CHAPTER 12

Meeting quality control and environmental needs

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1. Quality control

Opto-semiconductor products from Hamamatsu Photonics are used in a wide range of fields including medical diagnosis, measurement, industrial instrumentation, automobiles, information, general electronics, and academic research. As their product applications expand, demands for even higher product quality and reliability are increasing. To meet these marketplace demands, we are actively taking measures to improve product quality levels.

Quality policy

Our policy at the Solid State Division of Hamamatsu Photonics is to "take responsibility as an opto-semiconductor manufacturer to establish a quality control system that provides products the customer needs and to contribute to the progress of industry and science." To achieve this policy, we are making continuous efforts to supply products that are even better, cheaper, faster, and gentle on the earth to satisfy customers.

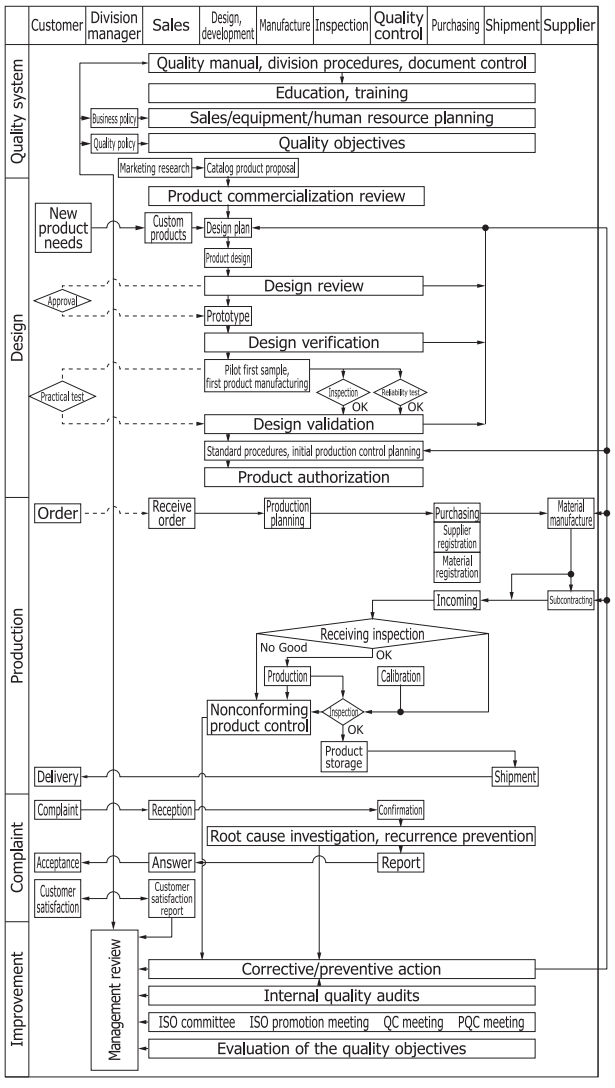
Quality standardization

The Solid State Division employs the ISO 9001 Quality Management System to standardize quality. In this system, items that are basic requirements are formalized in a "Quality Manual" and rules for design, materials, manufacture, inspection, shipping, and equipment management are placed in document form as "Standards" to create a consistent quality assurance system.
Figure 1-1 shows the quality assurance system chart.

Design and development

After performing market research and drawing up plans to develop a new project, we start investigating the possibility of production in terms of product functions, reliability, and costs, etc. Based on results obtained from judging design details, verifying the design from prototypes, trial mass production, and reliability tests, we make sure the design is valid and then authorize the product.

[Figure 1-1] Quality assurance system chart



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Reliability testing

We make reliability tests to verify that a product meets the specified reliability requirements. Reliability tests are performed by selecting typical products from among a group of structurally similar products. If needed, this testing is performed individually. Reliability test methods conform to JIS, JEITA,

IEC, and MIL standards, and also some products are tested according to their product application, for example, a test for optical communication devices conforms to Telcordia GR-468 standards. Products including automotive devices are also subjected to testing specified by the customer. Table 1-1 shows typical reliability tests.

Process management

The production process is supervised based on QC process charts and work standards to ensure that quality and reliability are at levels planned in the product design. Main production processes for opto-semiconductors include oxidation, photolithography, ion implantation, diffusion, electrode-forming, and etching in the wafer process, as well as wafer dicing, die bonding, wire bonding, and sealing in the assembly and testing process.

To verify that the products meet the required specifications, HAMAMATSU performs process inspections and product inspections that check the product electrical/optical characteristics and external appearance. The inspection items, methods, and test criteria are established in the product specifications. Destructive testing and lot evaluations are done by product sampling inspections.

Control to prevent contamination of light receiving/emitting surfaces is essential for opto-semiconductor products. The packing process also requires use of special packing materials and techniques to safeguard light receiving/emitting surfaces from contamination as well as countermeasures to vibration, impact, temperature/humidity, and electrostatic charges.

Table 1-2 shows a QC process chart example.

Equipment and work environment management

The work environment in the manufacturing process greatly affects product quality and reliability. Cleanliness, temperature, and humidity in particular must be strictly controlled. Opto-semiconductors are produced in clean rooms where cleanliness is maintained at a high level. To maintain and control the cleanliness level in clean rooms, strict control standards are established for factors such as cleanliness, entry/exit methods, work clothing, carry-in items, and work procedures. Damage caused by electro-static discharge (ESD) can be a serious problem as process geometry shrink and diverse packages become available, so electrostatic countermeasures are enforced. The department dealing with products requiring ESD countermeasures sets up special areas that must comply with ESD control standards and gives workers instructions in equipment and work site supervision, work clothing, and handling methods.

[Table 1-1] Reliability test examples

Test item	Conditions	EIJA standards
Terminal strength	Pulling: a load is imposed for 10 seconds, twisting: lead is bent 90° and rotated, bending: lead is bent 90° with a load applied, and is then bent back	ED4701/401
Vibration	Frequency range: 100 Hz to 2000 Hz, acceleration: 200 m/s^2, sweep time (100 Hz to 2000 Hz to 100 Hz): 4 minutes, sweep direction: 3 directions of X, Y and Z, 4 times each	ED4701/403
Shock	Maximum acceleration: 15000 m/s^2, pulse width: 0.5 ms, direction: 4 directions of X, Y1, Y2 and Z, 3 times each	ED4701/404
Resistance to soldering heat 1 (air reflow)	Heating temperature: 235 °C (peak: 240 °C), heating time: 10 seconds	ED4701/301
Resistance to soldering heat 2 (dipping)	260 °C, 10 seconds	ED4701/302
Solderability	Soldering temperature: 235 °C, dipping time: 5 seconds	ED4701/303
Electrostatic resistance	C=100 pF, R=1.5 kΩ, applied voltage: ±1 kV, number of times: 1	ED4701/304
High-temperature continuous operation	Ambient temperature: Topr max., operating conditions: depends on individual specs, test time: 1000 hours	ED4701/101
Low-temperature continuous operation	Ambient temperature: Topr min., operating conditions: depends on individual specs, test time: 1000 hours	ED4701/101
High-temperature & high-humidity operation	Ambient temperature: 85 °C, relative humidity: 85%, operating conditions: depends on individual specs, test time: 1000 hours	ED4701/102
Temperature cycle	Maximum storage temperature: Tstg max.: 30 minutes, minimum storage temperature: Tstg min.: 30 minutes, 100 cycles	ED4701/103
Resistance to UV light	200 nm to 400 nm deuterium lamp, test time: 1000 hours	-
Resistance to X-ray	Output tube voltage: 100 kV, 1 million roentgen	-
Resistance to solvents	Solvent type: isopropyl alcohol, dipping time: 5 minutes, rubbing: 5 times back and forth	ED4701/501

Note: Please contact us for information on reliability test for individual products.

Production equipment is given maintenance and also verified after modifications or expansions. Specific methods for making start-up and periodic equipment inspections are established to perform preventive maintenance, and constant efforts are made to prevent quality problems and keep stable production.

Procurement management

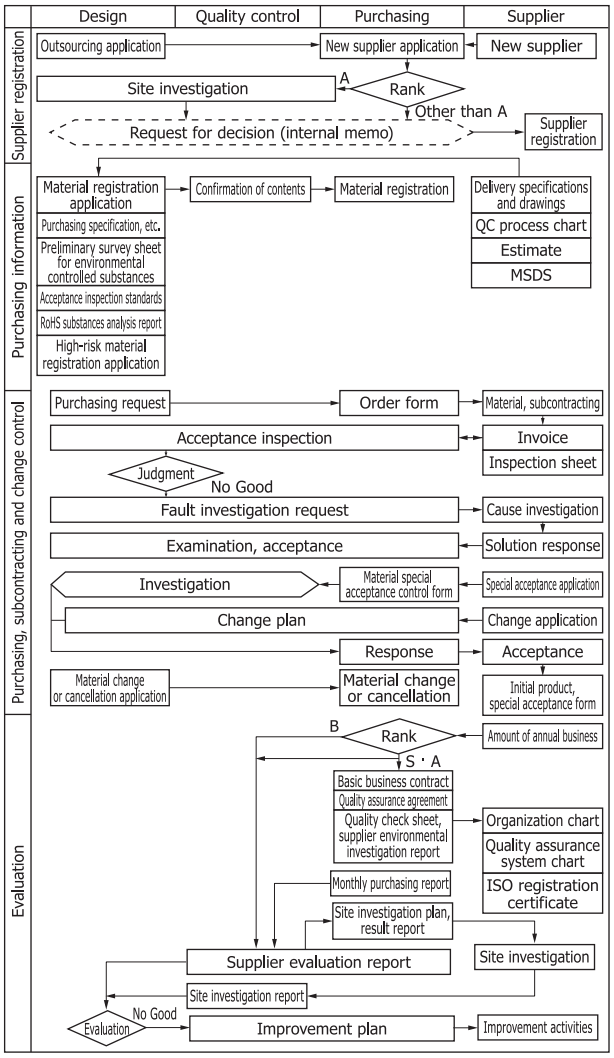
Procurement management of parts and materials has a large effect on product quality, so we use a system that judges and then registers both the suppliers and the parts and materials for purchasing.

We carry out an inspection of the suppliers to check compliance with quality environment system, green procurement policy, and other factors. We then register those suppliers who meet our standards and also make new and periodic supplier audits mainly by the purchasing, quality control, and design departments.

The semiconductor wafers, electrode materials, chemicals, and gases, etc. used to produce opto-semiconductors must be of high purity and high quality. The metal and ceramic materials used for packages, printed circuit boards, and mold resin must be of high precision and high quality. These types of purchased items undergo strict individual testing and are then registered before they can be used in our products.

An incoming inspection of those purchased items is then made based on the required specifications to verify their quality. After acceptance, these purchased items are stored in properly controlled locations that meet storage conditions specified in the design standards, and a high level of purchased item quality is maintained.

[Figure 1-2] Purchasing control system chart



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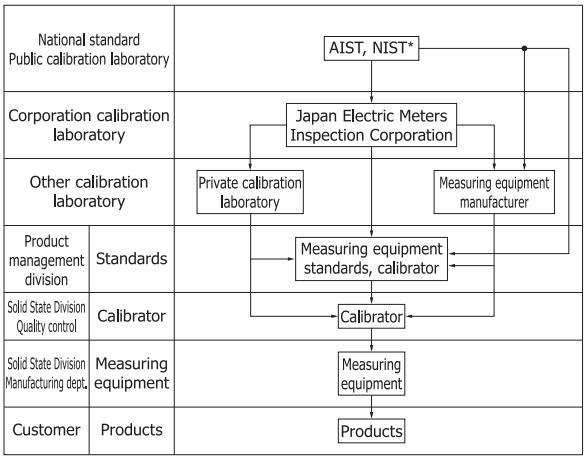
[Table 1-2] QC process chart example (part of process)

Process			Control item	Method			Document
No.	Symbol	Work name	Characteristic, condition	Measuring device, sample	Sampling	Record	
1		Material acceptance					
1-1	▽	Wafer	Resistivity, thickness Appearance	Check Visual check	Each time All wafers	Acceptance inspection sheet	Purchasing specification Work procedure
1-2	▽ 4-2	Lead frame	Dimensions Appearance Plating thickness	Microscope Visual check Thickness gauge	1 frame/lot 1 frame/lot 3 frames/lot	Acceptance inspection sheet	Inspection procedure
1-3	▽ 4-4	Mold resin	Characteristics	Check	When materials are delivered		Procurement specification
2		Wafer process					
2-1	○	Oxidation	Oxidation furnace Temperature, time Wafer appearance 1 Color, uniformity Wafer appearance 2 SiO_2 thickness	Check Visual check Color sample	Each time All wafers 1 wafer/lot	Run sheet Work logbook	Work procedure Wafer process Manufacturing specification
2-2	○	Photolithographic work	Photomask Wafer appearance 3 Pattern condition Pattern accuracy, pattern defect	Check Microscope Microscope	Each time 3 wafers/carrier 3 wafers/carrier	Run sheet Work logbook	Work procedure Wafer process Manufacturing specification

Measurement management

The quality control department periodically calibrates the test and measuring equipment. Calibration equipment is traceable to the national standards through the manufacturers and public organizations. Besides calibration, start-up inspections and periodic inspections are made to prevent and detect a drop in accuracy or a malfunction in the measuring equipment.

[Figure 1-3] Measuring equipment traceability



* AIST: National Institute of Advanced Industrial Science and Technology (Japan)
NIST: National Institute of Standards and Technology (U.S.)

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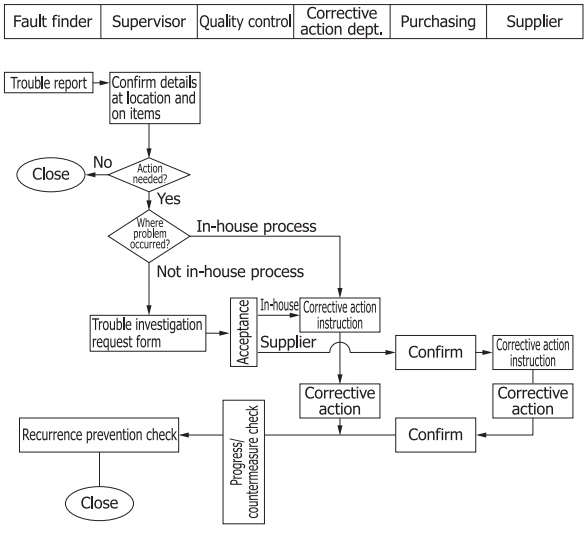
Dealing with process errors

Figure 1-4 shows a system chart for handling process errors.

[Figure 1-4] System chart for error handling



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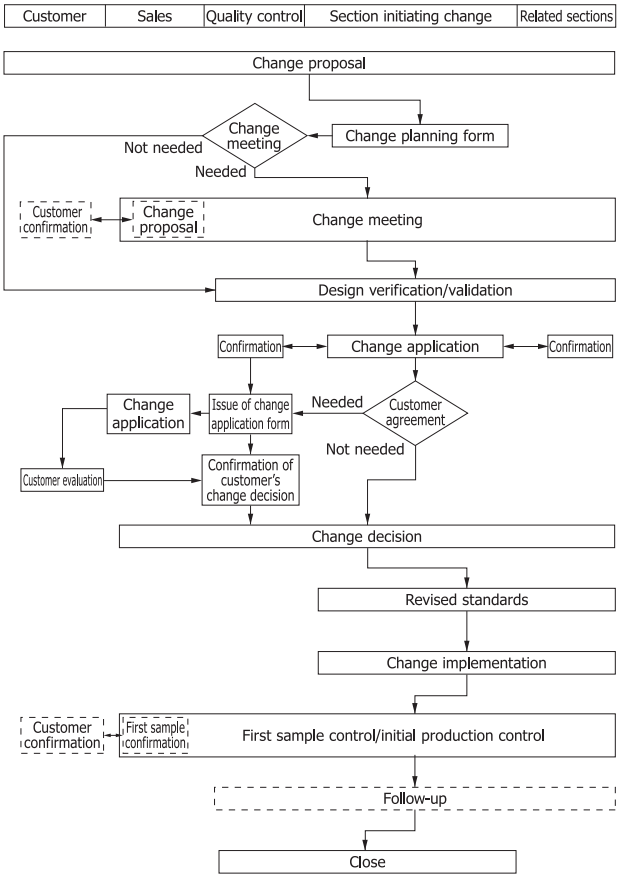
When a problem occurs in the production process, which might cause defects that exceed preset process standards or might adversely affect the product quality, then the problematic lot is immediately identified and separated from other semi-finished parts. At the same time, the cause of the problem is investigated, and the corrective action that should be taken is decided. Along with confirming the corrective action was effective, we take measures to prevent the problem from reoccurring.

Change control

Changes such as in designs, purchased items, and production methods and equipment are made in order to improve product quality, function, reliability, and productivity. Change planning is first of all drawn up, the job schedule from change setup to completion is clarified, and the planning then finalized at a change conference attended by all related departments including quality control. Finally, the change is decided after evaluating effects on quality, reliability, and productivity, etc. Changes requiring the customer's approval in advance are implemented after obtaining the customer's consent. Initial production control is performed as needed and a final check made of all effects caused by the change.

[Figure 1-5] Change control system chart



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Product identification

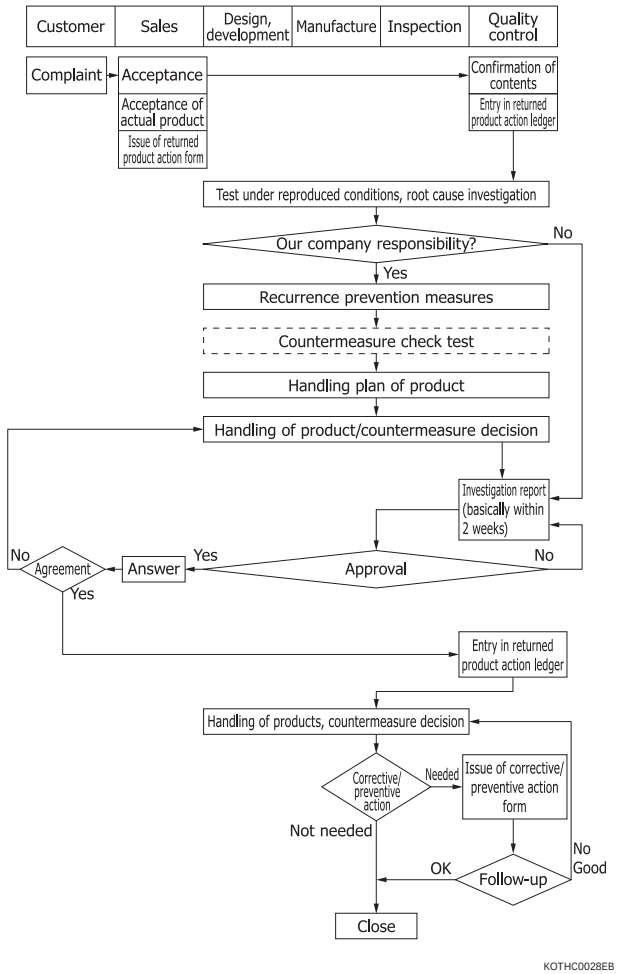
The type number, production lot (production year/month), and serial number are utilized to allow tracing the production history even after shipping the product.
A typical product identification example we use is shown below.

S1234 9A 001
- Serial number
- Production month (alphabetical order... Jan: A, Feb: B, Dec: L)
- Production year (last digit of year)
- Type number

Complaint handling

At HAMAMATSU we work to speedily resolve customer complaints by way of our complaint handling system.
The contents of the complaint are first checked and an investigation made to find the cause. Besides notifying the customer of these results, we also use them as feedback in the design and production processes to prevent a recurrence of the trouble. If we decide, based on those investigation results, that the quality control system must be overhauled, then corrective action is taken and results from that action are verified.

[Figure 1-6] Complaint handling system chart



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Instruction and training

The Solid State Division provides worker instruction and training as an active promotion to maintain and improve product quality as well as upgrade employee skills. Employee skills are periodically reviewed, and instruction/training plans are then drawn up and performed as needed. When a particular job requires obtaining qualifications, then those are clearly specified, and a system is then set up to certify employees who meet the requirements of the job.
The types of instruction span many areas including new employee education, on-the-job training, and safety and health instruction. Positive efforts are also made to collect information outside our company in order to upgrade employee knowledge and skills.

2. Responding to environmental needs

Environmental idea

Recognizing that living in harmony with the global environment is a critical issue for mankind, the Solid State Division of Hamamatsu Photonics conducts business with consideration to environmental conservation, and works to create new scientific fields and new industries and to show the road to true human health through research into photonics technology and extending its application.

Environmental policy

The Solid State Division is conducting environmental activities in compliance with the following environmental policy.

① Establish an environmental management system to promote conservation of the earth's environment by setting up and maintaining an internal organization for environmental protection.

② Assess the impact on the environment by our activities, products and services, and constantly improve our environmental protection activities and environmental management.

③ Comply with environmental regulations and other requirements we have accepted and impose our own voluntary standards as necessary, to reduce the burden on the environment.

④ Take preventative measures for curbing environmental pollution, save energy and resources, reduce waste, and ensure correct usage of chemical substances.

⑤ Strive to raise the understanding of the environmental policy and the awareness of environmental issues among all our employees through education and an in-house publication about the environment.

Standardizing environmental management

The Solid State Division is implementing the ISO 14001 Environmental Management System and making continuous improvements to provide proper environmental management and reduce environmental risks.

Products that meet environmental needs

"Environmentally conscious products" that meet product environmental regulations in each country such as RoHS (Restriction on Hazardous Substances) directives of the European Union (EU) now include many types of products used in our daily life such as household electrical appliances and automobiles. We at the Solid State Division are actively promoting to provide these environmentally conscious products that meet environmental regulations in each country and customers' environmental needs.

(1) Environmental management substances

We control the amount of substances contained in each of our products, which are specified in JIG (Joint Industry Guide) including the six substances (lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyl, and polybrominated diphenyl ether) regulated by RoHS directives. Deciding whether a product will comply with RoHS directives is clearly specified in the quotation sheet when drawing up the estimate.

(2) Management of high-risk materials

When there is possibility that a material may contain an environmental management substance, we determine that material as a high-risk material and inspect it using an X-ray fluorescence analyzer during the acceptance test.

Green procurement

To comply with environmental regulations on products and minimize the load on the environment, we at the Solid State Division have established green procurement policies and chemical substance management standards, and are promoting green procurement activities that give priority to materials with a smaller load on the environment.

Working toward global environmental conservation

At the Solid State Division we conduct environmental activities for global environmental conservation. These activities include use of cogeneration systems and achieving a full phase-out of ozone layer destructive substances. We are also promoting energy saving, reduction of carbon-dioxide emissions, management of chemical substance usage levels, waste separation/recycling, and zero emission.

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