Accelerating Development Activities through Open Innovation and DX

AGC Inc.
Senior Executive Officer, Chief Technology Officer and General Manager, Technology General Division
Hideyuki Kurata
1987 Joined Asahi Glass (present AGC), assigned to Chiba Plant
2004 General Manager, New Business Promotion Department, Chemicals Company
2008 President, AGC Chemicals Americas, Inc.
2014 General Manager, Business Development Office
2015 General Manager, Strategic Planning Office, Chemicals Company
2017 General Manager, Life Science General Division, Chemicals Company
2018 Executive Officer, General Manager, Life Science General Division, Chemicals Company
2019 Senior Executive Officer, General Manager, Technology General Division
2021 Director, Senior Executive Officer, CTO, and General Manager, Technology General Division
Vision 2030

By providing differentiated materials and solutions, AGC strives to help realize a sustainable society and become an excellent company that grows and evolves continuously.
**AGC will accelerate the following strategies toward Vision 2030.**

<table>
<thead>
<tr>
<th>Pursuing ambidextrous management</th>
</tr>
</thead>
<tbody>
<tr>
<td>• We will accelerate the growth in the strategic business area, and at the same time explore new business areas including those related to energy.</td>
</tr>
<tr>
<td>• In the core business, we will conduct a structural reform in the architectural glass and automotive glass businesses that need improvements in profitability and asset efficiency.</td>
</tr>
<tr>
<td>• For other businesses in the core business area, we will strengthen their profit foundation and cash generation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Promotion of sustainability management</th>
<th>Gaining competitiveness by accelerating digital transformation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Propelling materials innovation to help solve social issues</td>
<td></td>
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<tr>
<td>• Aiming for net-zero carbon in 2050</td>
<td></td>
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<tr>
<td>• Strengthening human resources and group-wide governance</td>
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<tr>
<td>• Taking a transformation of the business model itself into consideration, leverage digital technologies to improve the process from product development to sales activities</td>
<td></td>
</tr>
<tr>
<td>• Use digital technologies to provide value to customers and society and gain competitiveness</td>
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Development structure, technological foundations, and strategy
Development structure

Technology General Division
- Planning Div.
- Innovative Technology Laboratories
- Material Integration Laboratories
- Production Technology Div.
- Float Technology Promotion Div.

AGC

Intellectual Property Div.
Business Development Div.
Productivity Innovation Div.

R&D division of in-house companies

Companies
Start-ups
Universities
Public research institutions

(As of March 31, 2021)
By combining core technologies with common basic technologies, we are able to provide high-value-added solutions that cannot be achieved with a single technology.

**Core technologies**

**Materials technologies**
- Glass materials
- Ceramic materials
- Inorganic materials
- Organic and fluorine materials
- Polymer materials

**Functional design**
- Coating
- Composites of different materials
- Circuit and antenna design

**Production technologies**
- Glass manufacturing process
- Glass forming and processing
- Chemical processes
- Resin molding
- Protein manufacturing
- Microbial and mammalian cell culture

**Common basic technologies**
- Analysis and evaluation
- Simulation
- Data science
- Sensing
- Plant engineering
- Smart factory
Lineage of AGC’s core technologies

**Materials technologies**
- Glass materials
- Ceramic materials
- Inorganic materials
- Organic and fluorine materials
- Polymer materials

**Functional design**
- Coating
- Composites of different materials
- Circuit and antenna design

**Production technologies**
- Glass manufacturing process
- Glass forming and processes
- Chemical process
- Resin molding
- Protein manufacturing
- Microbial and mammalian cell culture

**Glass**
- 1907 Founded: Architectural glass
- 1910: Glass melting and in-house raw material production
- 1930: Development of chlorine utilization technology
- 1950: Glass for cathode-ray tubes*
- 1960: Introduction and development of float-method technology
- 1970: Glass antennas
- 1980: Synthetic fused silica glass
- 1990: Glass substrate for TFT-LCDs
- 2000: CMP slurry
- 2010: Cover glass for car-mounted displays

**Electronics**
- 1907 Founded: Glass for cathode-ray tubes*
- 1910: Glass for cathode-ray tubes*
- 1930: Glass for cathode-ray tubes*
- 1950: Glass for cathode-ray tubes*
- 1960: Introduction and development of float-method technology
- 1970: Glass antennas
- 1980: Glass for electronic materials
- 1990: Glass substrate for TFT-LCDs
- 2000: Glass for chemical strengthening
- 2010: Glass for chemical strengthening

**Chemicals**
- 1950: Chlor-alkali cells*
- 1960: Propylene oxide
- 1970: Chlorofluorocarbon
- 1980: Development of fluorocarbon technology
- 1990: Development of pharmaceutical and agrochemical intermediates
- 2000: CMP slurry
- 2010: Fluorinated antifouling treated agent

**Ceramics**
- 1910: Refractory bricks
- 1930: Development of chlorofluorocarbon technology
- 1950: Fluorine-based resin and films
- 1970: Fluoropolymer ion-exchange membranes
- 1980: Chemical process
- 1990: Development of biotechnology
- 2000: Contract manufacturing of biopharmaceuticals
- 2010: Introduction of mammalian cell technologies

*Business discontinued
Development strategy

- Issues are becoming more complex than individual companies can solve alone, and the required development speed is accelerating.
- AGC proactively utilizes open innovation and DX to respond to rapidly changing society.

Ambidextrous development

Combining and repeating right- and left-handed development to create new value and contribute to society

Open innovation

Accelerating open innovation with external companies, research institutes, universities, etc. in the AO co-creation space

AO Lab.

DX

Development using material informatics (MI), AR/VR, etc.

AMOLEA™

AR/VR
Ambidextrous development
Development strategy

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AR/VR
The starting point for development is the AGC Group's existing organizational capabilities and technologies, as well as existing markets and customers.
Ambidextrous development

- Right-handed development: Innovating manufacturing and basic technologies to develop new products together with customers

(1) Innovation in manufacturing and basic technologies

(2) Development of next-generation and new products
Close contact with customers and grow together

Markets and customers

Existing businesses (Core & Strategic)

Organizational capability & technology

Existing

New

Right-handed

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Ambidextrous development

- Left-handed development: Redefine proprietary technologies and develop new markets

1. Innovation in manufacturing and basic technologies
2. Development of next-generation and new products
   - Close contact with customers and grow together
3. Development of new businesses
   - Utilizing (redefined) capabilities to develop new markets

Markets and customers

Existing

Existing businesses (Core & Strategic)

Organizational capability & technology

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Example of ambidextrous development: CDMO business

- Existing technologies include pharmaceutical and agrochemical intermediates and active ingredients, and biotechnology

<table>
<thead>
<tr>
<th>Markets and customers</th>
<th>Organizational capability &amp; technology</th>
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<tbody>
<tr>
<td>Existing</td>
<td>Fluorine-based pharmaceutical and agrochemical technology, Biotech</td>
</tr>
<tr>
<td>New</td>
<td>New</td>
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©AGC Inc.
Example of ambidextrous development: CDMO business

- Redefining technology holdings through left-handed development and launching microorganism CDMO business from pharmaceutical manufacturers.

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<th>Markets and customers</th>
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<th>New</th>
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<tbody>
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<td>Biotech CDMO (Microorganism)</td>
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</tbody>
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Example of ambidextrous development: CDMO business

In 2017, acquired mammalian cell CDMO technology through M&A and started mammalian cell CDMO business.
Example of ambidextrous development: CDMO business

- In 2020, acquired gene and cell therapy technology through M&A and started the gene and cell therapy CDMO business.
- Aiming to further expand into new markets by utilizing left-handed development.

Organizational capability & technology

Existing

Biotech CDMO (Microorganism)

AGC

Fluorine-based pharmaceutical and agrochemical technology

Biotech

New

Biotech CDMO (Mammalian cell)

M&A

New market

Biotech CDMO (Gene and cell therapy)

M&A

New

Existing

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Example of ambidextrous development: Glass business

- Possesses existing technology for manufacturing flat glass

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<tr>
<td>Existing</td>
<td>New</td>
</tr>
<tr>
<td>Architectural glass</td>
<td>New</td>
</tr>
<tr>
<td>Existing</td>
<td>New</td>
</tr>
</tbody>
</table>
Redefining our technology holdings through left-handed development and expanding into new business areas. Providing society with automotive glass and CRT glass in response to changing times.

Example of ambidextrous development: Glass business

- **Markets and customers**
  - **Existing**
    - Architectural glass
  - **New**
    - Automotive field
      - Right-handed: Automotive glass, CRT glass
    - TV field
      - Right-handed
    - Glass processing and forming technologies
  - **Left-handed**

- **Organizational capability & technology**
  - **Existing**
    - Coating technology, etc.
  - **New**
    - LOW-E insulated glass, etc.
Example of ambidextrous development: Glass business

- A swift response to the historic shift from CRT to LCD TVs
- Development and manufacture of display glass using thin glass forming technology developed over the years

Organizational capability & technology

Markets and customers

- Architectural glass
  - Existing
  - New
- Automotive field
  - TV field
  - Existing
  - New
- Display field
  - Right-handed
  - Ultra-thin sheet float forming technology
- Display glass
  - Right-handed
  - IR-cut front glass
  - Growing CRT size, etc.
- Coating technology, etc.
  - RIGHT-handed
  - LOW-E insulated glass, etc.

©AGC Inc.
Technological innovation in display glass continues to evolve, transforming into cover glass for smartphones and automotive interiors.
Future development direction

- Aim for sustainable growth by pursuing right- and left-handed development in each field

(1) Innovation in manufacturing and basic technologies
   Core business technologies innovation
   (Architectural glass, Automotive glass, Display glass, Chemicals and Ceramics)

(2) Development of next-generation and new products
   Next-generation and new product of Glass, Chemicals and Ceramics

(3) Development of new businesses
   - Strategic businesses (Life science, Electronics, Mobility)
   - Environment
   - Energy etc.

Markets and customers

Organizational capability & technology

Existing

New
Utilization of open innovation
Development strategy

- Issues are becoming more complex than individual companies can solve alone, and the required development speed is accelerating.
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Ambidextrous development

Combining and repeating right- and left-handed development to create new value and contribute to society

Open innovation

Accelerating open innovation with external companies, research institutes, universities, etc. in the AO co-creation space

<table>
<thead>
<tr>
<th>AO Open Square</th>
<th>AO Lab.</th>
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DX

Development using material informatics (MI), AR/VR, etc.

- AMOLEA™
- AR/VR
Open innovation at AGC

Academia and external partners (Customers, companies)

Materials development
Process development
Facilities development

Original materials
Customers
End product

Accelerating co-creation with customers
Toward social reform and advancement
Experience in development partnerships with external parties (1)

Issues faced by automakers at the time

- Design constraints due to antennas
- Existing antennas were prone to damage

AGC technology

- Radio technology
- Antenna wire: Printing and calcination technology

Solution

Glass antenna developed

Conventional image

Glass antenna

A scene from a glass antenna performance test by AGC (1980s)
Experience in development partnerships with external parties (2)

Issues faced by Santen Pharmaceutical at the time

Major overseas pharmaceutical companies were leading in the development of glaucoma drugs
Santen had excellent formulation technology in ophthalmology, but lacked experience in prostaglandin drug synthesis

Solution

Development of eye drops for glaucoma treatment

AGC technology

- Fluorine compound synthesis technology (including prostaglandins)
- Molecular design capability for complex compounds
Experience in development partnerships with external parties (3)

End-user complaints

Concerned about sunburn caused by ultraviolet (UV) rays

Q. What are your frustrations or problems related to your car windows?*

- I am concerned about UV rays: 43%
- It's hot: 27%
- They fog up: 17%
- It's too bright: 14%
- They get dirty easily: 12%
- It is hard to see on rainy days: 10%

Solution

Development of UV-cut front door glass

AGC technology

Glass coating technology

*Results of AGC research

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Recent case study

NTT Docomo

Securing antenna installation sites in urban areas is an issue as 5G expands

AGC technology

- Transparent glass antenna design with low transmission loss
- ATTOCH method for installing antennas in existing windows
- Glass interface layer technology reduces radio wave attenuation and reflection

Solution

WAVEATTOCH™
Collaborative development of a glass antenna that can be attached to existing window glass from the interior side

Enables flexible antenna placement
Turning building windows into antennas in prime locations in city centers
Introduction of industry-academia joint open innovation activities

External academia

Presentation of needs and proposal of issues
Research funding, materials and information
Researchers

Presentation of seeds and proposals for issues
Researchers, students
Knowledge and know-how
Facilities and equipment

Expected impact

✓ Social implementation of research results
✓ Creation of new themes and academic results
✓ Educational opportunities for students

Expected impact

✓ Acceleration of development speed
✓ Creation of new products and businesses
✓ Human resource development and acquisition
Introduction of industry-academia joint open innovation activities

- Strengthening of systematic collaboration by building industry-academia collaboration system and launching collaborative research projects
- Establishment of a joint research space on the university campus
- Joint researchers dispatched from AGC

Partner

Main joint research field(s)

- Glass processing
- Fluorine chemistry
- MultiMaterial
- Bio device
- Life Science
- Mobility

Content of initiatives
New research building established at AGC’s Yokohama Technical Center

- Establishing a new research wing as a place to "connect" inside and outside the Company

Site: On the premises of the AGC Yokohama Technical Center (Tsurumi Ward, Yokohama)
Total construction cost: ¥20 billion
Total floor area: approx. 45,000m² (Including existing researching building area: approx. 70,000m²)
Completion: Completion in 2020, fully opened in 2021
"CONNECT" "CREATE" "MATERIALIZE"
Utilization of DX technology
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AR/VR

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Utilization of VR

- Implement virtual prototyping with VR
  - Accurately identify customer needs and provide products that meet them
  - Accelerate the speed of product development

Development of architectural glass

Development of automotive glass
Examples of using VR for development
Materials development and composition development by MI (material informatics)

- Utilizing MI for material and composition development, aiming to enhance R&D competitiveness and speed up development.
  In addition, researchers who receive proposals for AI will be able to strengthen their creativity.
In the development of fluorine compounds, it is necessary to actually synthesize a large number of candidate compounds. Dramatically shorten development time by narrowing down candidate compounds to 5-6 on simulations.
Numerical method to predict fracture patterns in chemically strengthened glass

- Depending on the production recipe, the way chemical strengthening is applied varies greatly. Destructive testing for recipe optimization was performed on simulations.
- Replaces huge amounts of prototyping with simulations, which can significantly reduce development time

Up to now...

Chemically strengthened Processing

- Observation of fracture pattern
- Analysis of crack

Drop test

Fracture pattern analysis by numerical method (A world first)

(a) Results of observation experiment with high-speed camera
(b) Reproduction with numerical simulation

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Closing
Development strategy

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AR/VR
Vision 2030

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Appendix
Narrowing down priority issues – Stage-gating method

<table>
<thead>
<tr>
<th>Stage</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>2'</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Brainstorming</td>
<td>Conceptualization</td>
<td>Proof of concept</td>
<td>Development</td>
<td>Pilot Business planning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R (desktop)</td>
<td></td>
<td>R (lab)</td>
<td>D (benchmarking)</td>
<td></td>
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</tr>
<tr>
<td>Gate 1</td>
<td>Is it interesting?</td>
<td></td>
<td>Make a sample and have the customer evaluate it</td>
<td>Create engineering samples and get them certified by customers</td>
<td></td>
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</tr>
<tr>
<td>Gate 2</td>
<td>Will it sell?</td>
<td></td>
<td></td>
<td></td>
<td>Can it graduate from development?</td>
<td></td>
</tr>
<tr>
<td>Gate 2'</td>
<td>Can it win?</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spin off</td>
<td>Will it make money?</td>
<td></td>
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</tbody>
</table>

Divide R&D into "stages" and make decisions on the next stage at "gates".

It has a scheme that is easy to gain buy-in.

Deliberations are conducted based on common decision criteria.
R&D expenses by segment

Unit: 100 million JPY

<table>
<thead>
<tr>
<th>Year</th>
<th>Corporate</th>
<th>Glass</th>
<th>Electronics</th>
<th>Chemicals</th>
<th>Ceramics &amp; Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>132</td>
<td>394</td>
<td>78</td>
<td>98</td>
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<td>2020</td>
<td>184</td>
<td>465</td>
<td>102</td>
<td>86</td>
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Never take the easy way out, but confront difficulties
Trust is the best way to inspire people
Strive to develop technologies that will change the world
A sense of mission leads us to advance

For more than a century, AGC has been guided by these founding spirits. Our unique materials, solutions and reliable partnerships have facilitated leading innovations across diverse industries and markets.

Today, by working with others to combine knowledge and advanced technology, we help make ever greater achievements possible, and bring bolder ideas to life.
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