

# Developing New Applications for Acrylic Glass

Interviewer: Takamasu Kanji

**T**HREE whale sharks, four mantas and a number of other subtropical ocean fish swim on the other side of the massive transparent wall. This huge tank, located at the Okinawa Churaumi Aquarium, contains 7,500 tons of seawater, and its 8.2m tall 22.5m wide acrylic glass panel is the biggest in the world. The panel was built by Nippura, a small enterprise of just 71 employees based in Kagawa on the island of Shikoku. Nippura has developed transparent walls and panels for aquariums all over the world — in ring and cylindrical shapes, and in tunnel ceilings where people can look at schools of fish swimming overhead — by using acrylic panels. The company has constructed transparent walls for large tanks at 120 facilities in nearly 40 countries, and boasts about 70% share of the world market. We interviewed Shikiyama Tetsuhiro, a man with the charisma of an inventor, and the founder of Nippura.



## Where did you deliver your first big aquarium panel?

**Shikiyama:** In 1969, there was a plan to build the Yashima aquarium in our home town of Takamatsu City. The aquarium director was not satisfied with the traditional museum-style viewing of separate tanks, and he ordered instead a ring-shaped tank in which the fish could swim around, while people watched them from inside the ring.

Glass was used for aquarium panel materials at that time, and the conven-

tional tank manufacturers all withdrew from the project, saying it was impossible to make the round, curved glass panels needed to realize this novel concept. From my previous experience, I was confident that I could create panels using acrylic glass, which allow freer shapes than using glass, and decided to bid for the construction.

The aquarium was completed 35 years ago, and the panels are still in use.

## How did you come up with the idea of using acrylic glass for the aquarium panels?

**Shikiyama:** I first came into contact with acrylic glass in 1964. I learned about it from books at first. Acrylic glass has a lot of interesting properties. It is highly transparent and strong with only half the weight of glass. It is strongly resistant against wind or snow, and almost never reacts with seawater and is easily molded. I looked around for various kinds of products that could make the most of these characteristics. These included roof panels for shopping arcades, lampshades decorated with embedded wood or bamboo, decorated windows and doors for cafes, and fish tanks for Japanese-style restaurants.

Based on these experiences, I knew that using a transparent glue could thicken the panels for greater strength and create aquarium panels made out of round links.

## What sort of technical innovations did you develop?

**Shikiyama:** The kind of homogeneous acrylic glass panels that we want to assemble can only be created up to a thickness of 4cm in chemical plants. What we do is bond these panels together to create one that is several tens of centimeters thick and capable of withstanding water pressure. However, to ensure that the extra thickness does not degrade the transparency or distort the view inside the water, developing a transparent glue is the key. To prevent water leakage, completely waterproofing the joints between the panels and the main body of the building is also important.

At the present time, the world's biggest aquarium panel is at the Okinawa Churaumi Aquarium. The panel can withstand the pressure of 7,500 tons of seawater, is 60cm thick, and is made from 14 layers of acrylic glass.

We get our acrylic glass panels from a chemical maker, then make its surface flat, bond the layers together and bend or mold them to the required shape with our technology. Modules are built in sizes that can be transported, and are then shipped to the construction site for assembly. We always have some employees at the site for this task, no matter how remote the location. The amount of time spent in assembly,



which includes bonding the modules together and waterproofing, can last anywhere from three to six months for a big project.

#### What do you use for the adhesive?

**Shikiyama:** We use an acrylic material. The glue must be transparent and have an even optical refraction to eliminate distortions.

#### Nippura's innovative panels have enhanced the popularity of aquariums in Japan. How did you manage to penetrate markets outside Japan?

**Shikiyama:** The boom in aquarium construction in Japan led to an unending string of orders, and our business expanded steadily. At that time, other companies were doing nothing, but eventually a major chemical company entered the aquarium panel market. We had confidence in our technology and had built up a certain amount of experience, even though Japanese consumers tend to place more trust in brand names. Technology alone is not sufficient, sadly enough. Gradually the best places were taken by our competitor.

We then turned to such nearby countries as South Korea, Singapore and China. But what really brought our name to the attention of aquariums in the world market was our work at the Monterey Bay Aquarium in California 11 years ago. We heard later on that three companies had tendered for the work, and Nippura's bid was second in terms of price. Fortunately, Monterey gave more weight to technological capability and the quality of the product than to brand names or low cost.

At the loading stage, we were confronted with a major problem. The United States had just added acrylic glass to its list of anti-dumping tariffs. We were perplexed by this. Monterey had to pay a 36% tariffs to import the panels. Consulting various people in Tokyo accomplished little – finally the US Embassy introduced us to the official in charge at the Department of



*An example of Nippura's vertical bonding technology*

Commerce in Washington. He advised me to export our panels as a product rather than a material. During the conversation, the official even suggested a name, "AQUA-WALL," which we use as our brand name now. As a product, the tariff was only 2.7%. The whole consultation took no more than 30 minutes to complete. However, I was desperate for a solution since I knew that if the customer were forced to pay such a high tariff, we would not have any work in the United States in the future.

Monterey's Director Julie Packard was extremely happy with the result and at the aquarium's opening ceremony, she celebrated the completion of the tank as well as our cost-reduction efforts. The ceremony was attended by aquarium officials from across the globe, and Nippura's name was suddenly spread worldwide. It was a job that proved to be a major turning point for us. We received orders in quick succession from New York, Monaco and Australia.

What is interesting is that, later on, Japanese people going overseas to inspect the world's most famous aquariums discovered that the tank panels were constructed by Nippura, and as a

result our business in Japan expanded rapidly. We received orders for a number of major projects, including the Osaka Aquarium Kaiyukan, the Yokohama Hakkeijima Sea Paradise, and the Okinawa Churaumi Aquarium.

#### What is the key point for international business?

**Shikiyama:** The foreign exchange rate. At present, our sales ratio between Japan and abroad is 3:7. When we converted the sum we received into yen after finishing the Monterey project, we suffered a major exchange loss. We had bad luck. The rate was ¥79.75 to the dollar, which even now is the highest rate against the dollar ever seen. We were forced to carry out corporate restructuring and increase production at the same time. Since then, we have been able to maintain a profitable business at a rate of ¥90 to one dollar.

#### Besides aquarium panels, what other products do you make?

**Shikiyama:** There are many types of acrylic glass. The products that utilize our adhesive technology include the

*Photo: Nippura Co., Ltd.*

transparent protective masks attached to the helmets of policemen at the 2002 FIFA World Cup, which was co-hosted by South Korea and Japan. But this kind of product is not for sale in the market, and we cannot really talk about the details because it is a matter of public security. We developed screen panels by using the same acrylic glass bonding technology.

### What kind of screens are these?

**Shikiyama:** These are giant screen panels for rear projection devices. Our screen panels are seamless despite their large size and the resolution and brightness are good enough for HDVR projections. At present, we are manufacturing screens in 72-inch to 100-inch sizes mainly for the North American home theater market.

A 200-inch large screen, presenting 3D images, is to be used in the “NEDO Technorium” pavilion at the EXPO 2005 AICHI, JAPAN. A screen will also be used for the sensory visual image space by the movie director Oshii Mamoru, the “Open Your Mind” at the “Mountain of Dreams” (the joint pavilion produced by the Chunichi Shimbun). Bright and clear images can also be obtained on the hemispheric screens, and one is being

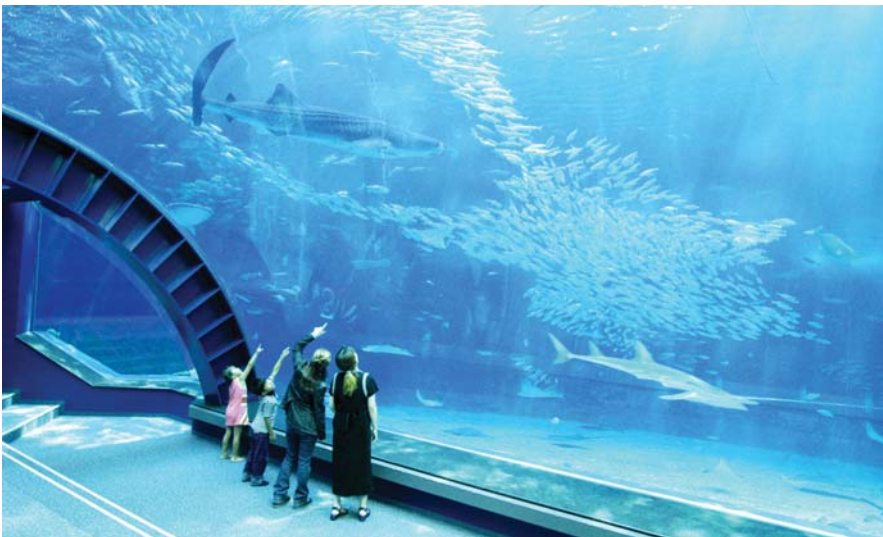
installed for advertising purposes at the TEPCO Electrical Energy Museum in Shibuya, Tokyo. In all of these cases, the customer had just about settled on the use of another screen, but cancelled it so that they could use our screens instead, all of which has strengthened our confidence in visual quality.

We also expect to see these screens used as panels for conferences and lectures. You can display images as well as write on the surface. They can even be used as a PC touch panel replacing the mouse for application software.

### These products sound quite far removed from the aquarium panels. What technologies are you using for these screens?

**Shikiyama:** These, too, are a development of the acrylic glass panel bonding technology. We sandwiched a special glue between two panels, and constitute the image in that adhesive layer. Technically, the creation of an adhesive surface which is more homogeneous than the aquarium panels is required to ensure that there are no distortions in the image. Since the image is constituted in the internal layer, users can write freely on the screen surface.

*Photo: Nippura Co., Ltd.*



Okinawa Churaumi Aquarium

### The mass production of identical-quality products is particularly important for rear projection TV screens, which is an adventure on unknown seas to you. How do you propose to respond to this challenge?

**Shikiyama:** The aquarium panels are produced as unique separate orders, and we only make a few of these each year. But for home theater screens, we can expect demand amounting to tens of thousands or even hundreds of thousands of orders. This is a field in which our company has no experience.

Since this is all still in progress, I am not at liberty to say anything specific. However, for this challenge, we think that perhaps we will import the basic material, then assemble the final product in the Okinawa Special Economic District. Some major consumer-electronics makers have expressed a strong interest in a rear projection TV device, and are beginning to launch manufacturing projects at various stages for the world markets.

Our company is currently studying where to order the manufacture of organic acrylic glass, how to carry out product assembly and other specifics, and we are making moves to hire people who can take charge of mass production projects. If everything goes smoothly, Nippura may be able to realize a major new product that may even surpass our aquarium panels in the future. In that case, the company and the number of employees is likely to become much larger.

### Why do you manufacture the home theater screen panels in Okinawa?

**Shikiyama:** I am determined to have our products made in Japan. I want to be able to show the world that high-quality products are made in Japan. That is the reason we are so fixated on making our home theater screen panels in Okinawa. The brand name is essential for building customer trust.

Photo: Nippura Co., Ltd.

**It seems that you have many corporate secrets regarding manufacture.**

**Shikiyama:** People recommended taking out patents for both the aquarium panels and the screen panels, but I have not done this because I am confident that no one else in the world can make acrylic glass products of the same quality as ours. Moreover, the very act of applying for a patent would require me to reveal what I hold in my hand, which could lead to the appearance of copy-cats.

I believe that our technology is a case of “the craftsmanship of master workmen and artisans.” Our factory has no automation whatsoever, with everything made using tools and manual operations. Even if you understand the theory, the skills of a master workman cannot be learned in a day.

**Do you keep development secrets and technology from Nippura employees, too?**

**Shikiyama:** No, I teach the employees everything. Nevertheless, I have always personally been in charge of the development of new products. I have never had partners. I hope that young employees with a sense of urgency will become desperate enough and convert new ideas into products.

**What kind of entrepreneur do you think you are?**

**Shikiyama:** From my childhood, I always wanted to be independent. But I have never really thought about making the company bigger. All I wanted was a company that I could maintain at a size suited to my talents, to aim for the creation of high value-added products, and to avoid being overwhelmed by the waves of public opinion. We had officially announced that our initial goals for the manufacture of screen panels were 12,000 units per year with annual sales of ¥1.5 billion. At present, though, we are proceeding even more cautiously. I myself have reached a ripe old age, and I do not want to make a huge facility investment that will be criti-



*The world's biggest aquarium panel (22.5m x 8.2m) at the Okinawa Churaumi Aquarium*

cized for leaving a negative heritage for the next generation.

In the area of product development, we are focusing on the development of new applications more than the development of new materials. I might be the type of technologist who is not really suited for mass production. It is now 40 years since I first became interested in acrylic glass, and I have thought of nothing else but possible new products for acrylic glass. From aquarium panels to screen panels, the common theme has been the pursuit of new applications.

**With your share of the world market for aquarium panels at about 70%, do you feel that the market is already saturated?**

**Shikiyama:** That is not the case at all. The figure is about 70%, but there are only three companies making aquarium panels in the entire world, including ourselves. The market will probably stabilize at about ¥1.5 billion annually.

Having been involved with aquariums

for more than 30 years, I believe that we have accumulated quite a bit of knowledge of various kinds. We can even offer a fair amount of advice for an appealing exhibition, and have even increased our knowledge about fish ecologies, so that we can supply fish haven rocks and other environmental materials for the tanks. I think there are possibilities for new display methods to be combined with our screens.

We are proud that not a single accident with our AQUA-WALL has ever occurred. While our guarantee term is set at 10 years, it would appear from Yashima that our products are fine for at least three times longer than that. But since bad rumors can spread just as quickly as good rumors, we never make compromises on technology, and are always prepared for whatever may happen. **J.S**

Takamasu Kanji is an editor and biographer. He is also a senior advisor to the foreign editor of the New York Times.