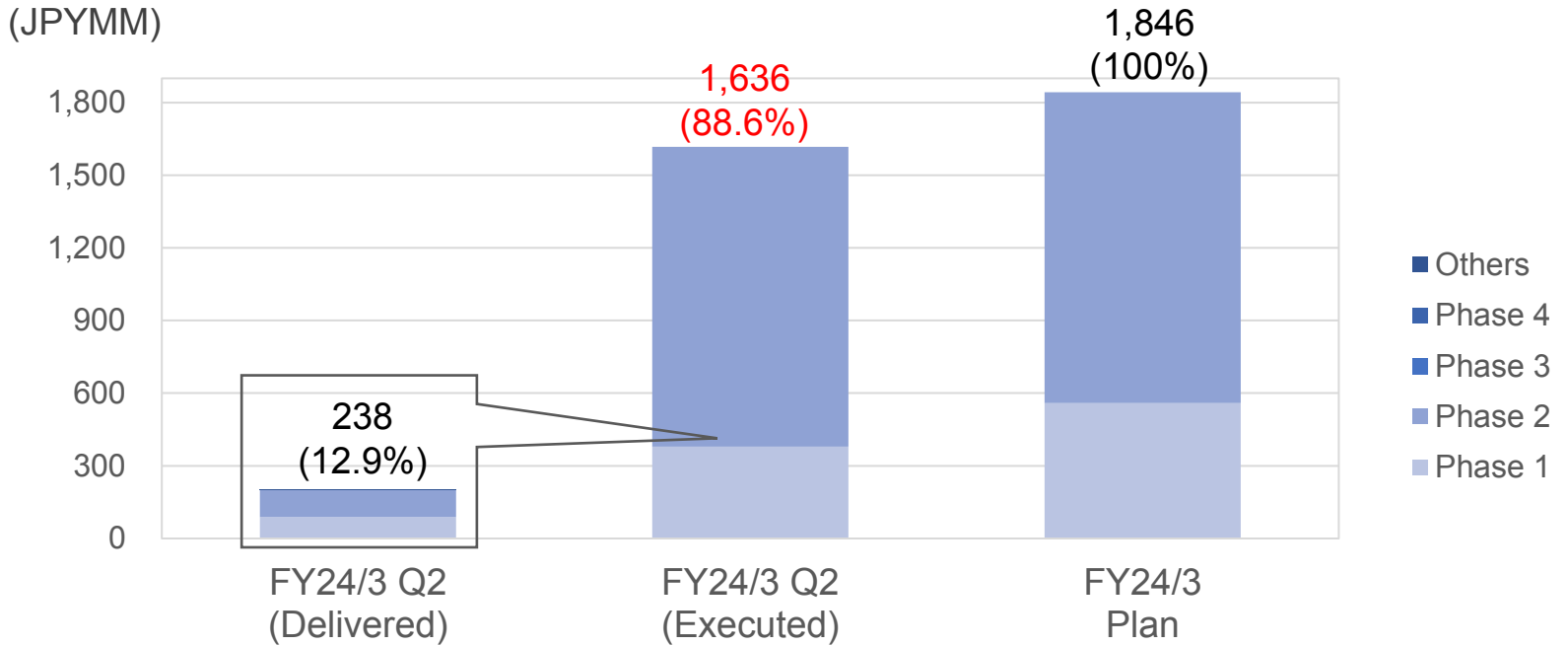
Expect similar number of contracts for FY24/3 compared to FY23/3.



Phase 1	14	33	44	50
Phase 2	5	5	12	13
Phase 3	0	1	1	0
Phase 4	0	2	1	1
Others	0	0	3	1
<b>Total</b>	<b>19</b>	<b>41</b>	<b>61</b>	<b>65</b>

# KPI (3) Sales by Phase

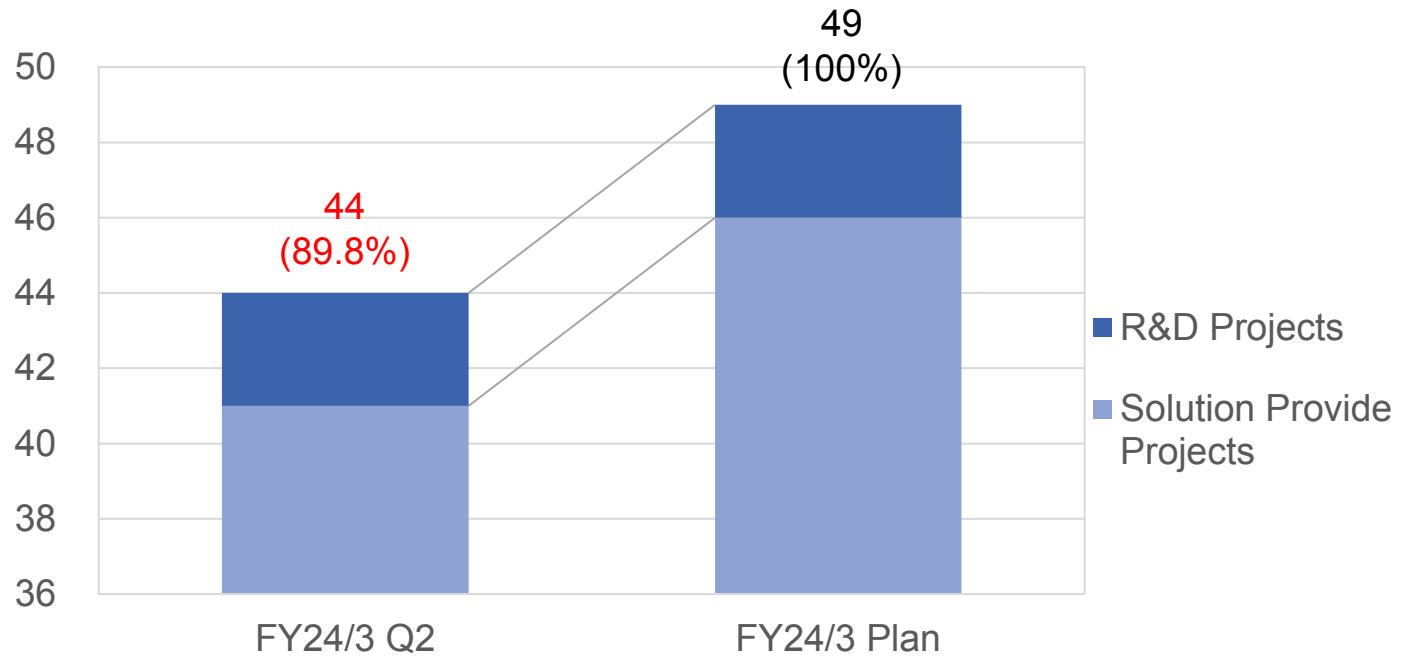
Steady progress made in each phase on contract basis.



Phase 1	148	412	559
Phase 2	90	1,224	1,284
Phase 3	-	-	-
Phase 4	-	-	-
Others	-	-	3
<b>Total</b>	<b>238</b>	<b>1,636</b>	<b>1,846</b>

# (Ref) Total Number of Projects

89.8% progress for full-year plan.



R&D	3	3
Provide solution	41	46
Total	44	49

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# Topics: Q2 Business Highlight

4

Focus on  
growth  
areas

Electrification  
of chemical  
industry

- Launched joint development of innovative naphtha cracking technology, "M-Cracker", using microwave heating (Partner: **Chiyoda Corporation** and **Mitsui Chemicals, Inc.**)  
(Announced on August 1, 2023)

- Launched joint development of microwave process application in elastomer manufacturing (Partner: **Zeon Corporation**)  
(Announced on August 30, 2023)

Mining  
process  
development

- Launched joint development of nickel smelting and refining technology using microwaves (Partner: **Pacific Metals Co., Ltd.**)  
(Announced on August 23, 2023)



# Joint Development of Naphtha Cracking with Mitsui Chemicals & Chiyoda Corporation

- Naphtha cracking is the process of thermally cracking naphtha, a petroleum product, to produce basic chemicals such as ethylene.
- **Fossil fuels have been used as an energy source in this naphtha cracking reaction.** Microwave Chemical has developed "**M-Cracker®**", which can replace it with microwave heating and reduce CO<sub>2</sub> emissions significantly by heating the reaction field directly.
- In this project, we plan to further improve the naphtha cracking technology by combining it with Chiyoda Corporation's advanced catalytic naphtha-cracking technology.
  - We will receive a grant from the New Energy and Industrial Technology Development Organization (NEDO)



×



三井化学

×

Chiyoda  
Corporation

# Joint Development of Microwave-based Elastomer Manufacturing with **Zeon Corporation**

- Elastomers, a type of chemical product, are used in a variety of situations, including electronic devices, food containers, and miscellaneous goods.
- Fossil fuels have been used as an energy source in the process of manufacturing elastomers and other chemical products. Zeon and Microwave Chemical discovered that **we can improve not only the economic efficiency but also the productivity of elastomer manufacturing by applying a microwave process.**
- We have conducted PoC (Proof of Concept) so far, and from this fiscal 2023, we will begin demonstration at Microwave Chemical's Osaka plant (Suminoe-ku, Osaka City) with the goal of social implementation by fiscal 2027.



**ZEON**



# Joint Development of Nickel Smelting Technology with **Pacific Metals**

- Nickel is an important metal required for stainless steel and lithium-ion batteries for electric vehicles, etc. Pacific Metals Co., Ltd. (“PAMCO”) manufactures ferronickel (a raw material for stainless steel), which is made mainly from nickel ore imported from overseas.
- PAMCO and Microwave Chemical have conducted lab demonstrations since 2022 to **replace the energy from coal combustion with microwaves for the nickel smelting process** and obtained prospects for **a significant reduction in CO<sub>2</sub> emissions as well as energy conservation** through improved thermal efficiency.
- This time we will conduct examinations to obtain data for scaling up using a small-scale demonstration facility. If effective results are obtained, we will proceed to operation with a large-scale demonstration machine, aiming to introduce the actual machine by the fiscal year 2030.



Rotary kiln in operation (at PAMCO)

# Agenda

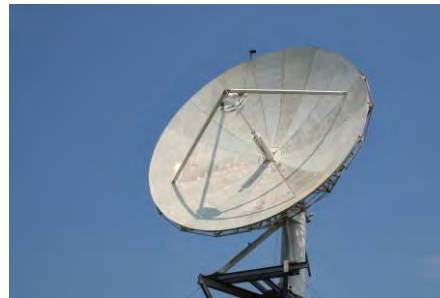
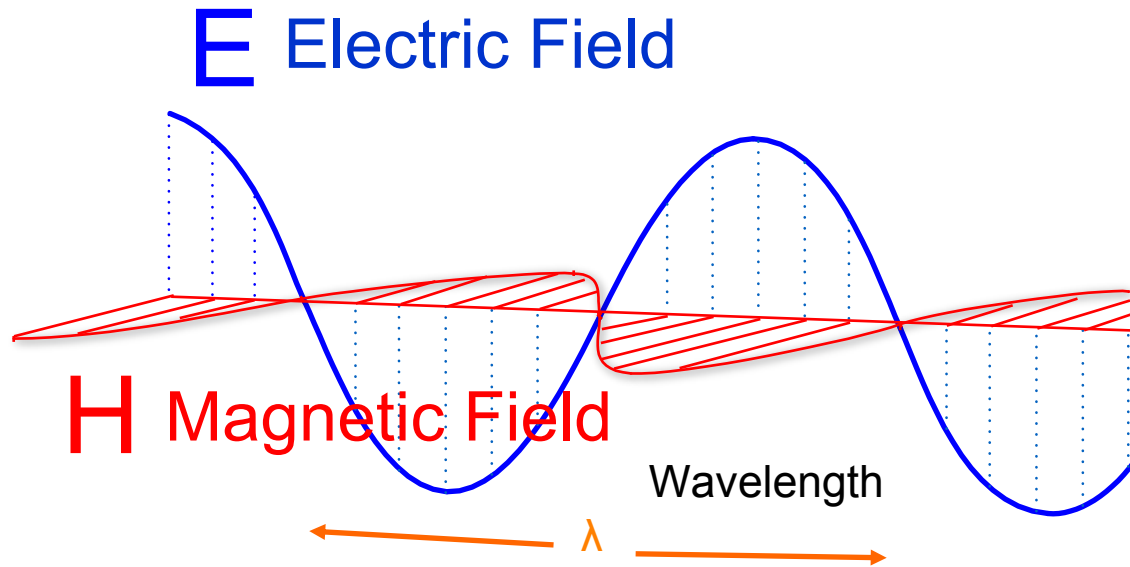
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# What is Microwave ?

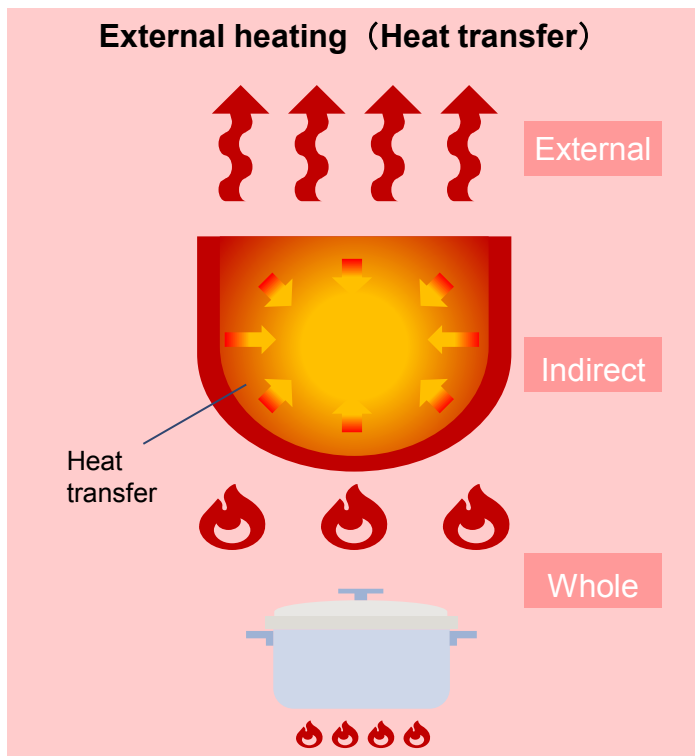
Microwave is an electromagnetic wave used in applications such as wireless base stations, radar-communication systems, and microwave ovens.



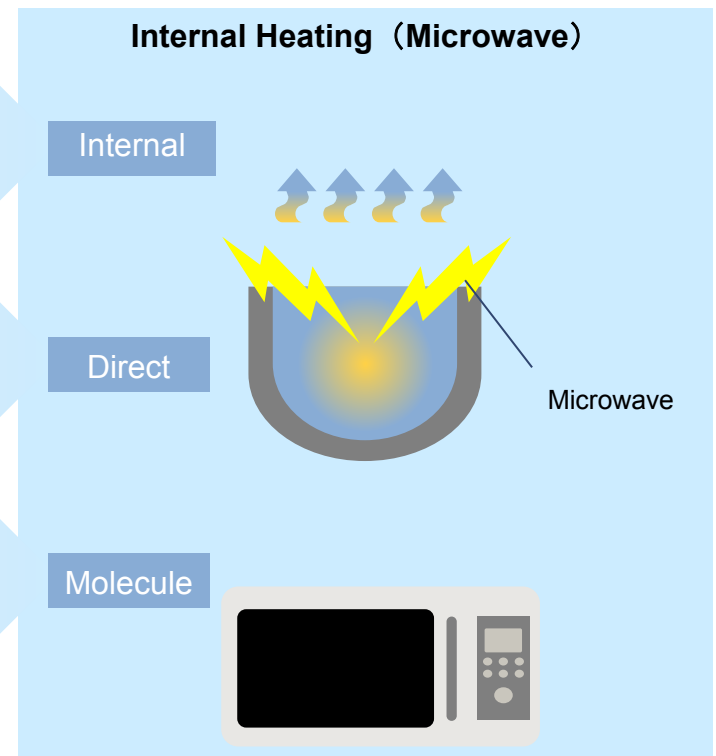
# Feature of Microwave Process

We will dramatically change the manufacturing process utilizing microwave technology.

## Conventional manufacturing process



## Microwave Process



Form of Heat Transfer

Heat Transfer Method

Target

Internal

Direct

Molecule

External

Indirect

Whole

High temperature

Low temperature

\*In the Conventional heat transfer process, energy is transferred to the whole object indirectly through external material. On the other hand, microwaves process transfers energy to the target molecule directly from inside. **Totally opposite approach.**



# Benefit of Microwave Process (1/2)

## Legacy System



Source : BASF Corporate History

1900



Current

Innovation



## Benefits

Process



Reduce Energy consumption by 1/3<sup>(1)</sup>

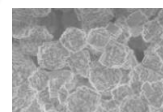
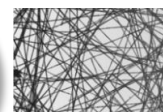


Highly efficient and reduces reaction time by 1/10<sup>(1)</sup>



Small Footprint 1/5<sup>(1)</sup>

Product



Development of new materials and high-quality materials

Decarbonation

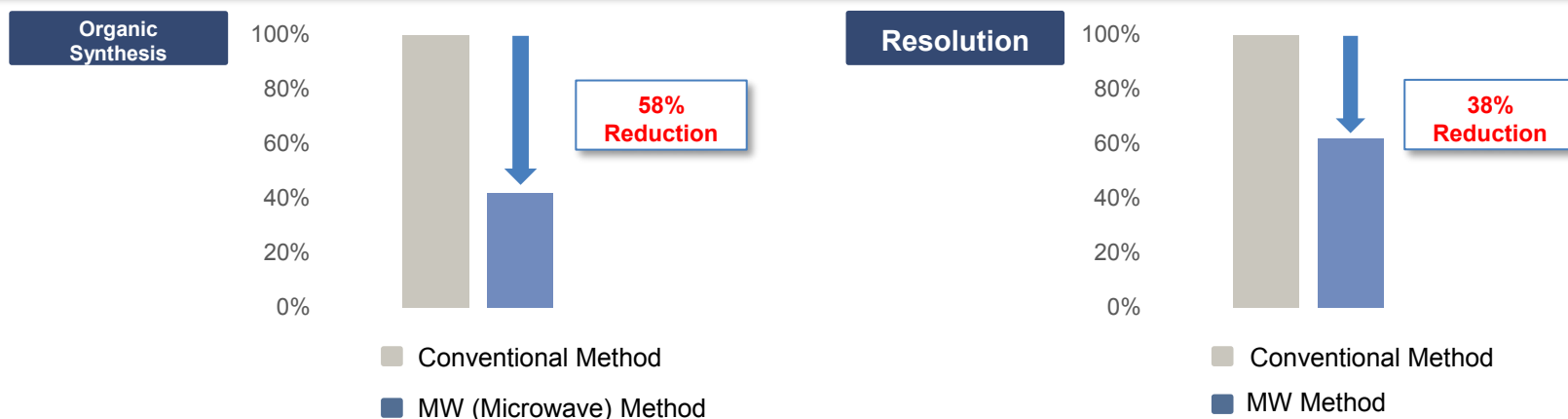


90%<sup>(1)</sup> reduction of CO<sub>2</sub> emissions with electrification using renewable energy

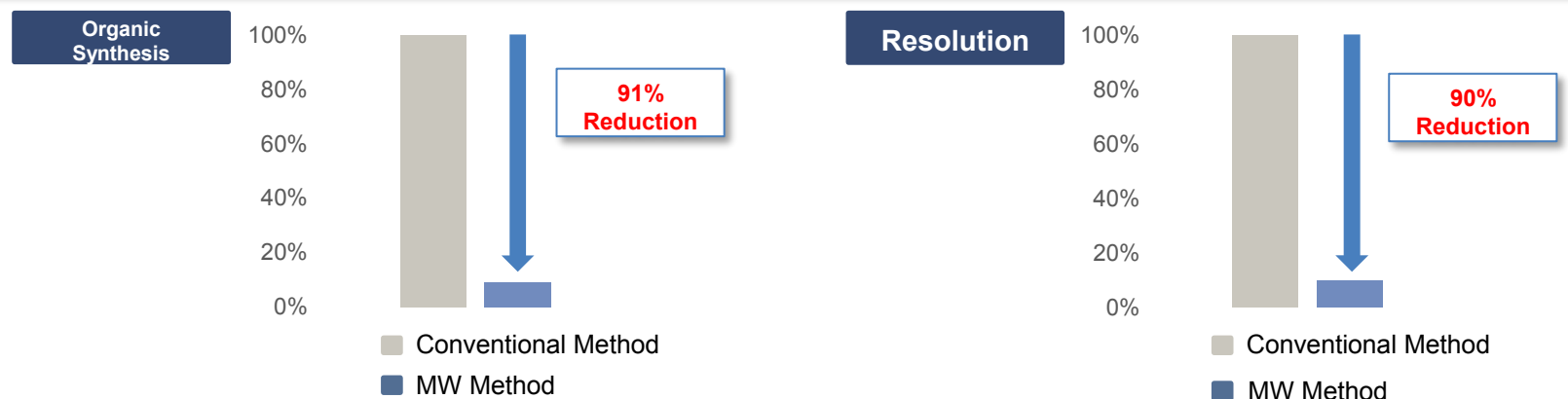
**Note:**  
(1) The figures are estimated from our plant of fatty acid esters operated in Osaka

# Benefit of Microwave Process (2/2)

## Energy consumption: (1) Energy saving with microwave systems



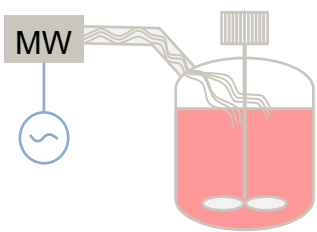
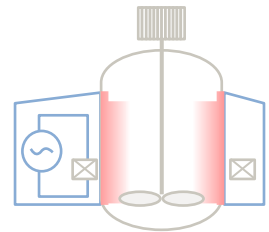
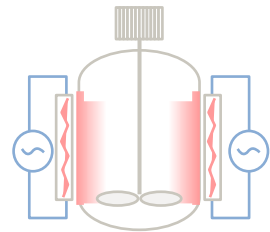






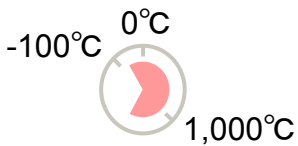
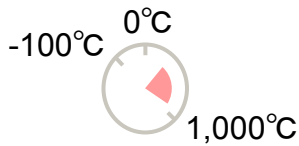
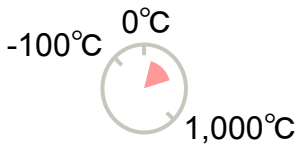
## CO<sub>2</sub> Emissions Cuts: (1) Microwave-assisted energy efficiency × (2) CO<sub>2</sub> emission intensity by energy source



- CO<sub>2</sub> emission cuts are calculated by multiplying (1) energy consumption by (2) energy sources used. Use of microwaves reduces energy consumption in many chemical reaction processes. There is a trend that chemical manufactures across the world are laying out their roadmaps, assuming that they significantly reduce the use of conventional fossil fuels to shift to natural energies, which will diminish the intensity of CO<sub>2</sub> emission from energy sources.
- MW Method assumes the use of photovoltaic electricity, CO<sub>2</sub> emission reductions and energy equivalent reductions are our estimates. Conventional method data is our trial calculation, and MW method data is based on our demonstration machine at commercial level

# Comparison – Electrification Technology

Microwave process is the only process that transfers energy directly, which provides advantage, such as scaling up, energy efficiency, and temperature range.

	Microwave Heating	Induction Heating	Electric heater Heating
			
Energy Transfer	Direct	Indirect	Indirect
Scaling Up	 Easy	 Restricted	 Restricted
Energy Efficiency	 High	 Medium	 Low
Temperature Range			

# Success in Scaling Microwave Process to Industrial Level

## Challenges for Industrial Applications of Microwaves

In the chemical industry, many useful experimental results using microwaves have been reported in papers since the 1980s. However, because microwaves are "waves," it is extremely difficult to control. Therefore, industry norm was that the microwave technology cannot be used in industrial setting and only in the lab.



Depth of penetration



Leakage



Reflection

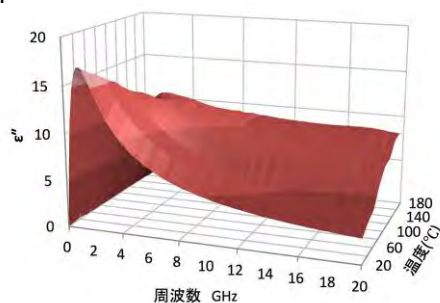


Distribution

## Solved by Our Unique Approach

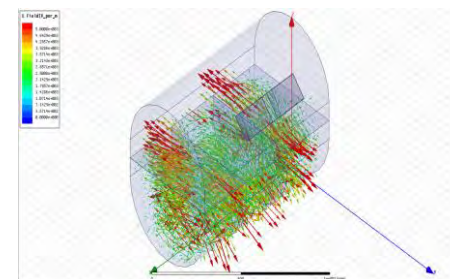
### 【Reaction System Design】

Developed data base of absorption rate of each molecule through our proprietary measurement technology. Design reaction utilizing the database by recognizing the pattern.



### 【Reactor Vessel Design】

Develop simulation technologies, couple electromagnetic field and thermic fluid analyses to increase the granularity in simulating the state, and introduce supercomputers, so as to apply to large-sized and complex reactor vessels



## Realizing Industrial Applications of Microwaves

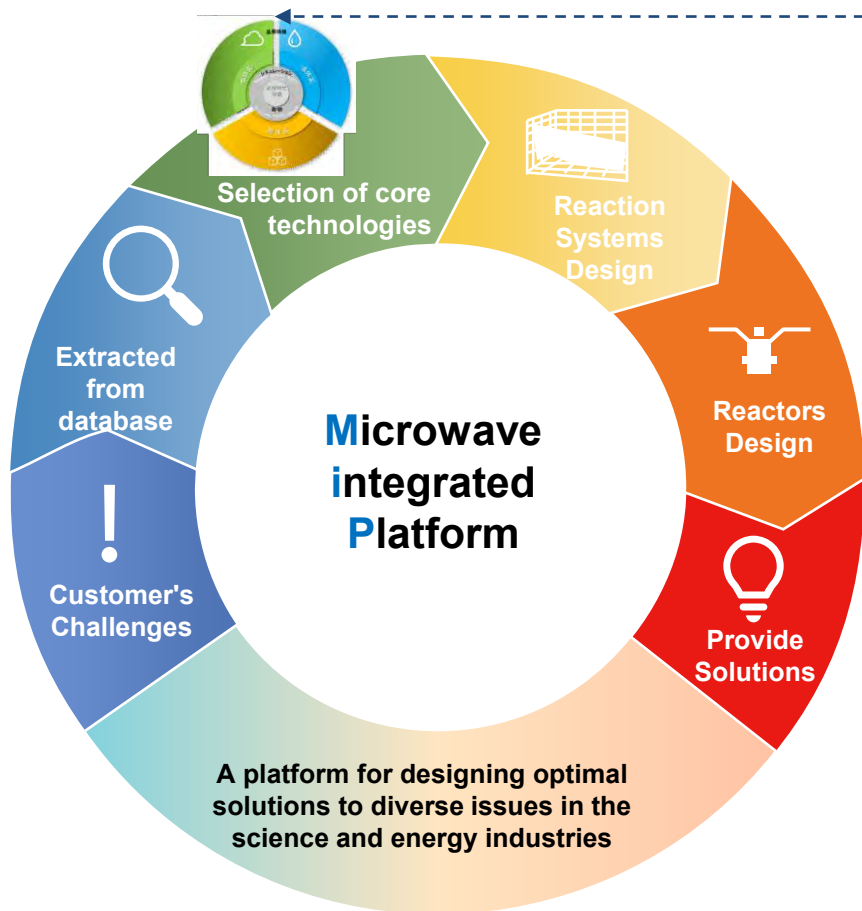
Completed large-scale chemical plant using microwave chemical process in Osaka in 2014 and started commercial operation complying with various laws and regulations such as the Fire Service Act.



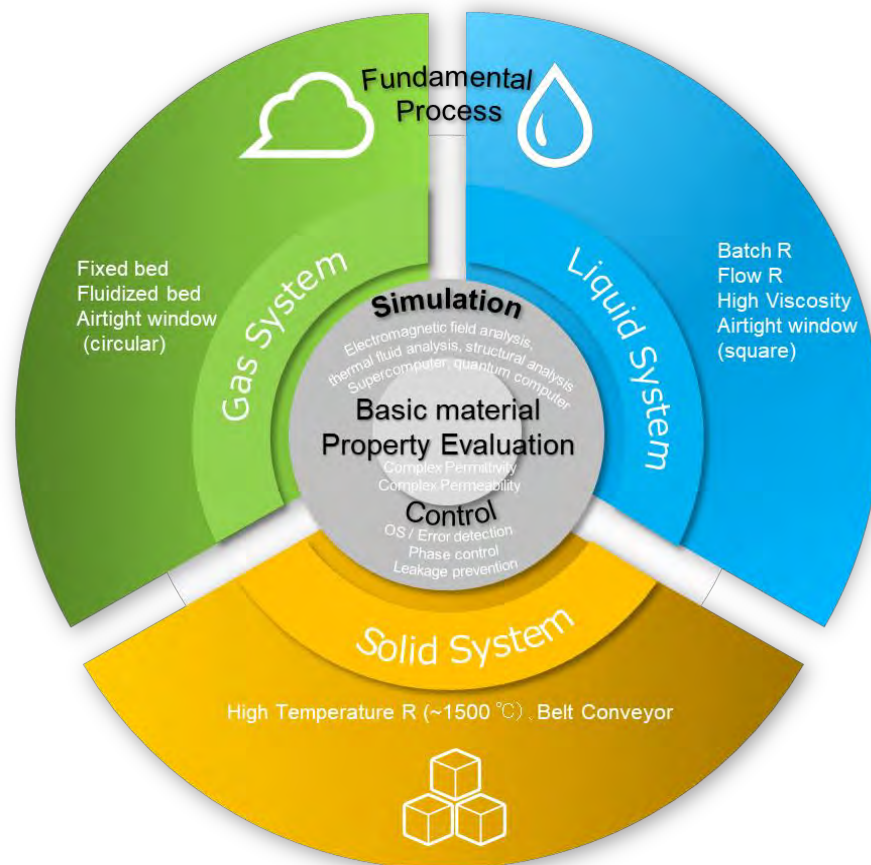


# Technology Platform and Core Technologies

## Our Technology Platform

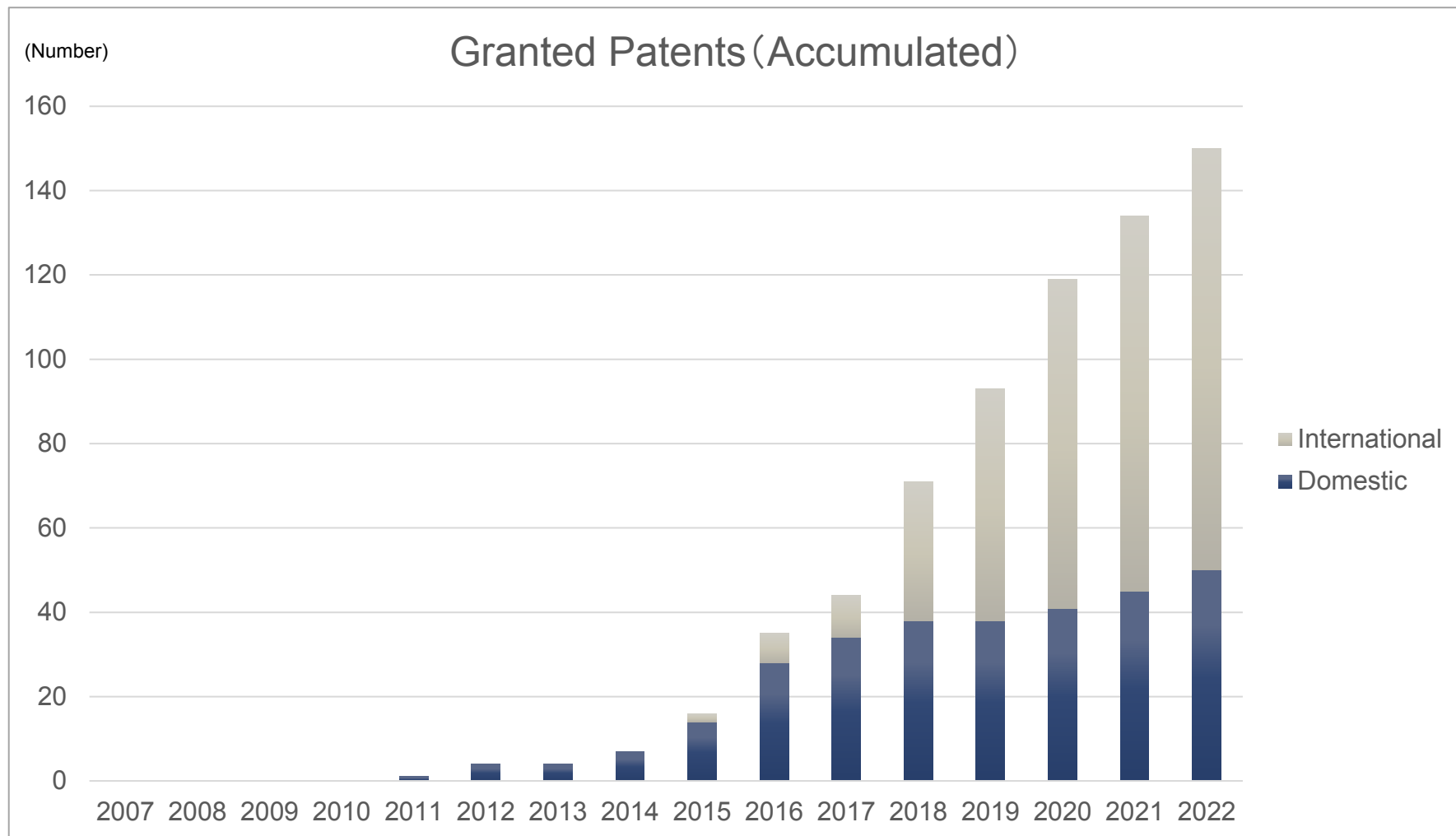


## Our Core Technologies



# Patent Strategy

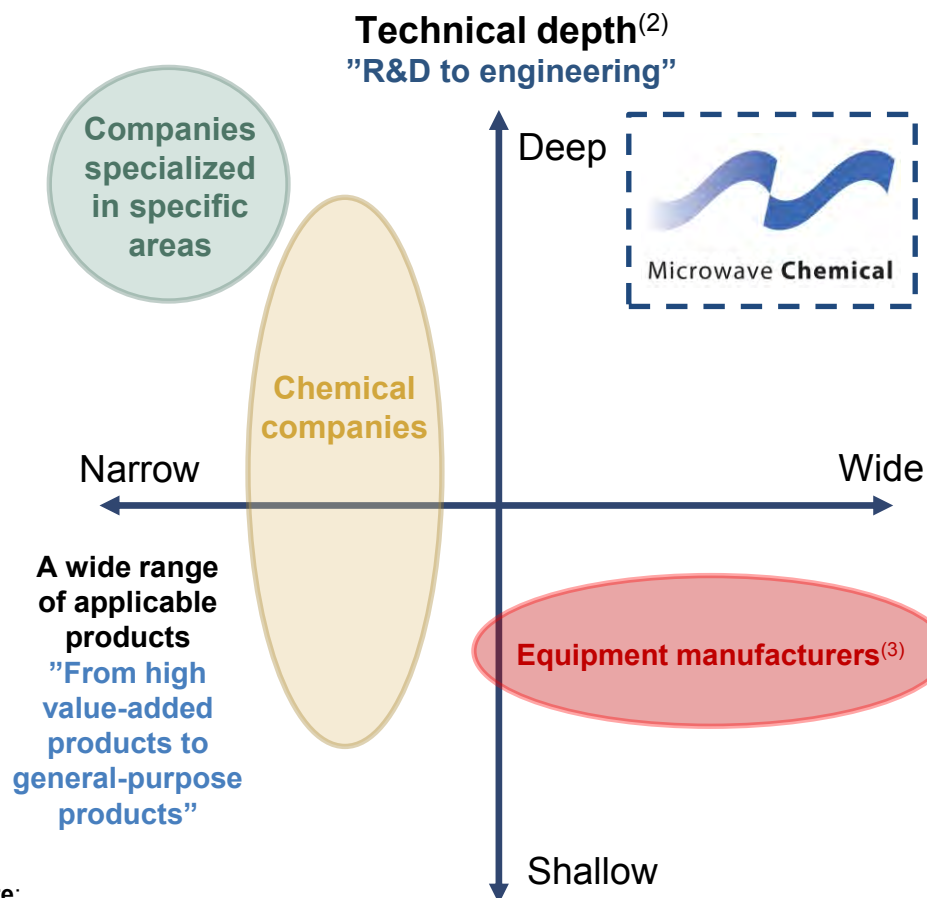
To ensure a competitive advantage, knowledge regarding **reaction and reactor design is kept confidential as trade secrets**, while knowledge centered around **hardware is protected through patenting**.



# Competitive Landscape

## Current Competitive Environment<sup>(1)</sup>

## Multi-layered Entry Barrier



### ● Technology platform

- ✓ Design capabilities and core technology groups for reaction systems and reactors
- ✓ Patents and know-how supporting the platform

### ● Development team and infrastructure

- ✓ Cross-sectorial team, such as physics, chemistry, engineering, and simulation
- ✓ The large microwave-focused labs and
- ✓ demonstration development infrastructure

### ● Customer base accumulation

- ✓ Deeply understanding issues and requests
- ✓ identified through constant relationships including horizontal connection
- ✓ Production technology and compliance with laws
- ✓ and regulations accumulated through experience
- ✓ in the start-up and operation of large-scale commercial plants

#### Note:

(1) The graph is an image of our own analysis of the positioning of each company in the industry

(2) Depth of solutions for clients' R&D and engineering challenges, based on our scientific capabilities. Generally, either only R&D or only equipment would be provided.

(3) Mostly machine manufacturers

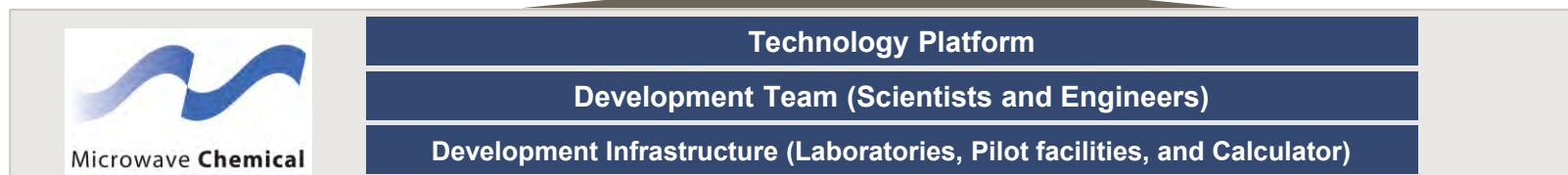
# Earnings Structure



## Estimated sales\*1

Large-scale projects	JPY10MM or more	JPY100-1,000MM	JPY500-1,000MM	Upfront payment + Recurring royalties
Mid- to small-scale projects	JPY10MM or more	JPY10-100MM	JPY200-300MM	

Total Solutions				
	Phase 1	Phase 2	Phase 3	Phase 4
	POC	Verification Development	Commercial reactor	Manufacturing support
Cost	<ul style="list-style-type: none"> <li>● Development at laboratories</li> <li>● Major cost is labor one</li> <li>● Selection of Laboratory equipment</li> </ul>	<ul style="list-style-type: none"> <li>● Development at office or customers' site</li> <li>● Major cost is labor and equipment ones</li> </ul>	<ul style="list-style-type: none"> <li>● Delivery of microwave reactors to customers' plants</li> <li>● Major cost is equipment one</li> </ul>	<ul style="list-style-type: none"> <li>● Support for manufacturing at customers' plants</li> <li>● Major cost is labor one</li> </ul>

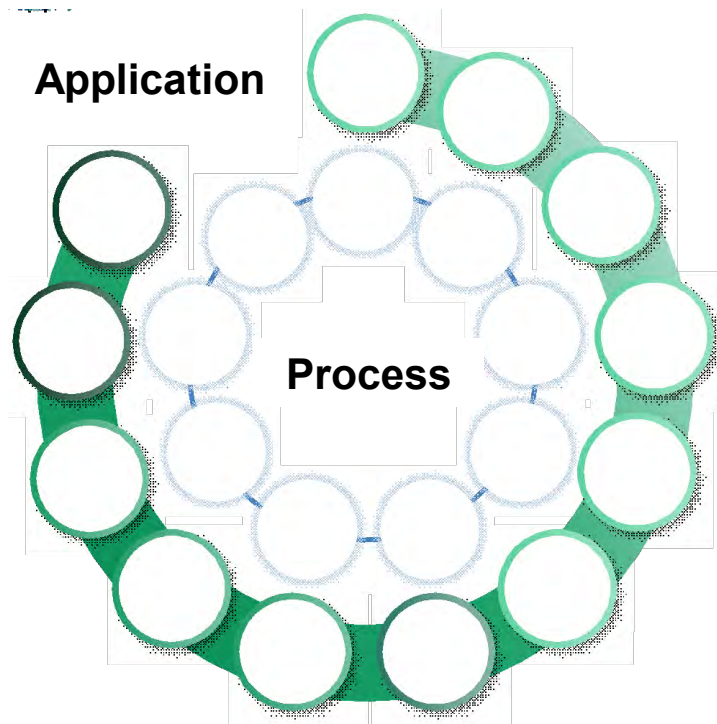
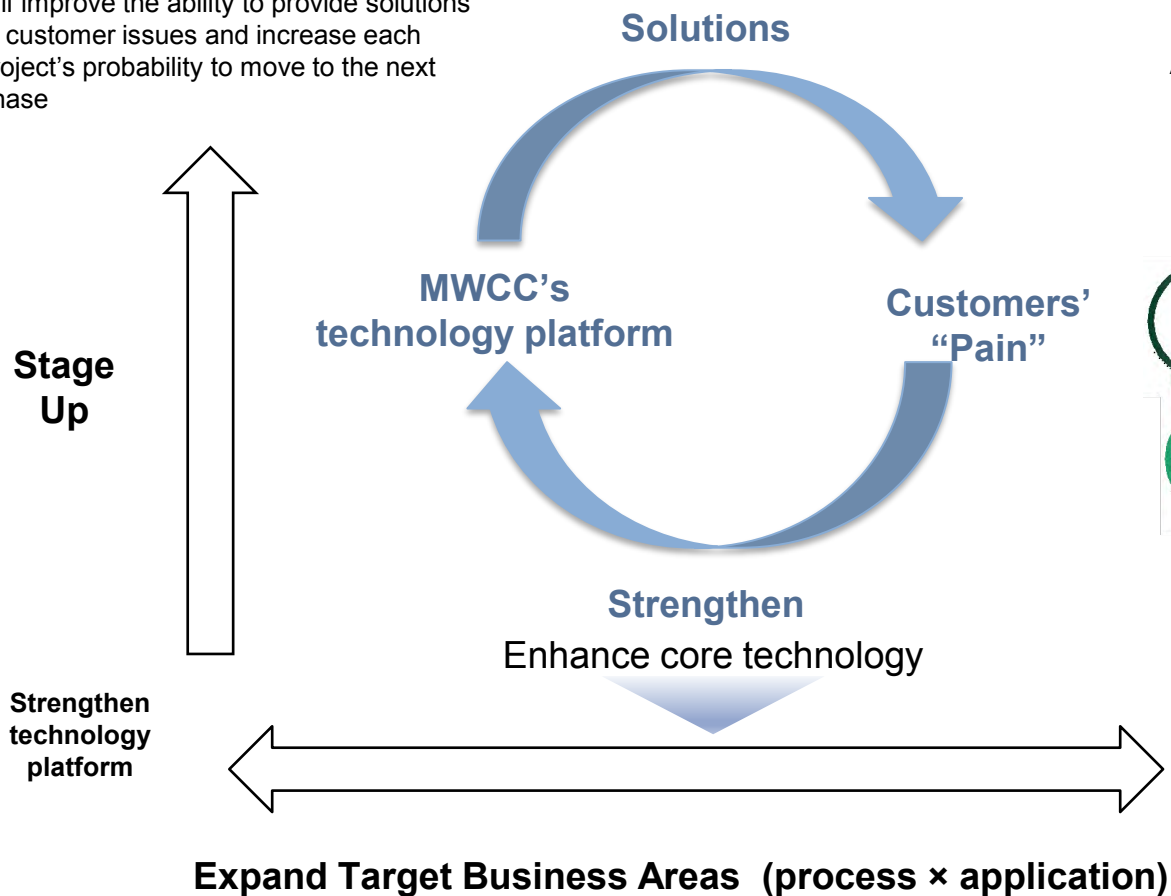


Note : Currently, no recurring royalties have been recorded

\*1: Assumed sales size classification based on past performance for each Phase, amounts are our estimates based on past results

# Virtuous Cycle Drives Growth

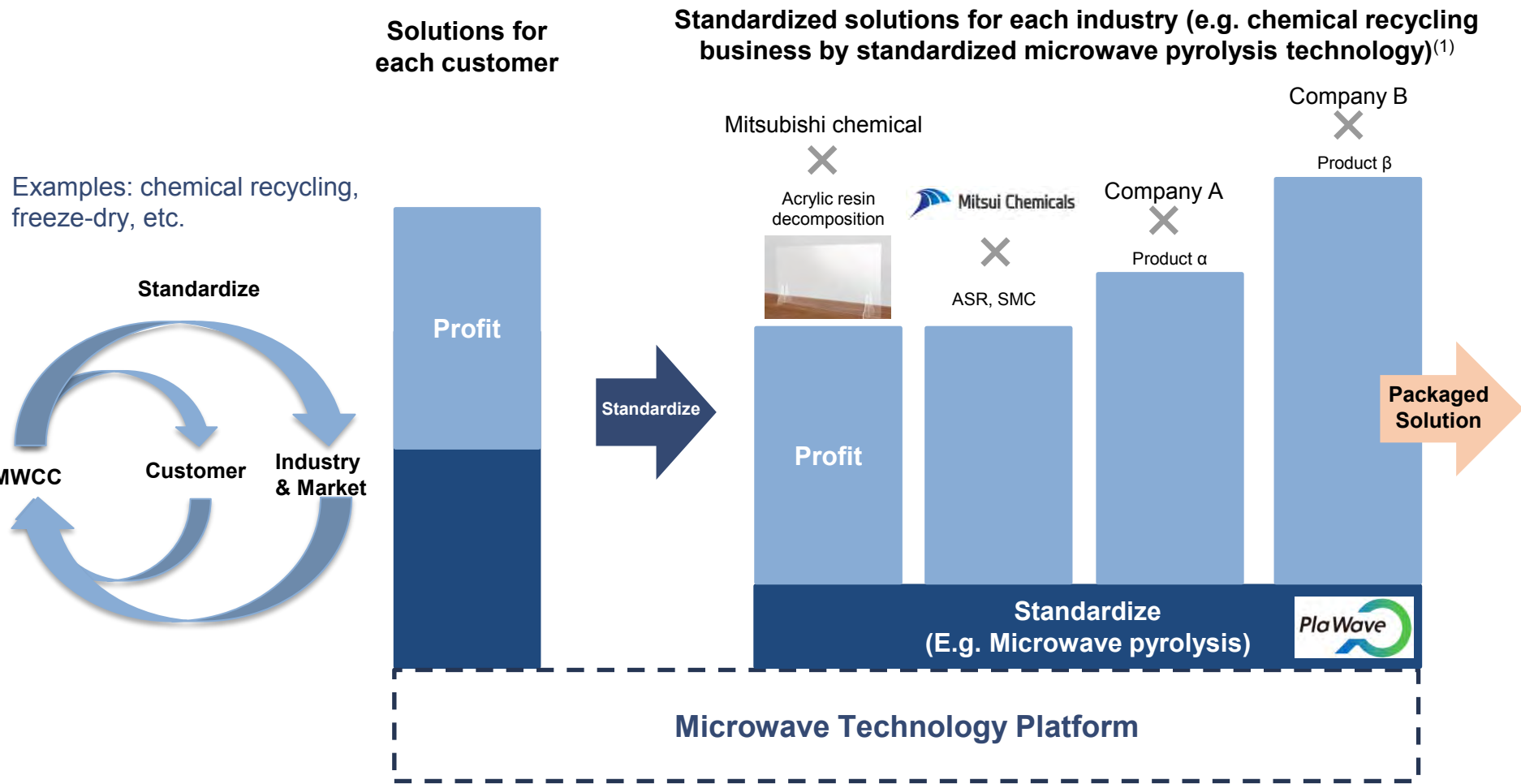
Strengthening of our technology platform will improve the ability to provide solutions to customer issues and increase each project's probability to move to the next phase



Enhanced core technology will increase the number of processes (manufacturing methods) and applications (products) for which microwave technology platform can be used

# Standardization Drives Growth

We scale our business by “standardizing” our technology platform and providing solutions to “pains” which is common to industries and markets. For example, we have conducted chemical recycling business using microwave pyrolysis technology, pharmaceutical-related and food-related business using microwave freeze-drying technology.



Note:  
 (1) The graph is an illustration of our own analysis of the scale of the business



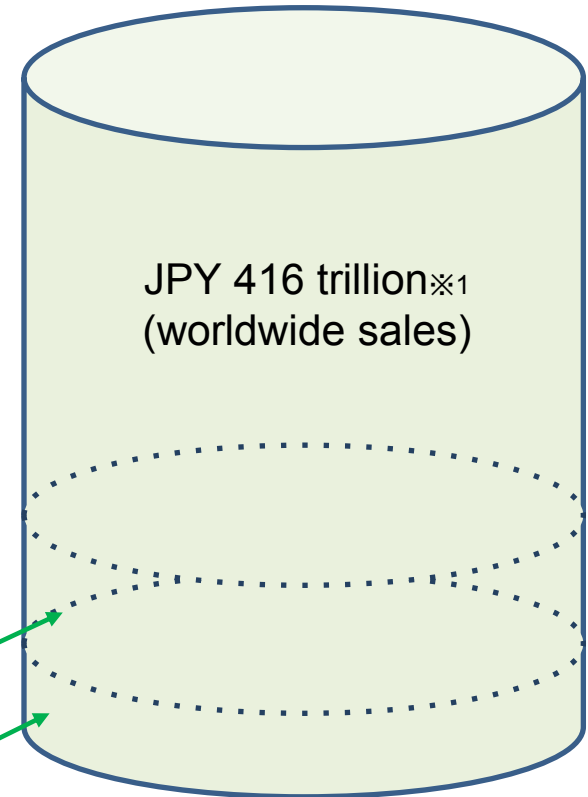
# Potential Market

- Customers pay fees for our solutions mainly from R&D expenses and CAPEX
- As such, the potential market size is considered to be the part of the total amount of R&D expenses and CAPEX in the overall manufacturing industry, including chemical, medical, foods, and oil refinery
- In the chemical industry, sales, CAPEX, and R&D expenses increased 3.9%, 4.6%, and 5.1% per year, respectively, from 2010 to 2020, which is expected to continue ※3

CAPEX: JPY 23.2 trillion※1

R&D: JPY 13.7 trillion※2

## Chemical Industry



Calculated based on the following:  
USD 1 = JPY 109 (average for 2019)

\*1 Guide to the Business of Chemistry 2021 American Chemical Council, August 2021

\*2 Forecast on global annual chemical industry capital expenditures 2019-2023

\*3 Research spending continues on an upward trajectory ) <https://cen.acs.org/business/investment/Research-spending-continues-upward-trajectory/97/i23>

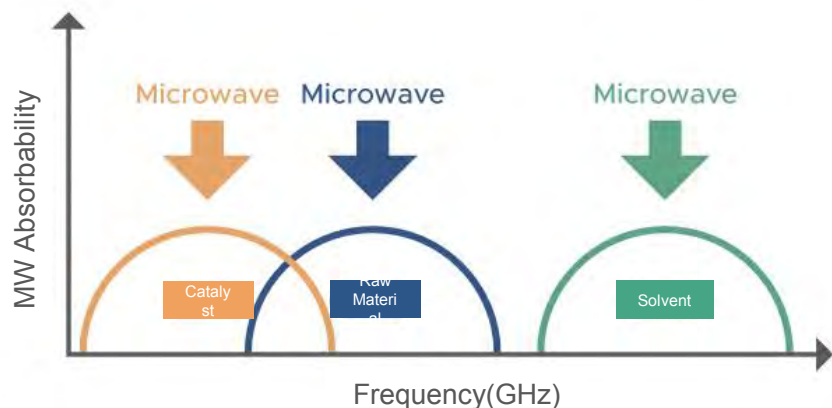
2022 Facts And Figures Of The European Chemical Industry) <https://cefic.org/a-pillar-of-the-european-economy/facts-and-figures-of-the-european-chemical-industry/>

# Reaction design

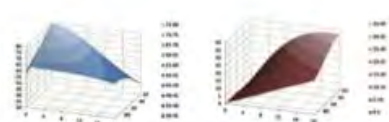
Microwave absorption rate varies by material with frequency and temperature dependency. We design the reaction utilizing this characteristics.

## Reaction system design

Design Microwave transmission: Which target material at what frequency and temperature.



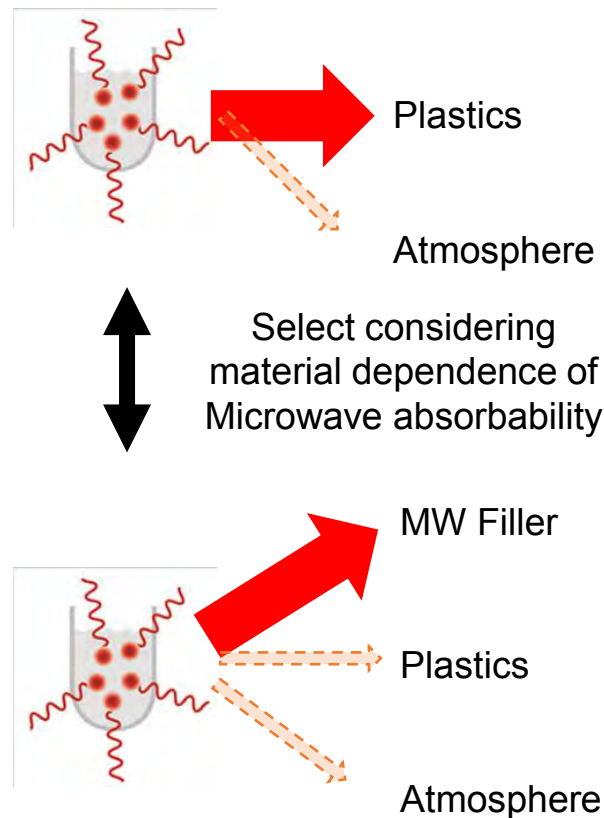
$\epsilon'$  of 2-Ethylhexyl ester



$\epsilon'$  of water



## Use case: Plastic decomposition

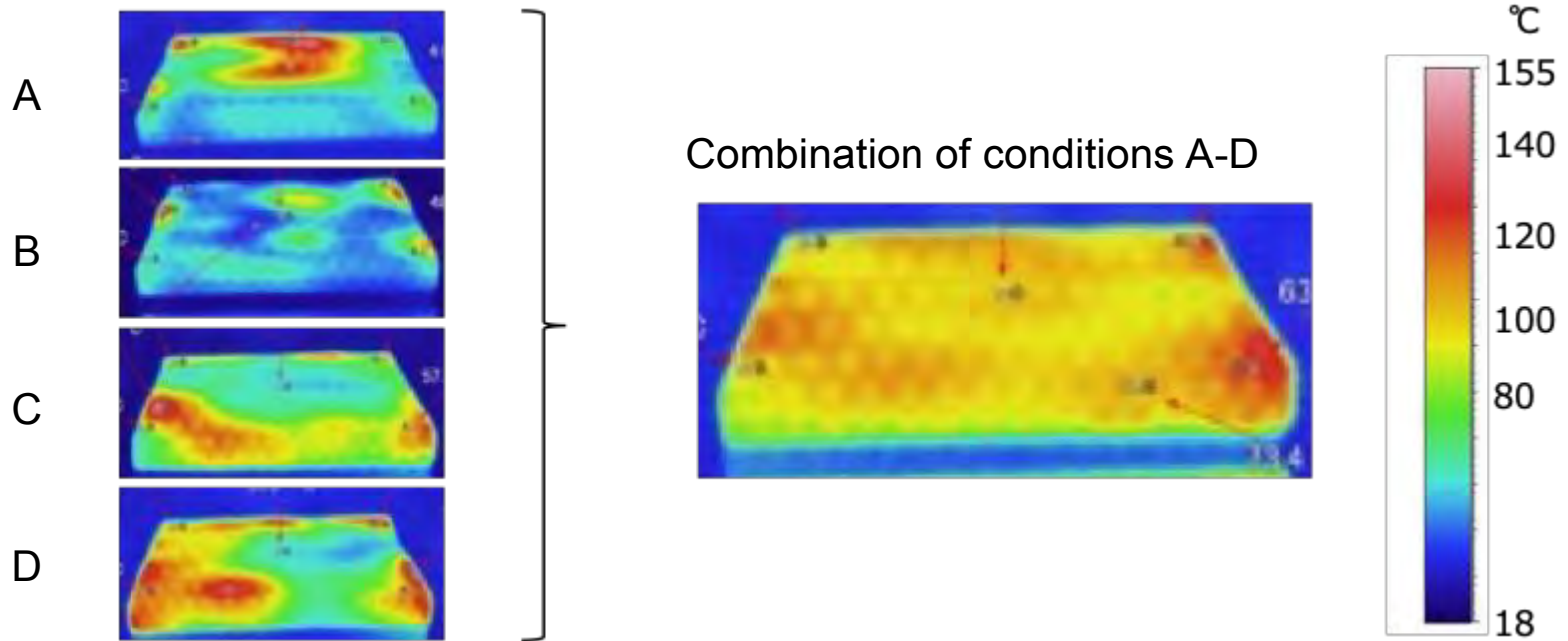




# Microwave phase control

- ✓ Microwave is an electromagnetic wave, we realized precise control of the wave utilizing microwave absorption data and novel simulation technology.
- ✓ This allowed us to control the temperature distribution of the target material.

ex) By precise control of microwave irradiation condition from A through D, we achieved uniform heating that was difficult with conventional methods.



# End of Document

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Microwave **Chemical**

**Make Wave,  
Make World.**

世界が知らない世界をつくれ