Respecting Diversity, Going for the Future

– Business and R&D Perspective in AGC Flat Glass –

多様性の中、未来に向けて

－AGC Flat Glassにおける事業と研究開発の展望－

Arthur ULENS
アーサー・ユレンズ

Executive Officer, AGC
Acting President, AGC Flat Glass
AGCグループ執行役員、AGCフラットガラス社長代行

In this article we have highlighted specific areas where technological, industrial, R&D and commercial development can benefit from proper understanding of AGC Flat Glass's diversity and international dimensions.

1) Today, though a fully-fledged global organization, AGC is nonetheless eager to strike the right balance between "local" and "global". On the local level, three regional entities operate on the business and R&D sides. Synergy between all regional operations is part of the global management process.
2) A general overview of the flat glass market shows shifting trends but still unsaturated markets in certain product categories. In any event, tight cost analysis and quality management are essential. All processes that encourage sustained, cross-border product innovation are to be properly managed.
3) R&D management must trigger both the individual input of each researcher and the global collective input. All recommendations and ideas generated by the cross-regional coordination can turn into value-adding steps.
4) There are two ways of looking at energy such as environmentally friendly manufacturing processes/glass products. In both cases, CO_2 reduction levels are important for our social corporate responsibility and also for our industry.

The market is expanding dramatically. It is time for the entire AGC group to optimize its diversity, its technological expertise and assets in a global manner together, involving not just all the FGC regions but also other in-house companies and AGC corporate.

本稿では、研究開発、製造技術開発またはビジネス開発が、AGC Flat Glassの多様性と国際的な広がりを正しく理解することで得られる効果について、いくつかのポイントに焦点を当てて論じた。

1）AGCは今日では真にグローバルな組織ではあるが、それでも尚「各地域」と「グローバル」の適正なバランスを常に心がけることが重要である。「地域」レベルでは3極がそれぞれの事業と研究開発を運営する一方、「グローバル」運営の中で地域間のシナジーを発揮しなければならない。

2）板硝子事業の市場全体観としては、変化のトレンドが窺えるものの、いくつかの製品群に関しては未だ未成熟市場と言える。その全てについて厳格なコスト分析と品質管理が重要である。また革新的商品開発を支援するプロセスがあらゆる境界を越えて適正に運営されなければならない。
3）研究開発の運営は、各研究者の個人的情報として、またグローバル全体観情報として、そのトリガー機能を果たさなければならない。地域を越えたコーディネーションによって生まれたアドバイスや新しいアイデアは、次なる高付加価値の種となり得る。
4）エネルギーに関しては、2つの視点が考えられる。環境に優しい製造プロセスおよび商品である。どちらの場合でも、CO_2の削減は企業の社会的責任において、またわれわれ硝子業界にとっても重要な命題である。

市場は劇的な広がりを見せている。今こそAGCグループ全体で、その多様性、技術の叡智とアセットをグローバルに最適化する時である。FGCの各地域間だけでなく他のインハウスカンパニーやAGCコーポレートとも一緒に取り組んでいきたい。

1. Introduction

A single vision has driven us over the last decade: to be recognized as the best flat glass producer in the world. As a result, we are now the largest glass manufacturing company with the largest market share in the world.

Today, though a fully-fledged global organization, AGC is nonetheless eager to strike the right balance between ‘local’ and ‘global’.

On the local level, three regional entities, Japan/Asia, Europe, and North America, operate close to regional customers, an acknowledgement of the fact that, however global the market may be, different regions may require different performances within the same product category. To this end, each region has its own regional HQ to manage its own business, including the allocation of resources.

To understand the extent of this regional organization, just take a glance at our worldwide business sites. From the cold of Russia to the heat of Thailand or Indonesia, every market speaks with a different voice in its day-to-day communications. Our ability to recognize and satisfy these different voices, to accommodate new products or services and customize wherever necessary, will sow the seeds of our success and trigger new developments.

On the global strategy side, our company HQ in Belgium ensures greater synergy in all operations, whether identifying business opportunities in emerging countries or benchmarking in production and product development.

Research & Development is one of the most promising areas for global collaboration, in terms of generating the right ideas on the service and product sides and offering adapted technical support to current business.

This article will focus on the way our R&D operates across the organization, both locally and globally, in order to fully optimize diversity and pave the way for the future.

2. General Overview of the Flat Glass Market

To gain a better understanding of how R&D works and its importance in preparing for the future, we need to take a helicopter view of the current situation in the flat glass market.

2.1 Global Market Overview

Figure 1 shows the history of float investments, with the circles indicating the number of float lines in each region. In the 1960s, when the technology was in its infancy, there were only 19 lines worldwide and most investments were concentrated in developed countries.

Over the last decade, investments in emerging countries have taken the lead, mainly in China but also in other areas such as Asia Pacific. This has brought new players to the game.

Globally, at the end of 2006, we estimate there were 337 lines representing a total capacity of 60 million tons/year. In 2007, the capacity is estimated at around 65 million tons, with 40% concentrated in China.

Capacity development has clearly followed the demand trend. Initially this involved developed countries with high consumption levels in Western Europe and North America. Today however, the potential is clearly shifting to emerging countries: two-thirds of incremental demand over the next

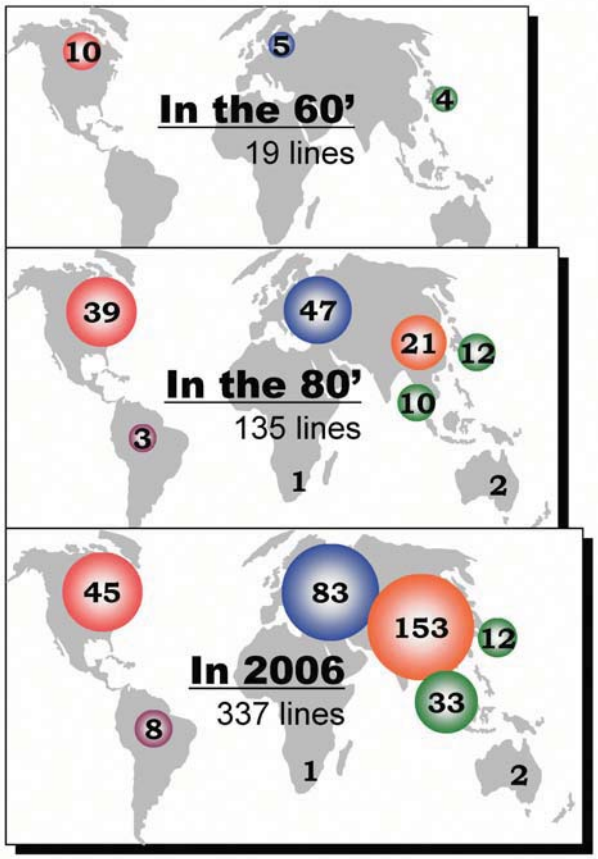

Fig. 1 History of float investments.

five years will come from China. High market potential and growth rate combined with cost advantages (as illustrated in **Fig. 2**) explain why capacity investments have been so high in these countries.

As a result, the industry is now threatened with substantial overcapacity, mainly from China (**Fig. 3**).

Commoditization of certain glass product ranges is inevitable. AGC Flat Glass is gauging these trends and shifts, seeing them as so many motivators and challenges to be seized. Innovation is a keyword in its strategy (**Fig. 4**).

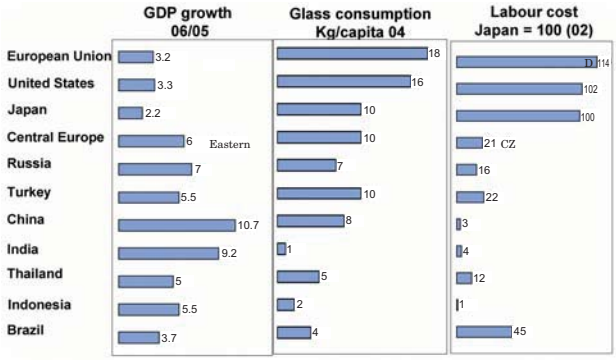

Fig. 2 GDP growth, market potential, and cost advantage.

2.2 Value-Added Product Penetration

Table 1 shows the penetration of the main value-added products in the five main geographical regions.

EU shows high demand and high penetration but there is a marked and major shift to the Russian market in terms of percentage growth, especially

Table 1 Demand and Growth of Value-added Products by Region.

2005 demand Million m^2	EU	NA	JAPAN	CHINA	RUSSIA
Insulated glazing	162	150	15.1	60	17
Low Emissivity	96	105	3.1	5	3
Laminated glass	65	8	2.2	8	0.7
Mirrors	44	26	3.7	25	5

2005 Growth %	EU	NA	JAPAN	CHINA	RUSSIA
Insulated glazing	5	−2	5	40	15
Low Emissivity	7	14	15	40	100
Laminated glass	7	10	40		40
Mirrors	−2	−10	0	10	6

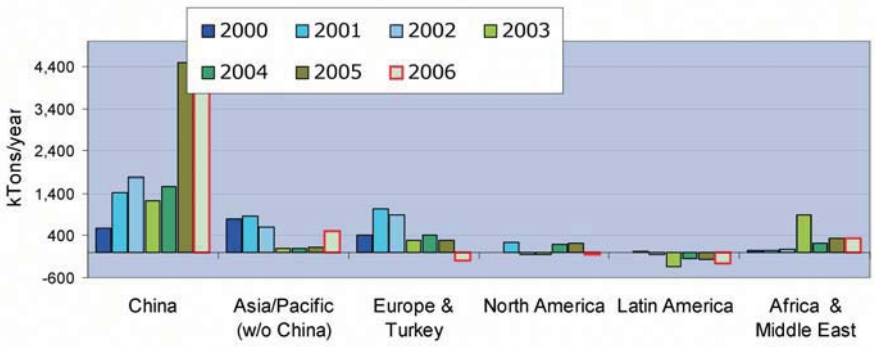

Fig. 3 Supply/Demand balance by region (import/export is not considered here. Postive value means over capacity).

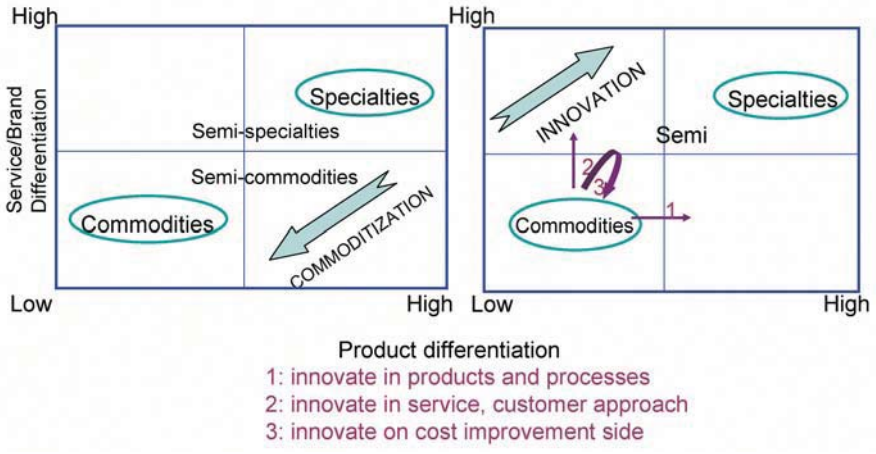

Fig. 4　Commoditization and innovation in differentiation.

in the Low-E sector. Energy regulations and standards are key incentives for increasing penetration rates. This can be seen clearly in North America where strong promotion by government programs has led to high penetration levels of both insulating and Low-E glazing.

In China, new energy regulations for public buildings were implemented in 2005 and have led to a considerable growth in insulating glazing and Low-E glazing: to such an extent that Chinese demand for insulating glazing, which is one third that of the EU, is already four times higher than Japanese demand.

In Japan, demand for laminated glass is increasing because of security concerns such as theft and earthquakes.

Compared with float, the general increase in value-added and therefore profitable products is beneficial to our industry. Certain markets are far from saturated and high growth can still be expected.

2.3 Strategic Consequences for AGC Flat Glass

This helicopter view enables us to identify two key issues:

− Firstly, the cost and quality aspects of our products are paramount if we are to capture growth in emerging markets while developing specialties in mature markets.

To this end, we must promote efficient communication exchanges and synergies at various levels: between R&Ds for best product/process development, between production units for best manufacturing processes, and between marketing and sales for best product positioning and commercial impact. All these synergies will provide us with the right products and services for the right market and thereby foster opportunities for growth.

− The second key issue, based on our experience, is that today's specialties will turn into tomorrow's commodities. Sustained product innovation leads to products with higher added value. Sustained product innovation is essential if we are to resist newcomers and stand up to rival commodities, unable to match our technical expertise and R&D investment. In fulfilling this major task, R&D takes centre stage and production units occupy the lead role.

3. AGC Flat Glass R&D

The previous chapter focused on market shifts in the areas of commodities and value-added products.

In preparing for potential business opportunities or threats, we need to refine our positions and optimize our business strategy using all the best resources available to us in our global and regional organizations.

3.1 Organization by Region

R&D too has a regional structure, enabling it to face the changing market head-on. Each regional R&D manages its own operations, acting in close cooperation with the AGC Corporate Research Center whenever necessary (**Fig. 5**).

In each regional R&D, all projects are managed using the Project Portfolio and Stage Gate systems (**Fig. 6**). Both are well-known worldwide and enable efficient allocation of R&D resources.

The Project Portfolio management system allows us to assess both the technological and commercial potential of each project. This helps us to gain a general overview of the status of all of our R&D projects.

The Stage Gate system performs a screening function so that assets are concentrated on the most promising project candidates. Throughout the

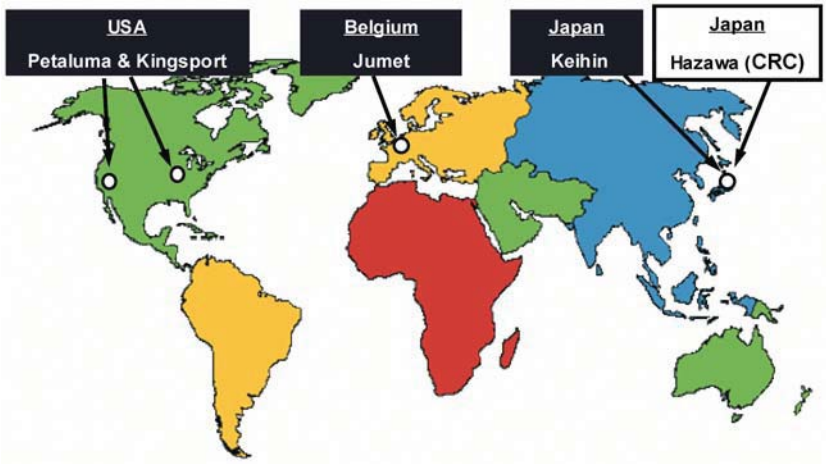

Fig. 5 Flat Glass Company R&D and Corporate Research Center.

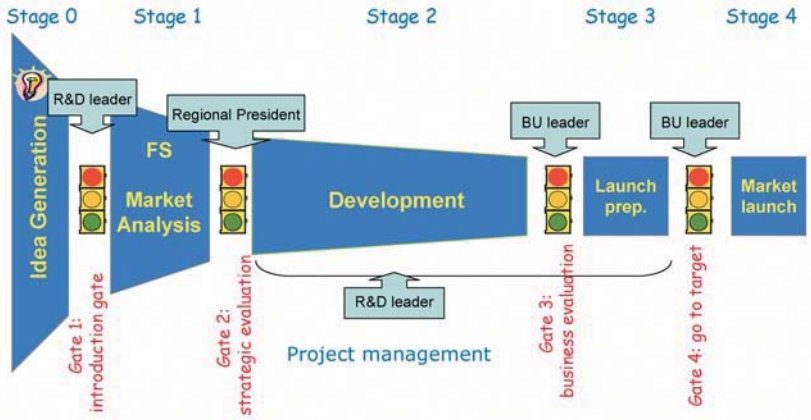

Fig. 6 Stage Gate system for project screening.

Stage Gate process, 'gate keepers' enable a range of useful developments, such as setting up meetings to pool all constructive ideas, while managing the entire process efficiently. This is essential as generating ideas is key to the whole R&D process. To be successful, the process must rely on stimuli that will trigger both the individual input of each researcher and the global collective input.

3.2 Global Collaboration for Synergy

Once the regional R&D strategy has been set up, we share the information and discuss possible collaboration.

During the process, some of the initiated projects prove technologically and commercially attractive to other regions and become 'shared projects'.

Once a project is 'shared', its development cost will be shared with other sponsoring regions. The actual implementation of the shared project becomes the responsibility of the initiating region. In practical terms, this means that the initiating region is accountable for progress and budget control across the regions during global R&D meetings which are also open to other divisions. Shared projects are a goldmine in terms of garnering recommendations and ideas from others. All recommendations and ideas generated by this cross-regional coordination can turn into value-adding steps. Diversity is one of the major advantages of this organization.

3.3 Going for the Future

For longer-term project management that will sow the seeds for tomorrow's business, we have introduced additional systems.

– *Competence meeting*

Our R&D activities are split up into specific technological competence areas, such as 'Melting', 'Coating', 'Surface treatment' and 'Transformation'.

Within each competence area, we can identify the most relevant topics and launch competence meetings with a network of experts to generate new ideas for the future.

– *Study (focus) teams*

Special 'study teams' can be set up to concentrate on specific issues such as a new technology or a new global applications process. All results are

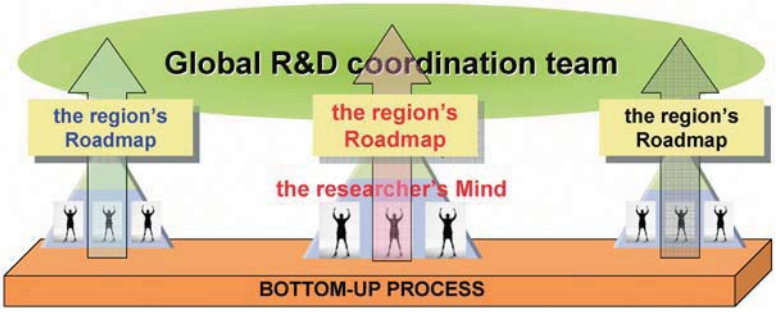

Fig. 7　Roadmap for global process.

also reviewed in global R&D meetings involving other divisions, if necessary, to assess the relevance of the project.

– *Roadmaps*

We have also developed roadmaps with a view to longer-term development. These are important for practical planning purposes but are also essential to enable each researcher to act as an individual, creative, and potent mind.

In view of this, we began by developing regional roadmaps involving researchers and broken down by competence/application, and then summarized them to gain a global viewpoint (**Fig. 7**).

These systems sometimes lead to 'future (long term) projects', which involve innovative processes with high potentials, big benefits but also investment risks. The Flat Glass Management Committee will take a decision on the project's viability and invest in innovative technology at a global level, hence minimizing the potential risk.

3.4 Respecting Diversity

In global communication, generating new ideas is the only way forward. This means being able to understand each other across all languages, cultural habits, business etiquette and ways of thinking. In other words, global communication means respecting diversity.

For a perfect example of diversity, you need look no further than our European product website - yourglass.com - where product ranges are described in nine different languages: English, French, Dutch, German, Spanish, Italian, Czech, Russian and Polish [1].

At the same time, however, diversity is something that can be exploited, by gathering expertise and learning from different cultures to create brand-new technologies and strategies. Indeed, provided we can all understand each other, diversity should be one of our organization's key assets.

4. Energy - A Focus for the Future

Climate change and global warming are the strategic issues of the 21st century, and environment and energy consumption are part of our corporate social responsibility. There are two ways of looking at energy:

– Firstly, in terms of environmentally friendly manufacturing processes.

– Secondly, in terms of environmentally friendly glass products.

4.1 Environmentally friendly glass manufacturing processes

Nowadays, the energy required to melt a ton of glass is less than 10% what it was a hundred years ago (**Fig. 8**). This improvement means that nowadays the energy needed to melt a ton of glass is approaching a theoretical minimum level, notwithstanding ever more demanding quality requirements.

Lower energy use has clear benefits for the environment but also for cost reduction. We need to push ahead with the energy reduction drive in other areas of our industry, focusing on raw materials, potential fuel alternatives to oil and gas, designing optimal float processes, and developing advanced defect inspection technologies.

In all our manufacturing developments, numerical simulation has played an important role in understanding the mechanism of complicated phenomena by enabling virtual experiments before actual equipment is bought or used (**Fig. 9**). This has proved particularly useful in the float process as the melting furnace and forming bath are highly complex pieces of equipment and extremely difficult to visualize.

However, simulation technology should not be the only answer. R&D's close involvement with plant operations is key to the development of future processes. Through all these collaborative efforts between the different regions, we have successfully applied new float manufacturing technolo-

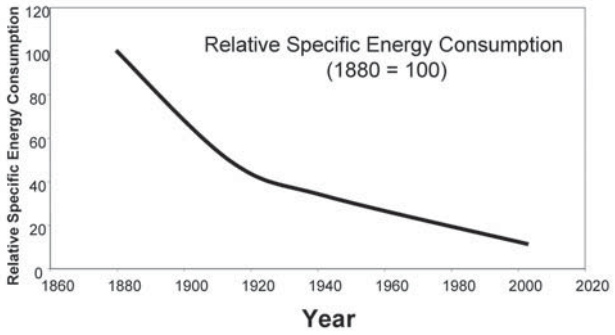

Fig. 8 Relative specific energy consumption in melting glass [relative value/ton].

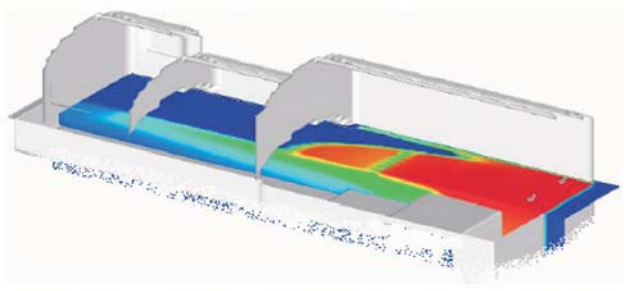

Fig. 9 Numerical simulation in float process.

gies to improve glass quality while cutting energy consumption.

4.2 Environmentally friendly glass products

Our high performance coatings offer consumers energy-efficient solutions that are ideal in terms of both heating and air conditioning consumption. Our range provides solutions for all types of climates - from the very hot and humid to the very cold - with solar control glazing, low emissivity windows and insulating glazing units that offer total comfort while using less energy and emitting less CO_2.

Let us take an example concerning Low-E glazing (**Table 2**).

- Manufacturing one m^2 of Low-E double glazing emits 25 kg of CO_2.
- Replacing one m^2 of single glazing with Low-E double glazing saves 91 kg of CO_2 a year.
- In other words, by replacing all single glasses with Low-E glasses, the CO_2 emitted during production is offset after 3.3 months of use. It is offset after 10.5 months if basic double glazing units are replaced with Low-E double glazing.

Our energy performance range is now marketed across all our markets [2][3][4]. The penetration level varies widely, depending on local regulations. We are committed to further developing these intelligent, smart and energy-efficient coatings together, in a spirit of global coordination.

Table 2 CO_2 Pay-back by Low-E Glazing.

Manufacturing Low-E double glazing	Generate CO_2: 25 kg/m^2
Using Low-E double glazing	Save CO_2: 91 kg/m^2/year
Replacing single glass by Low-E double glazing	Pay-back CO_2: 3.3 months

4.3 Clean Energy

As committed advocates of ***"Look Beyond"***, we need to facilitate more active implementation of clean energy solutions. Many government initiatives already exist worldwide and the solar cell market is forecast to increase dramatically in the near future (**Fig. 10**).

This is an area where AGC has been particularly proactive for a long time. By supplying cover glass for crystalline silicon units and TCO (transparent conducting oxide) for amorphous silicon units [5][6] (**Fig. 11**, **Fig. 12**), AGC has also helped to boost the performance of solar cells thanks to specific textured surfaces, composition designs, and process technologies.

TCO has three important properties that increase the conversion efficiency of solar cells: high transparency, low electric resistance, and light trapping capability. Our new advanced TCO coating is expected to increase cell efficiency by around

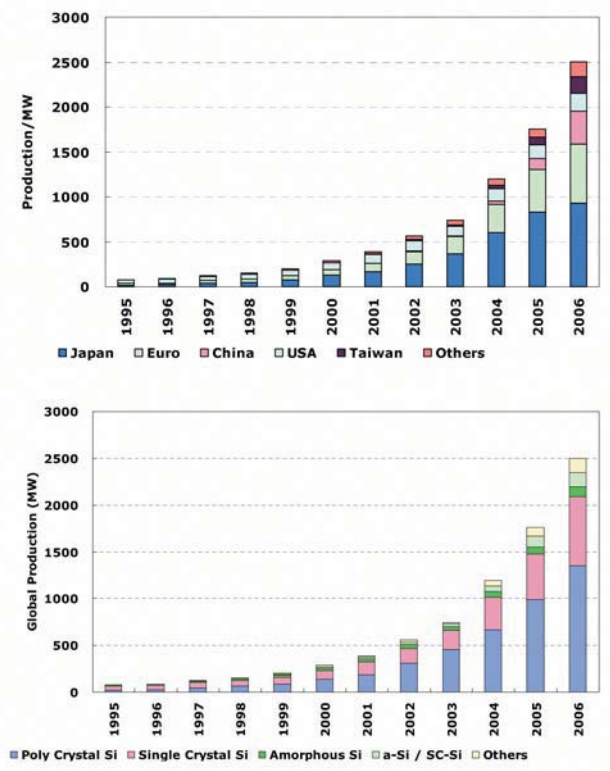

Fig. 10 Global market development of solar cell production.

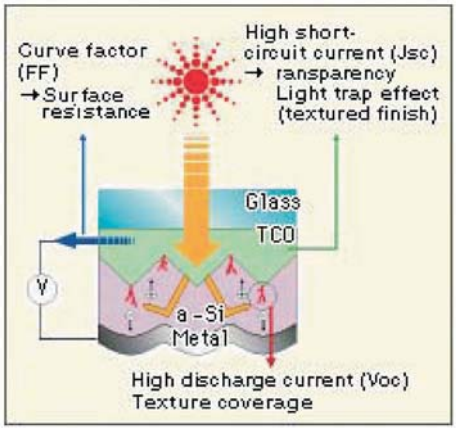

Fig. 11　Structure of amorphous silicon type solar cell.

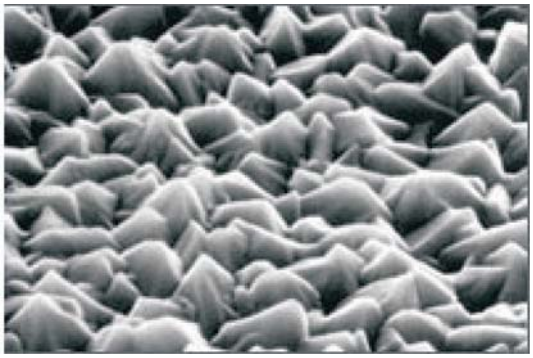

Fig. 12　Textured surface of TCO.

10% compared to other glass types. Furthermore, depositing it on larger substrates will lead to lower costs.

As far as cover glass is concerned, anti-reflective coating can improve solar cell efficiency by more than 2% and the most efficient patterned assembly and combinations can help boost light capture and conversion performance.

Finally, windows are the biggest surface available in a building and thanks to BIPV (Building Integrated Photovoltaic) they can be made to perform an additional function, generating power from solar energy which is otherwise completely wasted.

5. Conclusion

In this article we have highlighted specific areas where technological, industrial, R&D, and commercial development can benefit from a proper understanding of AGC Flat Glass's diversity and international dimensions.

1) Today, though a fully-fledged global organization, AGC is nonetheless eager to strike the right balance between 'local' and 'global'.
   On the local level, three regional entities operate on the business and R&D sides, close to each regional customer, an acknowledgement of the fact that, however global the market may be, different regions may require different approaches, services, or product ranges. Synergy between all regional operations is part of the global management process.
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4) There are two ways of looking at energy:
   − In terms of environmentally friendly manufacturing processes.
   − In terms of environmentally friendly glass products.
   In both cases, CO_2 reduction levels are important for our social corporate responsibility. Yet, both also hold great benefits for our industry, by generating cost reductions through improved processes and by creating brand-new added-value energy-efficient products.

The market is expanding dramatically. It is time for the entire AGC group to optimize its diversity, technological expertise, and assets together in a global manner, involving not just all the FGC regions but also other in-house companies and AGC corporate.

By doing this, AGC will continue to make new breakthroughs and maintain its position as the leading glass manufacturing company.

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