

Aiming to be the 'Center of the World' for Laser Diodes

Sony Shiroishi Semiconductor Inc.



The Shiroishi River flows gently by the site.

In the distance, the Zao Range holds on to its last remaining snow.

Sony's laser diode production facility, which boasts the top share in the industry, is located in the midst of relaxing nature.

While putting down roots in the region, Sony Shiroishi Semiconductor is leading the world in laser technology, in both R&D and manufacturing.

Next spring, when the swans, which are the symbol of the region, are about to take flight, mass production of blue-violet laser diodes will begin.

Completely Unified System With a Strong Leading Role

In laser diode manufacturing, MOCVD* crystal growth is said to be the first, and largest, difficulty. Sony Shiroishi Semiconductor is a manufacturing site that is unique in the world, even if we only consider its unified production system, which includes all four manufacturing processes from MOCVD, to the following wafer, assembly, and testing processes.

However, this site's uniqueness does not stop there: Sony moved its blue-violet laser development group here from the Research Center in Yokohama in 1999. By being entrusted with the development and design of the blue-violet laser for the next generation of large-capacity optical discs, Sony Shiroishi

Semiconductor became a critical site that holds the fate of optical media in its hands. Sony Shiroishi Semiconductor's president, Isao Umezawa, describes the merits of the fully integrated manufacturing system as follows.

"Even if one understands that mass production can be performed under the given conditions in a development line, when one switches to a mass production line at a manufacturing site, things do not proceed smoothly. The scale of operations and the actual equipment used are different, and the conditions end up being different. While this is the same for all silicon semiconductors, lasers are a particularly difficult device. For that reason alone, it is important to be able to apply exactly the same conditions as used in development to mass production."

Plainly stated, the main difference between lasers and other semiconductor devices is "the reversal of the leading role to the epitaxial stage." "While the equipment used for growing crystals is called "epi(taxial)", the conditions in these epitaxial growth furnaces differ slightly between each other. This is because the growth must be controlled on a nanometer scale. In silicon semiconductor devices, the epitaxial process is truly our hidden strength, and the processes that form





Isao Umezawa

President
Sony Shiroishi Semiconductor Inc.
Senior General Manager
Semiconductor Laser Division
Photonic Device & Module Business Group
Micro Systems Network Company
Sony Corporation



Masao Hanai

Managing Director
General Manager
Manufacturing Div.,
Supply Chain Production Dept.
Sony Shiroishi Semiconductor Inc.

circuits based on that foundation are the main area of concern. However, lasers are exactly the opposite: the epitaxial process is the star. This is because the quality of the laser diode product is changed greatly by how well the crystal growth can be controlled. It is safe to say that 80% of the competition with other companies in this area is determined here.” Managing director Masao Hanai describes the essence of the epitaxial furnaces as follows.

“Subtle differences in the behavior within the furnace, for example the amount of gas flow or direction of flow, can cause problems. Therefore the technology and know-how accumulated up to now is our great strength in the control of crystal growth.” This is a sturdy technological foundation for this greatest of technological problems, crystal growth. To take advantage of this, we have created a route consisting of a unified system from research and development through manufacturing, and are progressing toward mass production of blue-violet laser diodes one step at a time.

* MOCVD: Metal organic chemical vapor deposition

Keeping the Center of the World in Sight while Spreading Our Wings in the Tohoku Region

President Umezawa has said that he “wants to make (Sony Shiroishi Semiconductor) the ‘center of the world’ for laser diodes.”

“Ten or fifteen years ago, Sony Shiroishi Semiconductor was a site that only performed assembly operations. This site has a tradition of managers who have been committed to making it a unified system. The previous manager, who was fond of Mah-Jong, used to say “ikki tsuukan da!” (a pun on “unified” and a situation in Mah-Jong). Due to this commitment, various processes were moved here over the years. (See the chronology table.) Since the result of this process has been to create the current system, which is rare in the semiconductor industry, I hope to push this process even further and make this site the ‘center of the world’ for laser diodes. If you go to Shiroishi, you can learn anything and everything about lasers. We are always racing at the leading edge. That’s the sort of site I hope to create here.”

Managing director Hanai then emphasized his feelings for the region.

“Although the shift to foreign production is accelerating in the manufacturing industries, I want to keep not only the wafer processes,

but the assembly processes as well, here in Shiroishi. We are continually striving for revolutions in production, yield, and facilities. For example, in the facilities area, about 90% of the epitaxial furnaces and high-precision mounting stations in the assembly system are internally manufactured equipment that we designed ourselves. I hope to be able to take even better advantage of such technologies and also to contribute to stable employment in the local community.”

Managing director Hanai recognizes persistence and single-mindedness as a common, regional personality trait among the locally hired employees, who make up 70 to 80 % of the work force.

“Our employees do excellent work, even in the face of difficult problems. While our employees do not have the effusive and showy personality of the dahlia, their diligent efforts pay off.”



Sony Shiroishi Semiconductor Inc. (As of April 1, 2005)

Address: 3-53-2 Shiratori, Shiroishi-shi,
Miyagi Prefecture

Site area: About 150,450 m²
(with an addition 10,000 m²)

Buildings: Building 1: About 10,778 m²
Building 2: About 1,994 m²
Building 3: About 2,825 m²

Main products:

- Laser diodes
- Laser couplers

Number of employees:

943 (including temporary staff
and employees of subsidiaries)

Chronology

- November 1969: Sony Shiroishi Semiconductor Inc. established
- 1970: Manufacture of power transistors started
- 1986: Manufacture of laser diodes started
- 1989: Manufacture of laser couplers started
- January 1994: ISO9002 certification acquired (manufacture of compound semiconductors)
- March 1997: ISO14001 certification acquired
- July 1997: Wafer process (post epitaxial) manufacturing started
- July 1998: MOCVD manufacturing started
- April 1999: Development center established
- November 2000: Occupational Health & Safety Management System (JACO standard) certification acquired
- April 2001: Building 2 completed
- January 2002: ISO9001 certification acquired (Year 2000 Standard)
- December 2002: Received the “Ibuka Prize Incentive Award” for development of blue-violet laser devices
- May 2003: Building 3 completed with the intention of mass producing blue-violet lasers
- November 2004: Celebrated the 35th anniversary of the establishment of Sony Shiroishi Semiconductor Inc.



All of Sony's employees continue to feed (even on New Year's Day) the swans, of which there are more than 200. Sony Shiroishi Semiconductor is taking deep root in the region while racing at the leading edge of the worldwide semiconductor industry.



A Name Brought by a Swan

Sony Shiroishi Semiconductor, which aims at being the center of the laser diode world, is also committed to achieving the industry's highest level of safety management and environmental protection.

"Since, among other things, we also handle special gasses, our investment in safety management is in no way inferior to our investment in manufacturing equipment. In the corresponding areas of the plant, we have installed 30 or 40 special gas leakage sensors. Until now, we have had no accidents that have required shutting down operations, and our record for operation without an accident exceeded 4800 days in May. It goes without saying that our employees' awareness of safety issues is extremely high, and I have confidence in the quality of our daily improvement and maintenance activities." (Managing director Hanai)

When the northern Miyagi Prefecture earthquake of 2003 occurred, the Shiroishi region experience tremors that registered level 4 on the Japanese earthquake intensity scale. Although there was no direct damage from this earthquake, the seismic sensors responded, the flow of special gasses was cut off completely, and the manufacturing lines were stopped temporarily. This allowed us to verify the effectiveness of our safety management system.

Thoroughgoing environment activities are being implemented. The special gasses used are, of course, detoxified, we have introduced the industry's first gallium arsenide (GaAs) detoxification equipment, materials used are recycled, and even in the plantings in the sites, no herbicides whatsoever are used. Actually, when describing the environmental activities at Sony Shiroishi Semiconductor, there is a key word that is always used. That word is "swan." Every year in November, over 200 swans fly in from Siberia and spend the winter on the Shiroishi River that flows by the site. It would be unacceptable for the swans, who are treasured by the local community, to the extent that there is even a Shinto "Swan Shrine", to stop coming. This shared feeling of the employees increases our enthusiasm for environmental activities, and we even monitor the pH of the rainwater that flows from the site into the Shiroishi River. (Although it has never happened, the flow would be cut off if an abnormal value were measured.)

According to Managing director Hanai, "When the swans are here, all our employees take turns feeding them." This continues without break, on weekends and even on New Year's Day. "The swans will come right up to you at feeding time. They're really adorable." said President Umezawa. While there has not been a case of "The Swan's Gratitude" (a reference to a Japanese

folk tale called "The Stork's Gratitude"), there have been unexpected blessings.

"While the environment here is truly wonderful, the name of this town used to be a name that implied the town was smaller and more isolated than it actually was. Since Sony feeds the swans and contributes scraps of rice as feed to the "Shiroishi River Swan Society", the city council proposed changing the name of the town to 'Shiratori' ('Swan Town' in English)." said President Umezawa.

Managing director Hanai added "It's definitely a warmhearted and respected name for a locality."

It is from this sort of region that the blue-violet laser, which will support the arrival of the full-scale digital broadcast age as its foundation, and which will support the next generation of large-capacity optical discs, will soon be mass produced and shipped to the world.



Short wavelength (405 nm) blue-violet laser that will make high density writing to the next generation of large-capacity optical discs possible.

Researchers who have Alighted at Shiroishi

Science also Happens at the Manufacturing Floor

■ Seven Samurai and Burning Our Bridges

Since the short wavelength light source, the blue-violet laser, is poised to become the hero of the optical disc world, we felt that we had to develop and manufacture them ourselves. This is an area in which defeat would be unacceptable. We definitely had that much pride. Our idea was that we would be able to accelerate practical application if the Research Center development team moved directly to Shiroishi.

Since this was the first model case for this approach, we really wanted to make it succeed, and selected seven researchers who we thought could adapt to the new environment. This was our version of Kurosawa's "The Seven Samurai." Seven outstanding samurai plus one "oddball", that one oddball being myself, came to Shiroishi in 1999.

The Shiroishi River is flowing right beside the site here. We really felt as though we had burned our bridges. Since the manufacturing line was right next door, it felt as though we really had burned our bridges. The people involved in manufacturing were working hard every day to make sure that the line would be profitable. However, we were spending large amounts of money on research and development. With people next door working hard to pay our salaries, we felt a lot of pressure. This meant that all of us put all of our energy into the R&D and worked like work horses.

■ It's not Interesting if all that we Produce is Theory

It's commonly thought that the value systems in research and development and manufacturing are different, and that they should remain distinct and not be made the same. This is because one is an investment in the future while the other must produce daily profits. However, if we could just overcome the differences between these sensibilities, we would see advantages from working together. Certainly, the types of difficulties faced in fundamental research and in manufacturing are different. However, Sony engineers are not satisfied just to produce theories. We are aware that the effort required to release a final product is orders of magnitude larger than the effort to invent something, and we are proud to put our efforts into creating final products. The Sony spirit, nurtured by Mr.



Masao Ikeda and the Seven Samurai. According to the Sony Shiroishi Semiconductor employees who first met these researchers "We were expecting them to be rather difficult personalities, but they are actually quite outgoing and went out of their way to become part of the community." (Photograph taken in April 1999 at Shiroishi)

Ibuka and Mr. Morita, is still alive and breathing in current Sony engineers.

The "Seven Samurai" and I are often called on to give keynote or invited speeches at conferences and have published many papers. Our work as researchers has been well received. But this is not the main part of our work, rather, it is the result of the work of practical application that is our main purpose. Also, especially for laser diodes, which are leading edge compound semiconductor devices, there is science that needs to be done for the manufacturing phase, in particular, in assuring reproducibility and in improving yields. As researchers, we get particular satisfaction from working on those issues. If someone who preferred to work freely on their research and take it in whatever direction they pleased without such "constraints" were to come to Shiroishi, they would not be suited for this project.

There is one thing here of which I was particularly proud. All seven of the "Seven Samurai" are now working in positions of responsibility in various sections of Sony. Also, some of the people who came to this development center later have been chosen as Sony MVPs (Most Valuable Professional) or received other recognition for their activities. While there were samurai who remained in the village in the movie Seven Samurai, at Sony Shiroishi Semiconductor, it is only the one oddball who has remained.

■ To Construct an Ideal Factory

Although as a researcher it is true that I have felt that there were some rather restrictive rules here, I made a point of maintaining a



Dr. Masao Ikeda
General Manager
Shiroishi Laser Center
Semiconductor Laser Division
Photonic Device & Module
Business Group
Micro Systems Network
Company
Sony Corporation

happy face while I worked. Even though a rather temperamental group of people had come to work at Shiroishi, the staff of the manufacturing line greeted us warmly.

We used to go out drinking a lot, too. When a university professor, who had worked for another manufacturer and is now researching laser diodes at his university, visited, he was quite impressed that there was no division whatsoever between research and development and manufacturing. Thanks to all these efforts, we have completed preparation for mass production of blue-violet lasers, and we can finally repay our debt of gratitude to the folks in manufacturing who have been earning the money for our salaries.

We entered a cross-licensing agreement with Nichia Corporation in April 2004. This aimed at taking mutual advantage of our respective patents and technologies to create even better blue-violet laser diodes. We have also started industry/academia tie-ups with several universities starting with Tohoku University. Eventually, we would like to make Sony Shiroishi Semiconductor a major research and development center for laser diodes. This is a "fuseki" (early-game strategy in the game of Go) for becoming the 'center of the world' in this area.

Shiroishi is a wonderful environment for living. Rich in nature, with many hot-springs resorts nearby, there are also ski and golf facilities that can be enjoyed inexpensively. In golf, our younger workers are rapidly overtaking me, and I feel that all I do is dig up the turf. Nowadays, I can only go golfing with beginners. If there were adequate opportunities for work in this region where compared to the city, the quality of life is completely different, I feel there would be nothing better than if we could create the "ideal factory, made free, vigorous, and pleasant" proposed by Sony's founder Masaru Ibuka. The reason I am here is to construct a research and development site that will be the foundation for that ideal factory.

To Continue Being a Factory Loved by Swans,

We must Take up Regional Needs and Desires

Each time a new President takes up his duties at Sony Shiroishi Semiconductor, he is always told that “The two most important things that you must keep in mind at all times are protecting the safety of the MOCVD furnaces and protecting the safety of the swans. In any case, those two must be protected.” Since we are extremely careful, for example we always monitor the pH of rainwater flowing out of the site into the Shiroishi River, we quickly become aware and respond if something related to our activities is abnormal. However, the number of swans could fall or the swans could stop coming for some reason unrelated to Sony Shiroishi Semiconductor. Every year we find ourselves wondering “how many swans will come this year” and hoping that many swans will come. From the standpoint of increasing employee awareness of environmental issues, I think that our policy of having all employees feed the swans on a rotational basis has a significant effect. This contributes to the energy the employees put into the twice yearly (spring and fall, before the swans arrive and after they leave) “Clean Campaign”, in which we clean up the banks of the Shiroishi River and their environs.

These efforts, however, are still not adequate. We must take up more of the requirements and desires the local region has for Sony



Masakatsu Uchimura

General Manager
Managing Quality Promotion Dept.
Environmental Management Representative
Sony Shiroishi Semiconductor Inc.

Shiroishi Semiconductor, and deploy efforts at responding throughout the company. Our efforts cannot be said to be the real thing unless we assure that all Sony Shiroishi Semiconductor employees share this level of awareness. While everyone understands the environment goals set out by ISO, we must go beyond that. For example, since a strong earthquake is expected off the Miyagi Prefecture coast, it would be an effective use of our resources in contributing to the local communities if Sony Shiroishi Semiconductor were able to provide disaster relief headquarters functionality in the event of such an earthquake. While it does not rise to that level, we have organized both an Environmental Rescue Unit and a Disaster Prevention Unit and carry out training exercises once every other month. While these activities are still at the amateur level, there are very few companies that have such organizations.

We have also called to other nearby corporations and formed the “Shiroishi Zao Ecology Forum” and we participate in environment-related events sponsored by the prefecture or the city. In an effort to expand these efforts to other localities within Miyagi Prefecture, our “Environmental Collaboration with the Government”, in which prefectural environmental officers tour and inspect sites, is starting up. If the company grows, efforts in which we make approaches to the region and its communities will come to encompass an ever wider range. This is because contributions to the region are an important element of management quality. Even though I am in charge of environmental management, I still hope that the laser diode market will grow even more.



Rainwater Drain Emergency Shutoff System

Sony Shiroishi Semiconductor Environmental Activities

- Environmental Rescue Unit/Disaster Prevention Unit Activities
 - Preparing for the expected earthquake



Disaster prevention truck

Disaster prevention truck interior
Emergency preparedness equipment such as generators is on board at all times.



- Shiroishi Zao Ecology Forum
 - Environmental interactions with the neighboring regions
- Cooperation with government
 - Sony’s responsibility as a corporate citizen
- Swan Protection Activities
 - Swans are the symbol of both Sony Shiroishi Semiconductor and the region itself.



- Clean Campaign
 - Factory vicinity beautification activities
- Energy Saving Air Conditioning Project Activities
 - To reduce Sony’s impact on the environment
- Environmental protection measures for the special high-pressure gasses used in MOCVD
 - Detoxification and recycling of gas removal materials

