JPRS-JST-89-014
10 AUGUST 1989

FOREIGN
BROADCAST
INFORMATION
SERVICE

# JPRS Report

# Science & Technology

## Japan
## Development of Basic Technology for Large Surface Circuit Elements

19980630 120

# Science & Technology

Japan

Development of Basic Technology for Large Surface Circuit Elements

JPRS-JST-89-014

CONTENTS

10 AUGUST 1989

*Tokyo MINISTRY OF INTERNATIONAL TRADE AND INDUSTRY in Japanese Sep 88*

[Dawn of the Age of Giant Electronics]

# I. General

## 1. Basic Concepts: Increasing Needs for Larger-Surface Devices

[Text] Rapid development of information society and rapid increases in the amount of information generated have given rise to a need for giant electronics, due to the need for increasingly larger-surface devices, as a trend separate from the increasing degrees of miniaturization and packing densities which have been the mainstay of the conventional electronics technology.

Needs for increasing surface areas of information input/output and processing devices

(1) Larger surface image information I/O devices

(2) Larger surface high-fidelity information-processing/conversion devices

(3) Increasing surface areas and thinner profiles of other devices

### I. Elemental Technology Development Requirements

Development of large-surface circuit elements includes the development of many basic technologies, in which breakthroughs are needed through coalescence of a number of seemingly unrelated fields (electronics, printing, organic chemistry, inorganic chemistry, etc.)

(1) Large-surface precision glass substrate technology: Greater flatness, high heat tolerance, non-alkaline properties, resistance to deformation

(2) Large-surface high-fidelity thin-film technology: Highly functional semiconductor films, highly functional molecularly-oriented films

(3) Large-surface high-fidelity patterning technology: High-precision masks, exposure, and printing

(4) Highly functional liquid crystal materials technology: Low viscosity, high resistivity, low sharpness

(5) Large-surface precision assembly technology: Pasting substrates to create ultra-large-surface, thin substrates; high-precision LC injection; thin, flat light sources; high-precision shields

### II. Application Areas for Elemental Technology Development Topics Large-surface

Circuit elements and the base technology that allows their development are likely to have wide-ranging ripple effects.

(1) Large-surface precision glass substrate technology: Ultra-high density optical disks and ultra-high precision glass

(2) Large-surface high-fidelity thin-film technology: Optical recording thin films and ultra-thin insulation films

(3) Large-surface high-fidelity patterning technology: Fabrication of precision electronics components by printing

(4) Highly functional liquid crystal materials technology: Fast response liquid crystals

(5) Large-surface precision assembly technology: Large-surface glass pasting technology, chip-on-glass (COG) technology

### III. Application Areas for Large-Surface Circuit Elements

Large-surface circuit elements are expected to find applications in diverse fields.

(1) Image information I/O devices

(a) Large-surface high-fidelity thin panel image display devices

(b) Optical photoengraving systems

(c) Two-dimensional image sensors

(d) Ultra-thin photocopying systems

(2) Information processing/conversion devices

(a) Book-size computers

(b) Optical computers

(3) Other devices

(a) Large-surface thin-film solar cells

(b) Large-surface thin-profile flat light sources

### IV. Contributions to Industry and Society

a. Contributions to the international society

b. Expansion of domestic demand

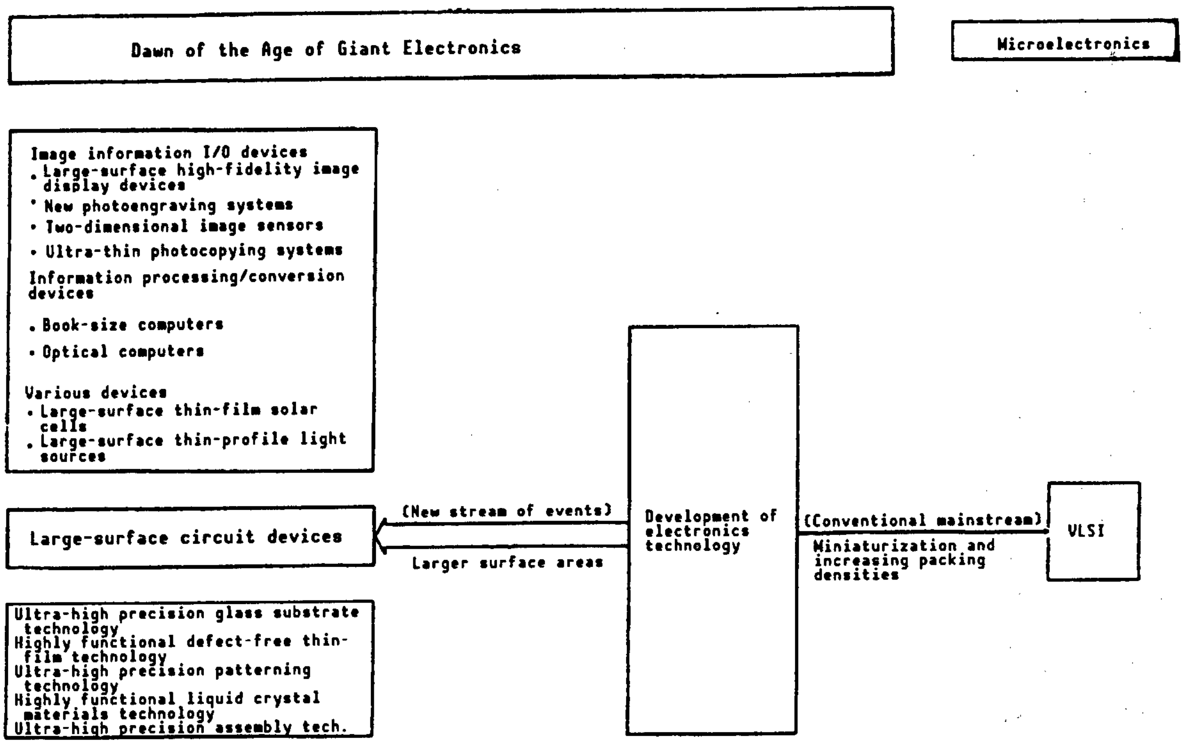
c. Enrichment of everyday life and culture

## 2. Project Summary

(1) Research period: 7 years (FY 1988-FY 1994)

(2) Total research costs: ¥13 billion

(3) Research objective: Development of various basic technologies necessary for the realization of large-surface circuit elements measuring 1 square meter each




(4) List of corporations participating in the project

Electronics:
Hitachi, Ltd.
Sharp Corporation
NEC Corporation
Seiko-Epson Co., Ltd.
Casio Computer Co., Ltd.
Sanyo Electric Co., Ltd.
Fujitsu, Ltd.
Semiconductor [ILLEGIBLE]
Thomson Japan
Hoechst Japan
Nippon Sheet Glass Co., Ltd.

Printing:

Toppan Printing Co., Ltd.
Dai Nippon Printing Co., Ltd.

Glass:
Asahi Glass Co., Ltd.

Liquid crystal materials:
Chisso Corporation

Chemicals:
Japan Synthetic Rubber Co., Ltd.

Machinery:
Ulvac Corporation

(5) Research Project Plan
Research Project Chart

## II. Specific Elements of the Large-Surface Circuit Element Basic Technology Development Project

### 1. Necessity for the R&D Effort

(1) Trends in Existing Technology

In advanced information society, which is likely to continue to grow, electronics circuit technology will play an increasingly important role. The use of electronics is pervading homes and offices, as well as industrial fields, and advances in electronic circuit technology will be essential to the next generation of human society.

The active circuit device, constituting the core of electronic circuit technology, has advanced from the diode, transistor, IC, LSI, VLSI, and wafer-size LSI, driven by advancement in semiconductor technology.

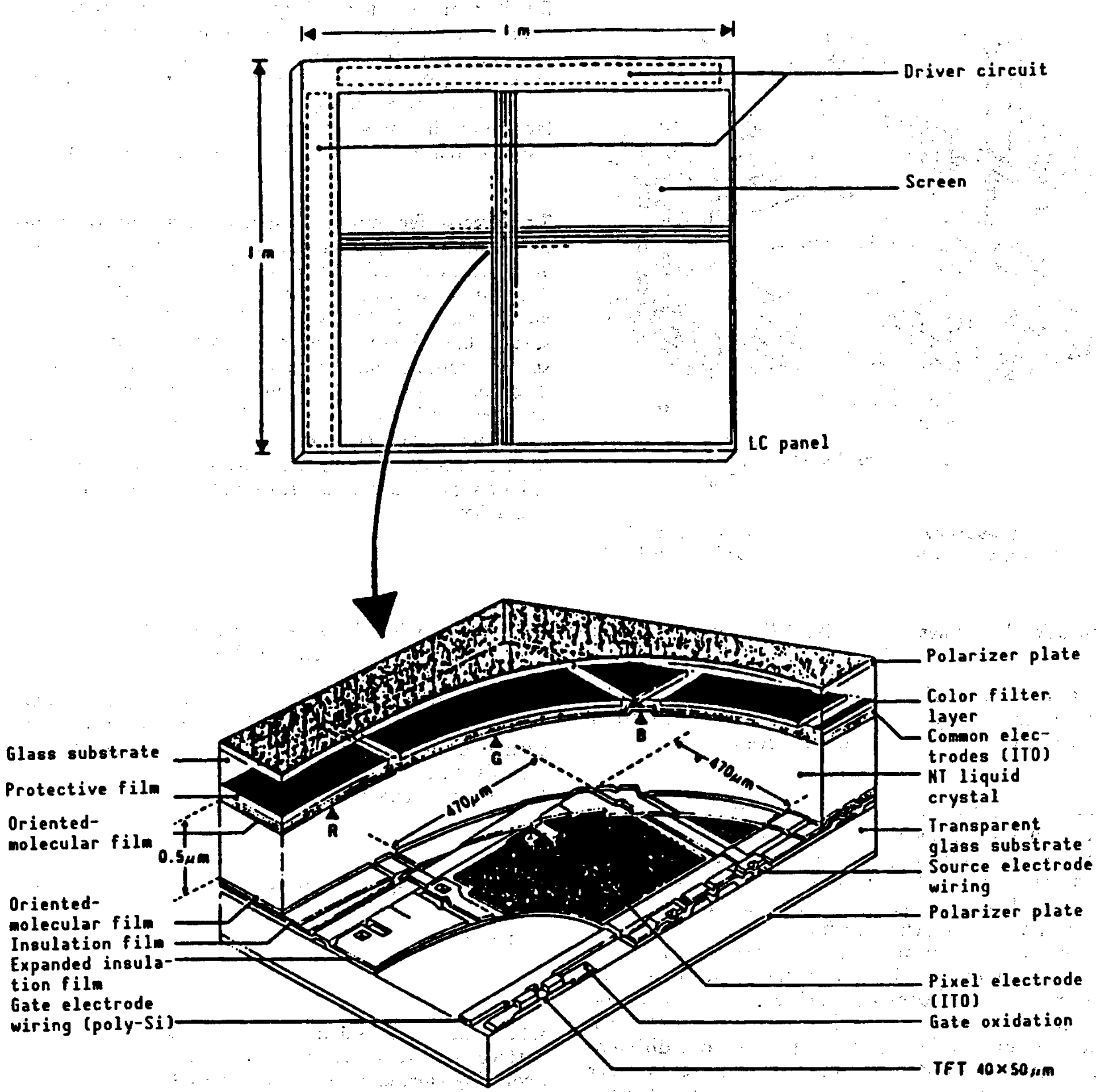
Until now, semiconductor technology has been progressing in the direction of formation of super-fine circuit elements in high-performance semiconductor

| Subtopics and subitems | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|---|---|---|
| 1. System design, prototype production, and evaluation | | | | | | | |
| 2. Large-surface precision glass substrate technology | | | | | | | |
| 3. Large-surface high-fidelity thin-film technology | | | | | | | |
| ① High-performance film formation technology | | | | | | | |
| ② Low-temperature doping technology | | | | | | | |
| ③ Highly functional large-surface molecular orientation technology | | | | | | | |
| ④ High-performance polarization film technology | | | | | | | |
| 4. Large-surface high-fidelity patterning technology | | | | | | | |
| ① Large-surface high-fidelity masking technology | | | | | | | |
| ② Precision exposure technology | Element technology development | | | | Midstream evaluation | Prototype production | Final evaluation |
| ③ Large-surface etching technology | | | | | | | |
| ④ High-fidelity color filter technology | | | | | | | |
| ⑤ Large-surface wiring/electrode printing technology | | | | | | | |
| 5. Advanced circuit structure technology | | | | | | | |
| 6. Highly functional liquid crystal materials technology | | | | | | | |
| 7. Large-surface thin-profile flat light source technology | | | | | | | |
| 8. Large-surface precision assembly technology | | | | | | | |
| 9. Total evaluation | | | | | | | |
| ① Large-surface panel evaluation technology | | | | | | | |
| ② Image evaluation technology | | | | | | | |

crystals, and of integration of these elements. With parallel development of manufacturing technology which has advanced man's capacity to deal with circuits measuring a few microns to less than one micron in line width, semiconductor technology has indeed blossomed. Thus, the impressive gains achieved in semiconductor technology have been made possible through microfabrication and increasing densities of circuit integration.

(2) New Trends in Technology

A notable recent trend has been the development of a capacity to form a highly uniform semiconductor thin-film on a relatively large substrate. Although as a rule semiconductor thin-films formed on a substrate through the use of various thin-film formation processes are not on a par with monocrystalline semiconductors in electric properties, they have been put to practical use as solar



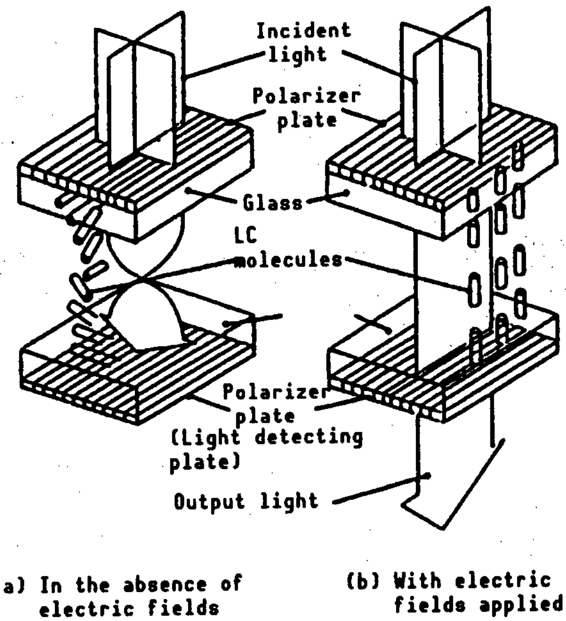

cells, and their further practical utilization of LC image display devices and as simple operating circuits are now being studied. Some of these have been commercialized. A characteristic of this technology, in contrast to the existing technology which is predicated on circuit miniaturization, is the goal of producing circuit elements implemented on a large surface.

The new technology, in contrast to "microelectronics" devoted to achieving miniaturization of circuits, has given rise to a new current in technology for which the appellation "giant electronics" seems fitting. The new direction in technology requires the development of large-surface circuit devices.

(3) Challenges Facing the R&D Effort

The basic technologies necessary for achieving large-surface implementation of circuits, however, are quite different from those intended for achieving circuit size reduction and greater packing densities. Devices laid out on a large surface area are highly affected by thermal expansion and gravity. Another factor is the effect of high-speed mobility of electrons, which can no longer be ignored.

Further, precise layering of large-surface glass substrates, electrodes, various thin-films comprising transistors, and molecularly oriented thin-films involves rapid increases in the degree of difficulty of alignment and the




**Operating Principles of TN Liquid Crystals (Negative Display)**

handling of large size thin-film materials. Also, size increases in the objects to be worked on give rise to a wide array of new problems to be solved.

Solution of these problems requires development of basic technologies such as large-surface precision glass substrate technology, large-surface high-fidelity thin-film technology, large-surface high-fidelity patterning technology, highly functional liquid crystal materials technology, and large-surface high-fidelity assembly technology, each requiring significant breakthroughs. It would be impossible for any single manufacturer, or even industry, to accomplish such a feat. It is essential that the R&D effort be carried out in the form of a large-scale project in which companies from different industries can coordinate and work together to bear upon problems that cut across organizational boundaries.

(4) The Ripple Effect and Impact of the R&D Project

These basic technologies, when developed, will have considerable ripple effects. For example, ultra-flat, deformation-resistant glass plates manufactured as a result of the development of large-surface high-fidelity glass substrate technology could have wide applications such as in the production of optical disk storage media. Large-surface high-fidelity thin-film technology could be applied to the manufacture of optical recording thin-films and ultra-thin insulation films. Large-surface high-fidelity patterning technology may open the possibilityof manufacture of precision electronic componentsthrough printing processes, and large-surface high-fidelity assembly technology may have applications in various circuit element mounting processes, such as the manufacture of chip-on-glass. Thus, these basic technologies are expected to have a wide range of ripple effects.

The large-surface circuit elements, which will come into being only through realization of these basic technologies, are potentially applicable to fields such as two-dimensional optical information processing devices and large-surface thin-film solar cells, in addition to large-surface high-fidelity thin-profile image display devices such as liquid crystal image displays and plasma image displays; or optical photoengraving, two-dimensional scanners, and related image I/O devices. These could have considerable economic and societal impact. Therefore, execution of the present R&D program will contribute significantly to the advancement of our industrial technology.

## 2. Topics for the Development of Elemental Technologies

Our goal for the realization of large-surface circuit elements will be development of a circuit element measuring 40 inches diagonally. Toward this goal, we have established the following demonstration research objectives for each example elemental technology.

(1) Large-surface high-fidelity glass substrate technology

(a) Summary

Glass substrates constitute the foundation for large-surface circuit elements, and provide a basis for achieving adequate mechanical strength of circuits and precision of circuit formation.

(b) Objectives for technology development

For the realization of glass for the manufacture of a circuit element with a 40-inch diagonal measure, the objective will be to develop a glass polishing technology for achieving a low variability of thickness, a high degree of flatness, and with an exceedingly smooth surface; and a technology for the detection of defects in the glass base material. These objectives will be predicated on the availability of highly flat, alkaline-free glass substrates.

| Item | Objective (tentative) | Constraints |
|---|---|---|
| Polishing precision | A thickness variability of less than 20 μ m in alkaline-free glass with 40-inch diagonal size | Difficulty of melting and molding alkaline-free glass |
| | | Effects of thermal hysteresis due to the increased substrate size |
| Precision of defects identification | Detection of bumps, dents, and foams down to 2 μ m in size | High-resolution, high-speed detection methods |

(2) Large-surface high-fidelity thin-film technology

(a) Summary

On a glass substrate, circuit elements and electrodes are created by repeated applications of thin-film formation and etching processes. The type of thin-film utilized and the formation method employed vary according to the object to be formed. It is in this thin-film formation process that numerical values such as device operating speed and electrode resistance, with significant impact on the performance of the resulting large-surface circuit elements, are determined. Also, the formation of a film in which liquid crystals are to be oriented in a specific direction (oriented film) requires special techniques.

(b) Objectives for technology development

Because of its high operating speed, poly-silicon (p-Si) is best suited as a thin-film for the formation of thin-film transistors (TFT) which drive the operation of the liquid crystals. Since peripheral driver circuit elements supporting the operation of large-surface devices must be capable of operating at speeds higher than those of the TFT, it is essential that the p-Si be formed as a thin-film of uniform thickness. Although normally p-Si is fashioned into thin-film under a high-temperature gas (600°C), a temperature which can be injurious to the glass substrate, to protect the glass substrate it is necessary to develop a low-temperature thin-film formation process.

Similarly, film formation for the creation of transparent electrodes for imparting voltage to the liquid crystals and the creation of electrodes for transmitting signals to the TFT requires uniformity of film thickness and the availability of low-resistance materials.

Especially, the formation of molecularly oriented films requires the formation of uniform films with a high degree of molecular orientation. For the formation of molecularly-oriented films, research in the rubbing method, development of which dates back to several years ago, and the Langmuir-Blodgett (LB) method, which has gained popularity as a method for direct formation of molecularly oriented films, is under way. It is necessary to carry out developmental efforts in these areas also.

The following specific objectives will be pursued:

| Item | Objective (tentative) | Constraints |
|---|---|---|
| Precision of film thickness | A film thickness variability of 10% or greater for a film with a 40-inch diagonal measure | Development of a process in which the maximum temperature will not exceed the glass distortion point |
| Doping process | Development of ion source shapes and scanning methods for the formation of substrates with a 40-inch diagonal | Development of a low-temperature activation process, a self-alignment process, etc. |
| Orientation technology | An LC azimuthal delta angle variability of 0.5 degrees or less on a 40-inch-diagonal substrate by the rubbing process | Elimination of nonuniform molecular orientation in a film |
| Polarizing film | A 99% polarization rate and a minimum transmissivity of 30% | Elimination of nonuniform pigment concentrations, nonuniform concentrations in the directionof stretching, etc. |

(3) Large-surface high-fidelity patterning technology

(a) Summary

During manufacture of precision electronic components such as VLSI chips, micropatterns are formed by repetitive applications of pattern exposure, etching, and similar processes onto a thin-film surface. These processes are also important in the formation of TFTs and color filters during the manufacture of large-surface circuit devices.

(b) Objectives for technology development

Realization of a large-surface patterning technology requires quantum jumps in achievable resolution, position alignment precision, and control of dust. The formation of TFTs and peripheral driver circuits requires extremely precise pattern formation over a large area. This is also true of the photomask itself, which is used in the exposure process. In cases where a color filter is used on large-surface circuit elements, the pitch accuracy of the filter relative to transparent electrodes, and the absence of any scratch or blemish, are extremely important factors.

Under this research topic, the following specific objectives will be pursued:

| Item | Objective (tentative) | Constraints |
|---|---|---|
| Mask precision | A mask line width variability of less than 1 μ m relative to a 40-inch diagonal size, and a minimum alignment precision of 5 μ m | Development of large-surface delineation technology, process technology, etc. |
| Exposure precision | A resolution of 3-5 μ m relative to a 40-inch diagonal size | Uniform resist application process, development of a deformation correction process through the use of swelling and heat treatment processes |
| Etching technology | Development of plasma ECR methods for working substrates about 40-inch diagonal in size | Reduction in liquid temperature/concentration variability on the etching surface |
| Color filter | Development of improved coating application and physical properties enhancement techniques relative to about 40-inch diagonal substrates | Development of uniform coating processes |
| Electrodes | Development of direct pattern printing processes relative to 40-inch diagonal substrates | Elimination of problems of wire electrodes shorting and nonuniform resistance |

(4) High-performance circuit structure technology

(a) Summary

Circuit elements such as transistors and resistances will be created by combinations of semiconductor, conductor, and insulator thin-films formed on a large-surface substrate such as a glass substrate, to be connected organically to form circuits.

(b) Objectives for technology development

The most important technical objectives in achieving a large-surface circuit are attainment of improved operating speeds and provision of an adequate level of redundancy to ensure correct circuit operation even if there are defects in the circuit. These, in turn, require development of proper circuit methods and of circuit element structures.

Under this research topic, the following specific objectives will be pursued:

| Item | Objective (tentative) | Constraints |
|---|---|---|
| Vertical driver circuit operating frequency | Approx. 100 kHz | Development of high-mobility p-Si films, and development of circuit methods |
| Horizontal driver circuit operating frequency | Approx. 10 MHz | Development of high-mobility p-Si films, and development of circuit methods |
| Integration of peripheral circuits | Defect-free construction in the ultimate sense | Development of circuit methods |

(5) Highly functional LC materials

(a) Summary

These materials are essential to the application of large-surface circuit elements to the construction of an LC panel, functioning as a light valve that controls the amount of light penetrating the LC material. LC molecules have rod-like shapes so that when subjected to voltage their molecular orientation changes. This property can be used for controlling the amount of light passed.

(b) Objectives for technology development

To achieve a high degree of functionality, these materials must offer significantly improved response time, and consequently reduced viscosity of the LC constituents. To achieve desirable display qualities, the LC constituents must offer high resistivities. Also, to retard the degeneration of resistivities by age, it is necessary to identify the impurities present in these materials and the development of a device structure that prevents intrusion of contaminants.

Under this research topic, the following specific objectives will be pursued:

| Item | Objective (tentative) | Constraints |
|---|---|---|
| Response speed | 100 ms or less | Development and analysis of materials capable of maintaining low viscosity even at low temperatures |
| Specific resistance | $10^{14}$ ohms.cm or greater | |
| Threshold voltage | 1.5 V or less | |
| Difference between saturation voltage and threshold value | 2 V or greater | |

(6) Large-surface thin-profile high-performance light source technology

To realize a high contrast in image display devices, the following objectives will be pursued in the areas of brightness and emitted light wavelength distribution:

| Item | Objective (tentative) | Constraints |
|---|---|---|
| Power consumption | 150 W maximum | Long-life cold cathode tubes, development of a high transmissivity light conductor using acryl diffusion plates |
| Service life | 2,000 hours minimum | |
| Area | 40-inch diagonal or greater | |
| Thickness | 50 mm or less | |

(7) Large-surface high-fidelity assembly technology

(a) Summary

This is an especially important technology to allow the use of large-surface circuit elements as LC panels. Realization of a large surface area requires advanced techniques to address problems such as: the thickness precision of an LC has a significant bearing on panel performance; accurate handling of a large-surface substrate must take the effects of gravity into account; and the existing LC injection method requires too much time to be of practical use for the manufacture of large-surface LC panels.

(b) Objectives for technology development

To ensure a uniform thickness of LC, the LC will have to be inserted between two large-surface substrates, endowing it with a spacer-type pressure-resistant structure (each crystal being a particle about 5 μm in diameter), to counter the effect that when a large-surface LC panel is used in an upright position, the weight of the LC exerts pressure on the bottom of the panel, causing deformation of the glass and consequent change in LC thickness.

Techniques for handling large-surface circuit elements are yet to be developed; it is necessary to develop handling techniques that take into account the effects of gravity.

Although currently LC is injected after the panels are bonded together, to ensure efficient LC injection it will be necessary to develop techniques that allow LC injection before the panels are joined together.

Under this research topic, the following specific objectives will be pursued:

| Item | Objective (tentative) | Constraints |
|---|---|---|
| Gap variability | 0.2 μ m maximum | Overcoming difficulties such as the effects of gravity, thermal expansion of materials, and inherent limits in the strength of the materials used |
| Alignment precision | 10 μ m or greater | |
| LC sealing | Techniques for sealing LC in a panel about 40 inches in diagonal measure | |
| Tools | Techniques allowing handling of panels about 40-inch diagonal | |

(8) Overall evaluation technology

Methods for testing large-surface circuit elements includes: (a) electric testing in which test voltage is applied to an I/O terminal or is measured on an I/O terminal; and (b) pattern or image testing. To test a device containing a large number of circuit elements on a large surface, either method requires a high-speed testing capability and an ability to produce 2D maps or 3D graphs to render the test data into a form that is easy to see. Under this sub-topic, the following objectives will be pursued with development of a technology for electric, optical, or graphical testing of large-surface circuit elements such as large-surface TFT LC image display devices.

| Item | Objective (tentative) | Constraints |
| --- | --- | --- |
| Defect test technology | An ability to test large-surface circuit element patterns 40-inch diagonal in 20 minutes or less, with a maximum electric testing time of 5 minutes | Development of evaluation algorithms and evaluation parameters |
| Defect correction technology | Development of a laser trimming technology | |
| Display characteristics | Development of methods for efficient measurement and processing of 40-inch diagonal image display characteristics | |
| Response characteristics | Development of a technology for measuring 40-inch diagonal image display characteristics | |
| Reliability and time-dependent change assessment technology | Development of a technology for measuring the reliability and time-dependent changes in 40-inch diagonal image display devices | |

## 3. Difficulties Lying in the Path of Increases in Circuit Surface Area

(1) Higher precision requirements

(a) Increases in required relative precision

Implementation of circuit elements on a large surface area must be accomplished without sacrificing the absolute precision of those elements (approximately 5 μ m). This entails exceedingly higher relative precision.

The problem of precision is of gigantic proportions, given the linear expansion of glass substrates, device components, and color filters; the temperature of the reaction process (approx. 600°C); and density increases in the p-Si-TFTs (approx. 1.7 times).

(b) Effects of thermal expansion

Thermal expansion and contraction due to temperature changes must also be taken into account. Since different materials have different thermal expansion coefficients, in contrast to the conventional micro-scale technology the giant electronics technology requires film formation and assembly processes that take temperature changes into account.

(c) Effects of gravity

Construction of large-surface circuit elements entails warping of the glass substrate due to gravity as a factor that cannot be ignored. This factor can exert adverse impact on the precision (film thickness precision and assembly precision) of the final product (Figure 1). Also, if an assembled LC panel is to be used in an uprightposition, the intrinsic pressure of the LC can cause the lower part of the panel to expand, resulting in a collapsed upper part (Figure 2). Development of techniques to minimize this effect will be necessary. Given a required LC thickness precision of 0.2 μ m, the amount of deformation must be kept within 0.2 μ m.

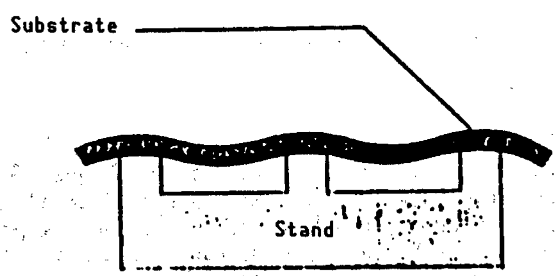



Figure 1

(2) Required breakthroughs in circuit element technology

(a) Increases in electron mobility

Implementing circuit elements on a large surface area requires increases in the speed of semiconductor device operation, in the order of μ m > 300 ($cm^2$/V.sec), vs. the electron mobility, μ m, of a conventional silicon semiconductor of μ m = 50 ($cm^2$/V.sec). However, it would be extremely difficult to manufacture such a high electron mobility semiconductor at a low temperature of less than 600°C. Therefore, significant breakthroughs in film formation processes will be necessary.

(b) Reducing the resistivity of interconnections

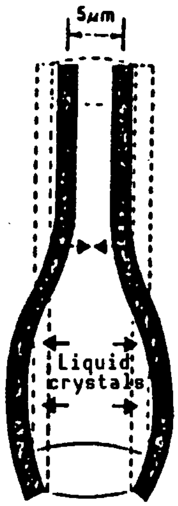



Figure 2

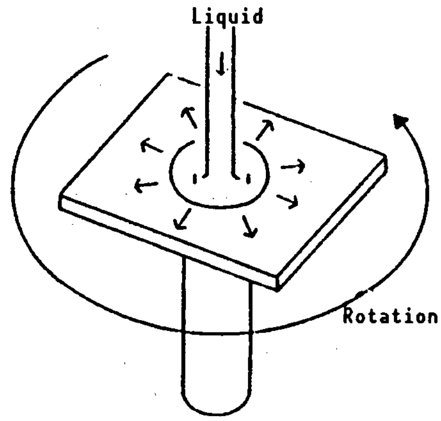



Figure 3

In the application of large-surface circuit elements to the operation of a large-surface high-fidelity thin-profile image display unit, scanning lines and signals lines serve to supply required charges to pixels, simultaneously supplying charges to floating capacities between the constituent elements. Such charge operation, however, exacts a cost in the form of delay time, and tends to lower the image display quality. The currently produced experimental wiring materials and structures for 14-inch diagonal devices, if applied directly to the 40-inch diagonal version, would require 10 times greater charge-up time due to the increased number of pixels (12 times) and increased screen length (2.5-3.2 times) involved, equivalent to the length of time required to switch on the TFT in a pixel. In such a case, image signals would spend all their time on charging and discharging floating capacities, with no time left to operate the liquid crystals. To address this problem, it will be necessary, for example, to reduce the resistivity of wires by a factor of 10.

(3) Increases in defects

Increasing the surface area of a circuit device entails rapid increases in the probability of defects in the circuit elements, in proportion to the size increase. The probability of dust particles finding their way into the product, for example, will be almost infinitely greater than the probability of dust contamination during VLSI manufacturing process. It will be exceedingly difficult to produce large-surface LC panels that are defect-free, for the probability of occurrence of a defect on the entire surface area of a circuit device increases as an exponential function of the rate of defect occurrence per unit surface area. To address this problem, it will be necessary to develop special techniques for providing a redundancy in the circuitry and for correcting defects and salvaging injured circuit elements.

(4) Difficulty of handling

In addition to the above difficulties, the large size of the substrate entails unique problems.

For example, transport and handling of panels during production process will require development of new methods and devices.

In the case of small substrates, coating of a substrate with liquid can be carried out through the use of a spin coater, which spins the substrate at a very high speed of approximately 3,000 rpm. It would be very difficult, however, to extend such a technique to coating of a large substrate, given a board thickness of 3 mm and a board weight of 5 kg or greater (Figure 3).

## 4. Application Fields for the Elemental Technologies

(1) Large-surface precision glass substrate technology

(Materials for the construction of optical disks)

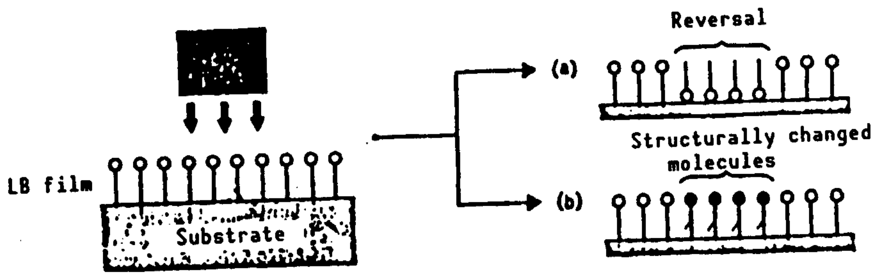
(a) Specific objective

Materials for the construction of optical disks

(b) Technological necessity

Although optical disks are being used for the recording of graphical data (analog data), due to their high error rates compared with magnetic disks, they are rarely used for the recording of coded data. If optical disks are to be used for the storage of coded data, especially those requiring a high degree of data security, the error rates must be reduced through ultra-high-precision glass processing.

(c) Objectives for technology development




This research topic requires the development of ultra-high-precision glass processing technology to realize exceedingly high levels of flatness, high heat resistance, an alkaline-free composition, and resistance to deformation. These objectives are common to the ultra-high-precision glass substrate technology development objective under the large-surface circuit element basic technologies.

**A Comparision: Error Rates for Various Data Storage Media**

| | Compact disk | Optical disk | Magnetic disk |
|---|---|---|---|
| Main uses | Music | Pictures Coded data | Coded data |
| Capacity (bytes/cm of diameter) | 550M/12cmφ | 2.6G/30cmφ | 20M/13.3cmφ |
| Error rate | $10^{-5}$ | $10^{-5}$-$10^{-6}$ | $10^{-7}$-$10^{-8}$ |
| Birefringence | (<100nm) | (<40nm) | — |

Source: NIKKEI ELECTRONICS, 12 March 1984.

(2) Large-surface high-fidelity thin-film technology

(Optical recording thin-films)

(a) Specific objective

An ultra-thin-film for high-density recording of digital signals

(b) Technological necessity

In the field of optical recording media, development of a recording medium that allows high-density recording of signals is desired. To realize high-density recording, it is necessary to achieve extremely thin recording film structures and a regular molecular array.

(c) Objectives for technology development

Development of an LB optical recording film capable of undergoing a reversal or structural change when subjected to irradiation by light.

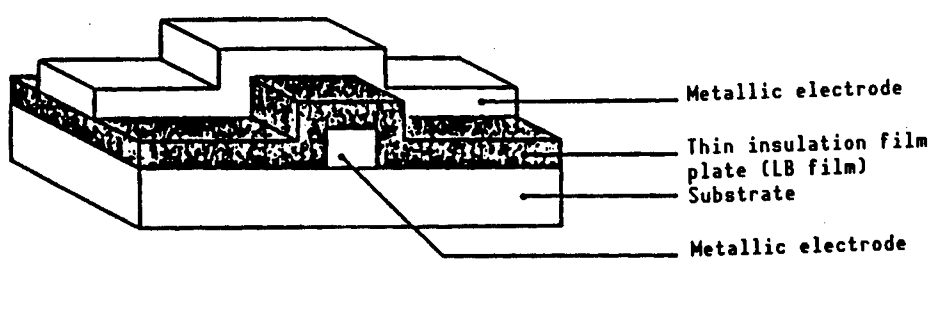
(Ultra-thin insulation film)

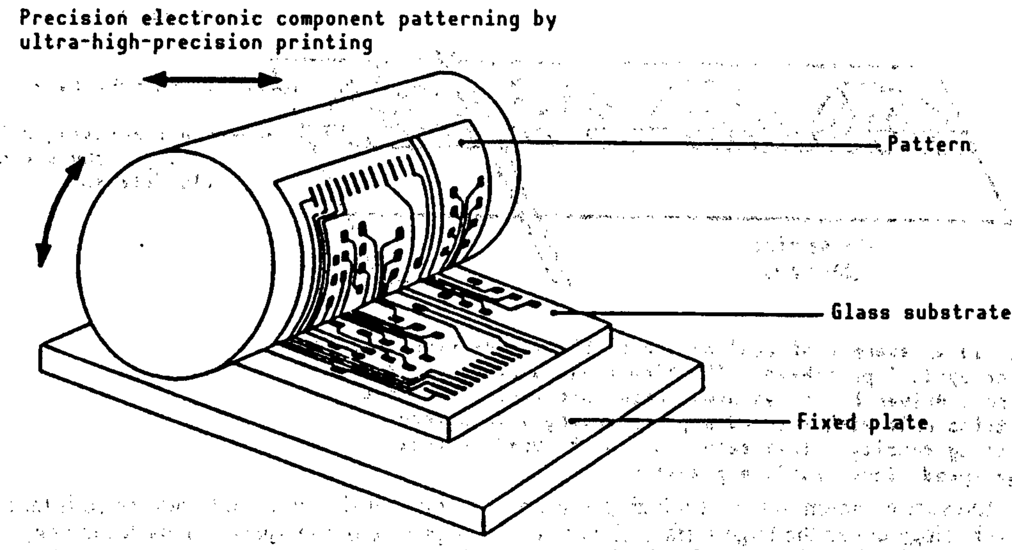
(a) Specific objective

Formation of a monomolecular layer ultra-thin insulation film by causing the molecules to form a rigidly regular array, such as a unidirectional array.

(b) Technological necessity

Switching device






Construction of ultra-thin insulation films for VLSI devices or the next generation of devices such as Josephson devices requires extremely small, fast-operating switching devices using ultra-thin insulation films.

(c) Objectives for technology development

Formation of an ultra-thin LB film with a unidirectional array regularity.

(Other)

Application development is under way in diverse fields, such as molecular devices, biodevices, sensors, and other functional devices; and nonlinear optical devices.

(3) Large-surface high-fidelity patterning technology

(Precision electronic components)

(a) Specific objective

Under this subtopic, techniques for manufacturing precision electronic components (precision patterning), hitherto manufactured by photolithography, by ultra-high precision printing (precision patterning) will be explored. An example might be the application of printing methods, used in the manufacture of LC color filters, for the manufacture of CCD filters and color facsimile filters.

(b) Technological necessity

Although the use of printing methods for the manufacture of precision electronic components would greatly improve productivity, current printing methods are inadequate in resolution, compared with the photolithography method, and therefore cannot be applied to the manufacture of electronic components.

(c) Objective for technology development

Application of printing techniques to the manufacture of precision electronic components requires substantial improvements in precision and picture quality of printing. Therefore, this objective is common to the manufacturing pattern technology development objective, such as for the printing of color filters, under large-surface circuit element basic technologies.

(4) High-performance circuit structure technology

(Chip-on-glass (COG) technology)

(a) Specific objective

To achieve a high device packing density and size reductions through direct mounting of LSI chips on a glass substrate. This technology may find a wide range of applications to electronic and image-processing devices (optical printers) that use glass components.

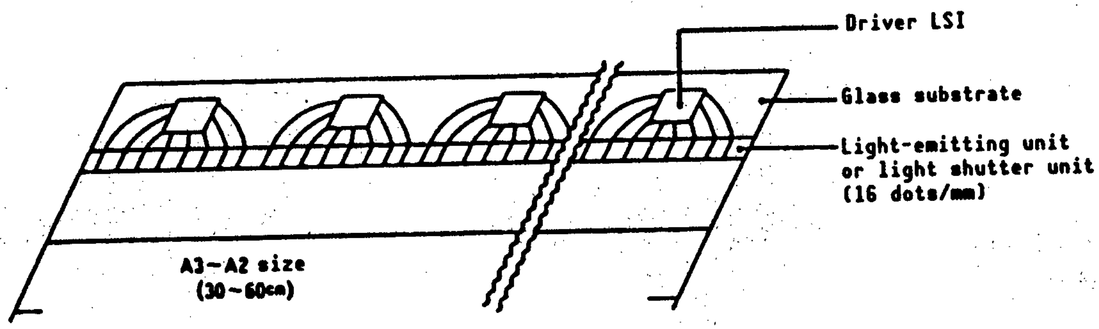
(b) Technological necessity

Because of intrinsic incompatibility between glass and LSI (problem of poor reliability due to the difference in thermal expansion coefficients of these substances), COG technology has made inroads only to the fabrication of small-scale LSI, in which only a few LSI's are mounted.

(c) Objectives for technology development

(i) Large-scale implementation: one or more LSI chips supporting over 100 I/O pins will be mounted on a single glass substrate.

(ii) High reliability: development of junction materials capable of ameliorating the effects of heat cycles and glass deformation.




This is an example of application of COG to the construction of an optical printhead. The figure illustrates an example where a driver LSI is mounted, chip-on-glass, on a light-emitting unit with size A3-A2, supporting a 16 dots/mm printing density. This technique can be used to realize high-speed, large-surface printers.

These objectives are common to the ultra-high-precision assembly technology under the large-surface circuit element basic technologies.

(5) Highly functional LC materials

(Optical information processing devices)

(a) Specific objective

Fiber-optic communication optical switches

(b) Technological necessity

Functional LC materials offer the advantages of producing a large photoelectric effect with low driver voltage, and ease of device manufacture. However, the problem of low response speed needs to be addressed.

(c) Objectives for technology development

A most critical issue to be addressed is that of achieving higher response speeds. This technology development issue is common to the development of highly functional LC materials for the fabrication of large-surface circuit elements.

(6) Large-surface precision assembly technology

(Large-surface glass bonding technique)

(a) Specific objective

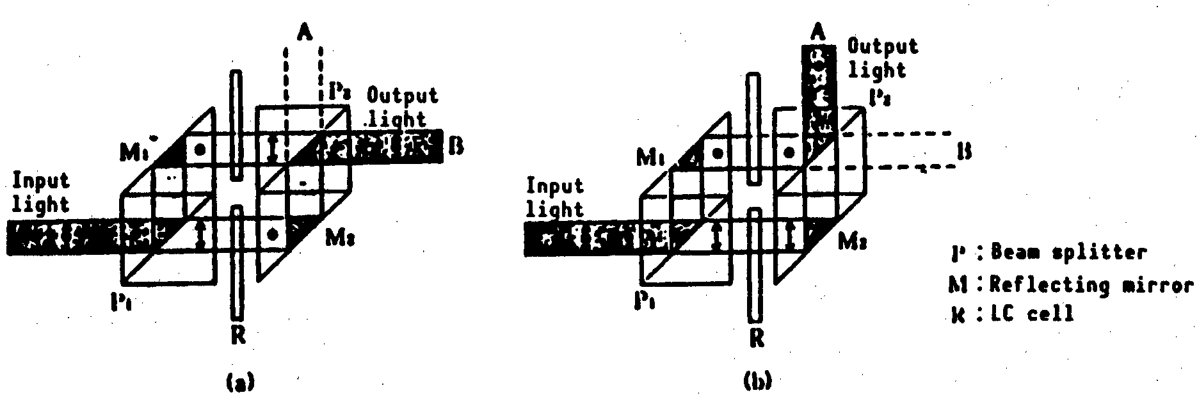
Large-surface optical devices, such as optical shutters and screens, requiring bonding of large-surface glass plates with precise amounts of gaps.

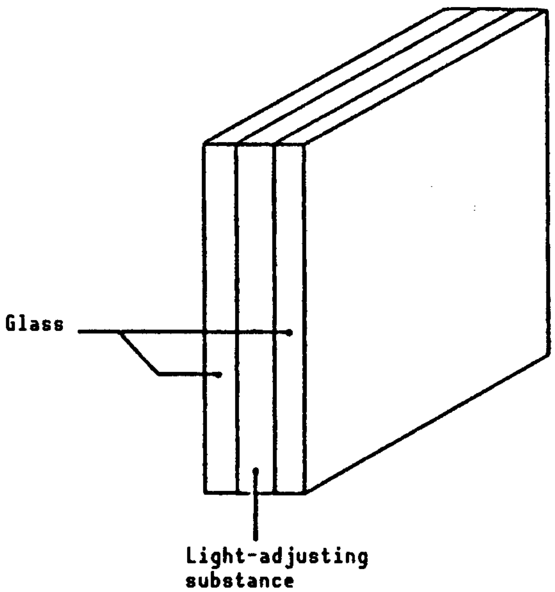
(b) Technological necessity

There is no existing technology that allows formation of large-surface, precise gaps.

(c) Objectives for technology development

Optical switches using LC cells






The figure illustrates an application of large-surface precision assembly technology to the construction of a light-adjusting, thermal insulation glass. Application of voltage changes the light transmissivity of the glass, endowing the glass with an ability to adjust the amount of light which it passes.

(i) Large-surface implementation: a gap variability of less than 0.2 micron over a 40-inch area

(ii) Alignment precision assurance: to align top and bottom glass plates with an accuracy of 1 micron or less

The high-fidelity assembly technology as part of the large-surface circuit element base technologies will open the door to the above-described new technology developments.

## 5. Applications of Large-Surface Circuit Elements

Large-surface circuit elements are expected to find applications in the following specific areas:

(1) Image data I/O devices

(a) Large-surface high-fidelity thin-profile image display devices

The most important device among the next generation of graphic systems is the image display device.

The image display device is an important link (man-machine interface) in the chain of devices for passing information from machine to man. As the use of advanced information technologies spreads, in every facet of society there will be a need for information display in forms that are the least burdensome to the human eye.

Currently the vast majority of image display devices used are based on CRT (Brown tube) technology, with the exception of a few application fields. Although excelling in cost and performance, however, the CRT cannot be made in any significantly larger format than currently available formats because a larger CRT would have to be necessarily heavier and with a greater depth.

Although advances in the graphical form of information transmission are likely to require large image display devices for receiving TV broadcasting, a CRT-based implementation of high definition TV (HDTV) in 40-inch diagonal format would require a TV set weighing more than 200 kg and measuring more than 50 cm deep, which would be ill-suited for use in ordinary homes, given the smallness of houses in Japan.

Lightweight, thin-panel, low-power consumption image display devices are also needed as aircraft simulators and automobile display devices, in addition to use in homes. It has been pointed out that CRT technology leaves much to be desired in realizing these objectives.

Another point is that because it uses an electron beam in it, a CRT is not suited to operation in the presence of a strong magnetic field, such as near a nuclear magnetic resonance (NMR) apparatus or superconductor experimental apparatus.

Further, the CRT is associated with the problem of screen flicker and UV light discharge, which can cause eye problems (VDT syndrome), the severity of which has gained notoriety in recent years. Also, since a CRT contains a vacuum in it, it is an inherently dangerous, explosive structure, and the risk of explosion increases with increases in the CRT size.

These considerations call for development of a safe, large-surface high-fidelity image display device that can be implemented on a large scale. Currently the most feasible method is considered to be the TFT-LCD method, for which development of large-surface circuit elements is needed.

Note: The term "TFT-LCD method" refers to a technique in which thin film transistors (TFT's) are used to drive a liquid crystal display (LCD) unit.

**Advantages of a Large-Surface Precision Thin-Panel Image Display Device (LC-Based)**

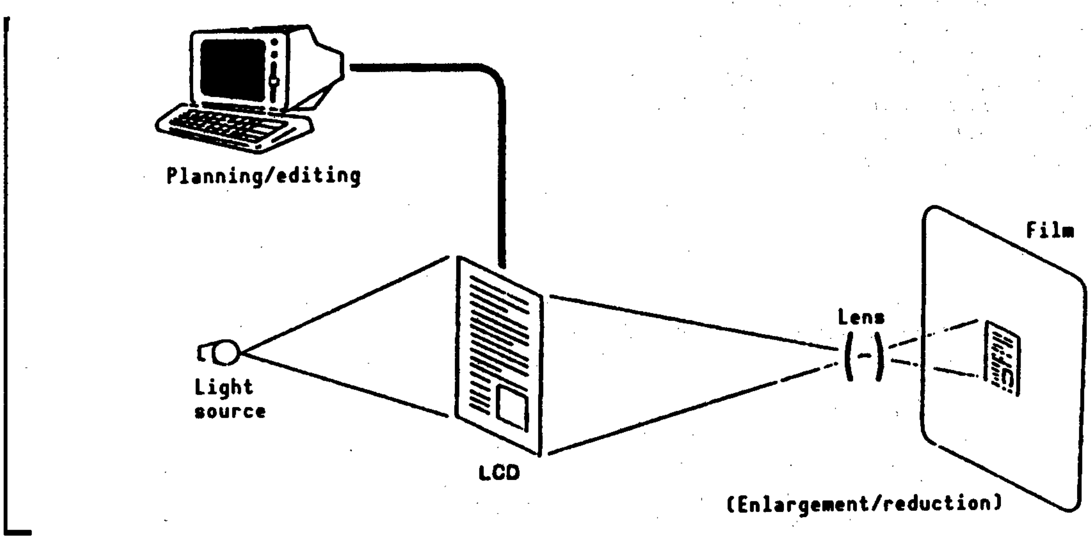
| | LC-based large-surface high-fidelity image display device | CRT (Brown tube) | Plasma-based image display device |
|---|---|---|---|
| (1) Impact on the eye | UV: none; Flicker: None, due to an operating speed of 80 msec | Increases in OA and TV devices have brought on the problems of flicker and electromagnetic radiation (UV, X-ray, and low-frequency e.m. radiation, causing eye problems (VDT syndrome). | Color display requires UV light from an xenon source. Less flicker than a CRT. Lower brightness can cause eye fatigue. Medium (requires high voltage for xenon-based light emission); limited brightness. |
| (2) Energy consumption | Low (4 mw/40 inches -w/o backlighting; 40 w/40 inches, w/ backlighting. (Low energy consumption relative to the level of brightness produced) | High: (400 W output at 40-inch diagonal; or 5-7 lumen light intensity/W) | 0.1-1.0 lumen/W (widely variable with color) |
| (3) Area/weight | 1 cm-1 m, thin (a few cm), and lightweight | 2-40 inches; 150 kg/40 inches | 10 cm-1 m, light and thin |
| (4) Amount of data display | Low-high (1125x1920 pixels) An ability to support any pixel density | Low-medium (525x910 pixels) Dificult to enhance the display density | Medium (525x910 pixels) A large minimum pixel-to-pixel gap |
| (5) Safety | 1.5-30 V operating voltage; normal atmospheric pressure | 10-30 kV operating voltage; internal high vacuum; potentially explosive | 120-300 V internal voltage; reduced internal pressure |
| (6) Environmental tolerance | Immune to magnetic effects. Can be used in leading-edge scientific research, including superconductivity and magnetic resonance research (-20 -+ 85°C) | Liable to magnetic effects. Unsuited for use in scientific research (w/o an e.m. shield, the device is so sensitive to e.m. fields so as to be able to detect earth magnetism) | Virtually immune to magnetic effects. Operating temperature: -40 -+ 70°C |
| (7) Appropriateness for interactive use | Flat structure lends itself to efficient I/O operation. Can easily be layered with a touch-sensor panel. | Unsuited due to its great thickness. Takes up a lot of space. | Flat structure lends itself to efficient I/O operation. Can be layered with a touch-sensor panel. |
| (8) Color filter capability | Can accommodate a color filter. Color quality: good color balance | Can be realized through fluorescent emission. Color quality: good color balance | Can be realized through fluorescent emission. Color quality: variable from color to color; unsuitable for natural-looking color display |
| (9) Image distortion | No angle-of-vision distortion thanks to the prefectly flat shape. Digital addressing allows distortion-free image representation even at corners. | Screen curvature necessarily creates distortion. Use of the analog beam addressing makes peripheral distortion unavoidable. | No angle-of-vision distortion thanks to the perfectly flat shape. Digital addressing allows distortion-free image representation even at corners. |
| (10) 3D display (requires high resolution) | Suited for high resolution | Somewhat unsuited for high resolution | Ill-suited for high resolution. Major limitation on minimum luminescent point intervals. |
| (11) Ease of assembly | Allows micro-scale terminal connection thanks to the low voltage. Ease of mounting. Easy to develop a driver LSI. | — | Ill-suited for micro-scale connection due to high voltage. Difficult to develop a high-voltage driver LSI. |
| (12) Uniformity of brightness | Little temporal or spatial variation in brightness | High peak brightness relative to average brightness, with small luminescent point. Liable to uneven brightness. | High peak brightness relative to average brightness, with small luminescent point. Liable to uneven brightness. |

Note: The above is a comparison of the advantages of the LC method, considered to be the most promising approach to the realization of large-surface precision thin-panel display devices, with those of CRT and plasma image display technologies.

(b) Photolithography systems

The photolithography process, a part of the book production process, involves the use of drafting equipment to create graphs and drawings, typesetting equipment to print characters, and photographing the prints, which are the results of editing through cutting and pasting, to render them as images on film. However, the increasing use of wordprocessors and computer-based typesetting equipment (CTS) in many cases has transformed the book production process to one involving planning, editing, and verification of print images on a CRT monitor. This has created a need for systems that allow capturing the image data on the CRT monitor directly onto film with a high degree of fidelity for subsequent output. The need for such systems is likely to increase further as the popularity of desktop publishing (DTP) widens.

A promising approach to realizing this goal would be the use of TFT-LCD cells to capture the image data on a monitor optically onto film with a high degree of precision and with any desired magnification, in order to achieve system-based high-speed publishing. This calls for the development of large-surface circuit elements.




(c) 2D flat scanner

The current procedure for the creation of color printed materials involves input of source documents, such as color photographs, by one-dimensional scanning through the use of a cylindrical image input device called a color scanner. The process is time-consuming (requiring about 10 minutes to process a sheet of an A4 size document) and the equipment used is bulky. To address these problems, development of a 2D flat scanner is highly desirable, as has been pointed out in a recommendation by the Industrial Structure Council, entitled "The Future of the Printing Industry."

A most promising approach to the development of a 2D flat scanner would be construction of an input system consisting of a planar array of contact TFT sensors, and which reads the source document by treating it as an area. Such a system would speed up the input process, eliminate the need for a lens system, result in simpler construction, and could be a powerful tool for use in small print shops.

(d) Ultra-thin copying system

The currently available copying systems are optical, drum-based systems that are bulky, noisy, and difficult to maintain (drum cleaning). Because of these problems, the realization of a copying system based on entirely new operating principles is desired.

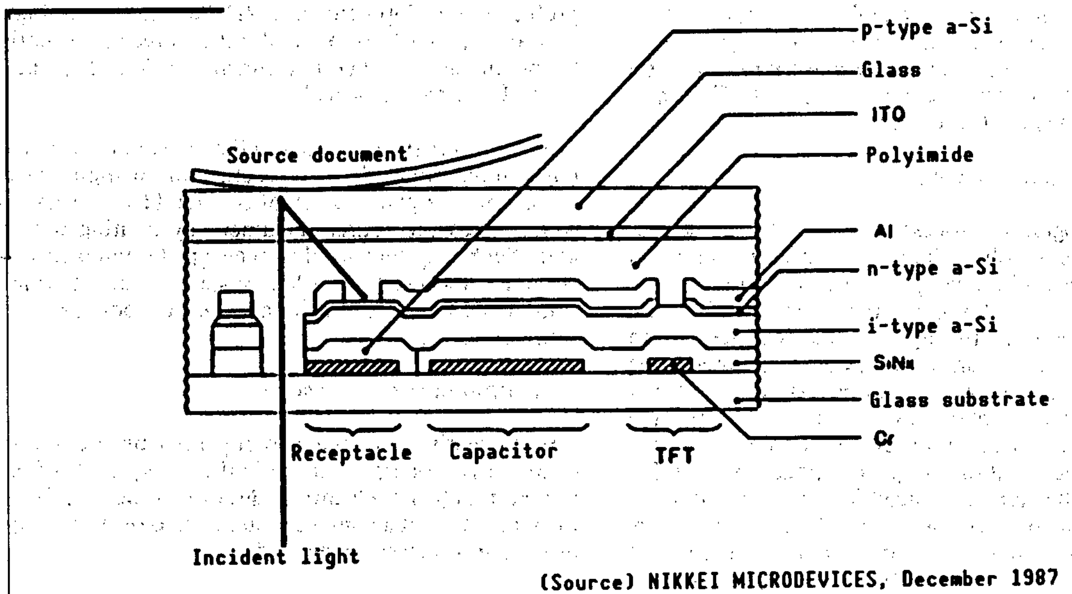
An ultra-thin copying system could be realized by utilizing large-surface circuit elements as 2D image I/O devices, and combining them with a silver halide-based one-shot color photosensitive material. The use of large-surface, high-fidelity CCD sensors as input devices and the use of large-surface high-fidelity TFT-LCD cells as output devices could lead to the realization of an ultra-thin copying system in which lenses have been eliminated.

In terms of output, such a system will allow color printing, which is difficult to achieve with currently available laser beam printers.

(2) Information processing/conversion devices

(a) Book-size computer

Computers for the 21st century will be book-size units that can be filed away in a binder. In terms of structural




**Sectional View of the Structure of a 2D Flat Scanner**

elements, the LC display unit with a touch panel would be a high-fidelity display unit supporting touch input capability, and would be equivalent to the "face" of the computer. Thin-film computers are mounted on a mounting panel, consisting of a multi-layer wired structure, together with batteries and optical memory units. The 2D image sensors and thin-profile printers will all be made with large-surface circuit elements. Consequently, in a book-size computer the processor, display unit, I/O devices (touch panel, printer), files (optical memories), and communication functions will be integrated through an interface box, so that they are detachable and capable of parallel processing, to realize features that are attuned to the user's needs.

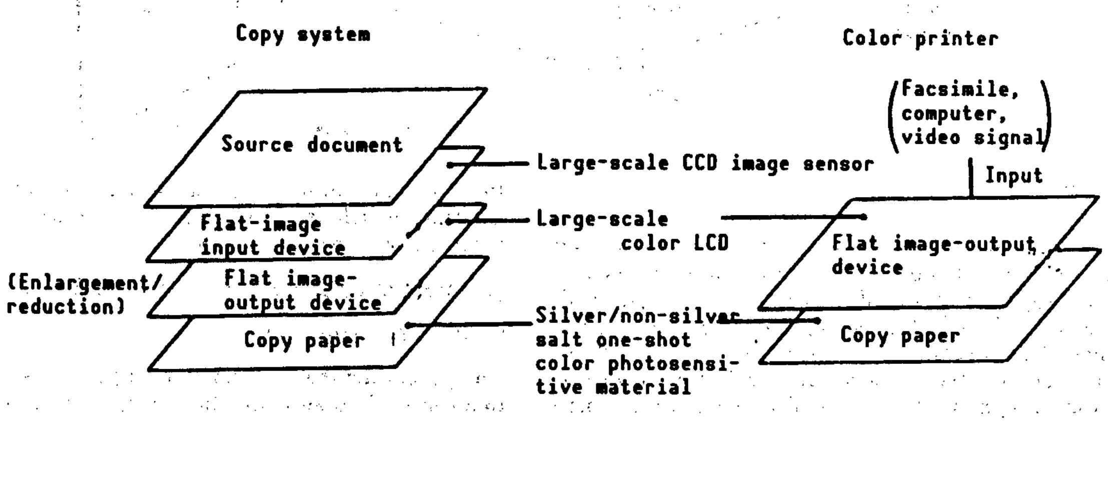
(b) Optical computer

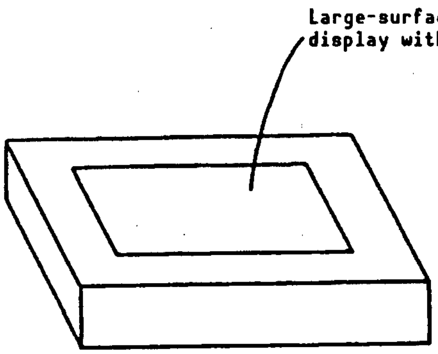
There are two broad strategies for realizing an optical computer:

(1) To take advantage of the high-speed operation capabilities of semiconductor light-emitting diodes, photosensitive devices, and other optical logic devices to increase the operating speed of a Neumann-type computer;

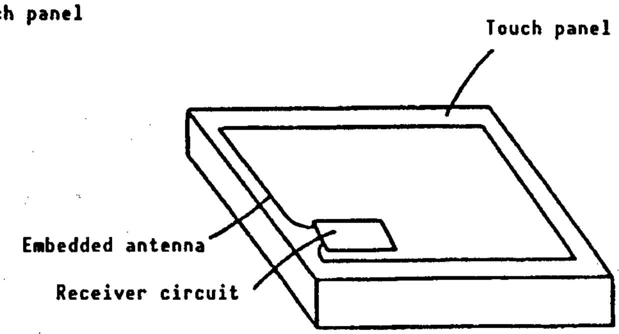
(2) Parallel processing of most data in two-dimensional space to take advantage of the ability of light to propagate in parallel, to achieve an equivalent gain in the operating speed of a computer.

Approach (1) represents a logical extension of the conventional computer, and is subject to speed limitations inherent in the conventional system. Approach (2) seeks to achieve novel computational methods, including high speed computation, through expansion of the computational system itself. Therefore, this approach has much expansion potential.

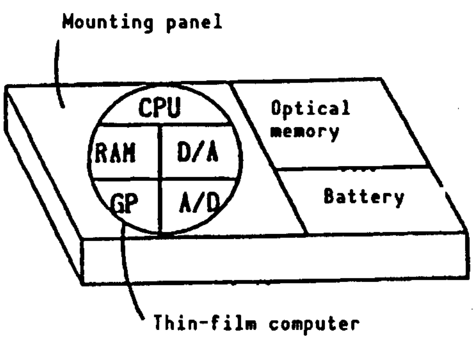




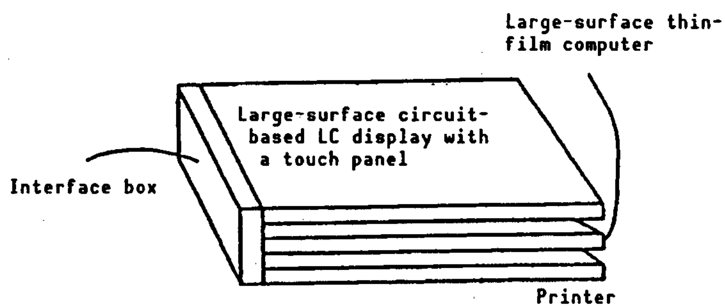

(a) Book-size computer




(b) Large-surface circuit-based LC display with a touch panel




(c) Thin-film computer and mounting panel

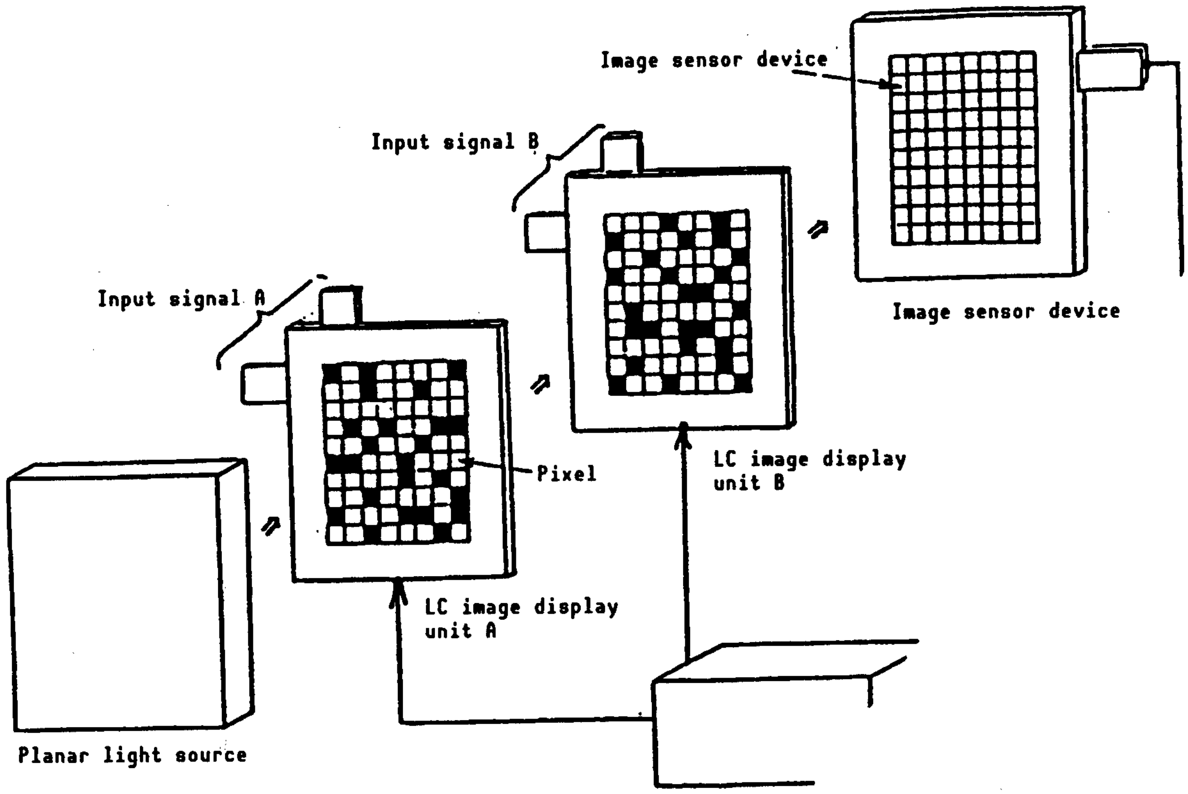



(d) Concept of a book-size computer

The optical computer described below belongs to Approach (2). The main processing device for this computer consists of 2 matrix LC image display units and 1 2D image sensor, each of which is made with large-surface circuit elements.

To construct a computer through the use of these devices, on/off (light/dark) signals are imparted from an external source independently to the individual pixels that are distributed in a two-dimensional array in each of the LC image display units. The result is that each pixel independently acts to either admit or block the passage of light that seeks to pass through the position occupied by the pixel. The two LC image display units are positioned to face each other, with the pixels aligned in their corresponding positions. When planar light is directed at the LC image display units from an external source, the light will pass only when the 2 opposite pixels are "on" at the same time; in other cases the light will be blocked. Thus, over an entire circle on the surface of a unit, light signal undergoes an AND spatial modulation.

An example of application of such an image-processing computer would be fingerprint checking. In such a case, a binary image of a known fingerprint, obtained from a computer file, would be drawn on LC image display unit A on the left-hand side of the figure, and a binary image of the fingerprint to be identified would be input into LC image display unit B on the right-hand side. A beam of parallel light is directed from the left of LC image display unit A. The light image passing through the two LC image display units is detected in parallel by the 2D image sensor placed on the right. The individual image sensor elements incorporated into the image sensor device operate independently at any given time, and the result of overall detection and computations performed




**Parallel-Processing Computer System Using Large-Surface Circuit Elements**

by these elements is output. Thus, if the images drawn on the two LC image display units agree in most part, it can be concluded that the fingerprints are identical. To arrive at an appropriate conclusion, overall fuzzy-logic comparison calculations will be performed, rather than comparing images pixel-by-pixel. To do this, image B can be enlarged, reduced, or rotated in any desired fashion in order to check the degree of agreement of A with B under various conditions.

The number of LC image display units to be inserted into a pattern-matching computer that uses 2D images is by no means restricted to two. It would be possible to construct a parallel-processing computer featuring a combination of a large number of LC image display units, on which 2D images are drawn independently, and in which the planar light emerging from the several LC image display units is processed in parallel fashion. Such an operation takes advantage of the fact that when the corresponding pixels on the LC image display units are on, these units are transparent to light, a property unique to this type of image display device.

Beyond the writing of on/off binary image data to pixels, as described above, multi-value signal images, such as those consisting of trivalue signals 0, 1/2, and 1, can be input into the pixels so that such images can be compared over the entire surface of 2 LC image display units. In such a case, by providing appropriate nonlinear threshold values in the image sensor devices, a full-fledged fuzzy-logic computer could be realized. Further, by using input light of different wavelengths and by taking advantage of optical rotation and birefringence properties of crystals, it might be possible to realize even higher-order optical computations.

A common thread applicable to the above examples is that the larger the number of pixels contained in an LC image display unit or image sensor device, the greater is the precision in parallel computation that can be attained. It is in this sense that large-surface circuit elements hold the key to the realization of an entirely new breed of computers.

## Grants-in-Aid and Loan Assistance for FY 1988 (7 March 1989)

### Tentative Selection of Research Proposals

### Base Technology Research Promotion Center

1. The Base Technology Research Promotion Center, whose responsibility includes provision of grants-in-aid and loan assistance to demonstration research on basic technologies conducted in the private sector, has recently selected new research proposals for FY 1988, subject to later confirmation.

2. Of these proposals, 8 proposals will receive grants-in-aid (with a funding of ¥700 million from the FY 1988 budget), and 22 proposals will receive loan assistance (with a funding of ¥500 million from the FY 1988 budget).

3. These proposals have been selected, subject to confirmation, after rigorous review of the 18 proposals requesting grants-in-aid and 58 proposals requesting loan assistance, submitted during the 1-9 September 1988 open solicitation period.

4. The Base Technology Research Promotion Center will fund these proposals in the order in which the necessary administrative procedures are completed with the requestor, such as the signing of a basic contract.

Contact points: Suzuki and Sodeyama; General Affairs Department, General Affairs Division, Base Technology Research Promotion Center. Telephone: 03-505-6811.

**New Projects Earmarked for Grants-in-Aid Funding During FY 1988**

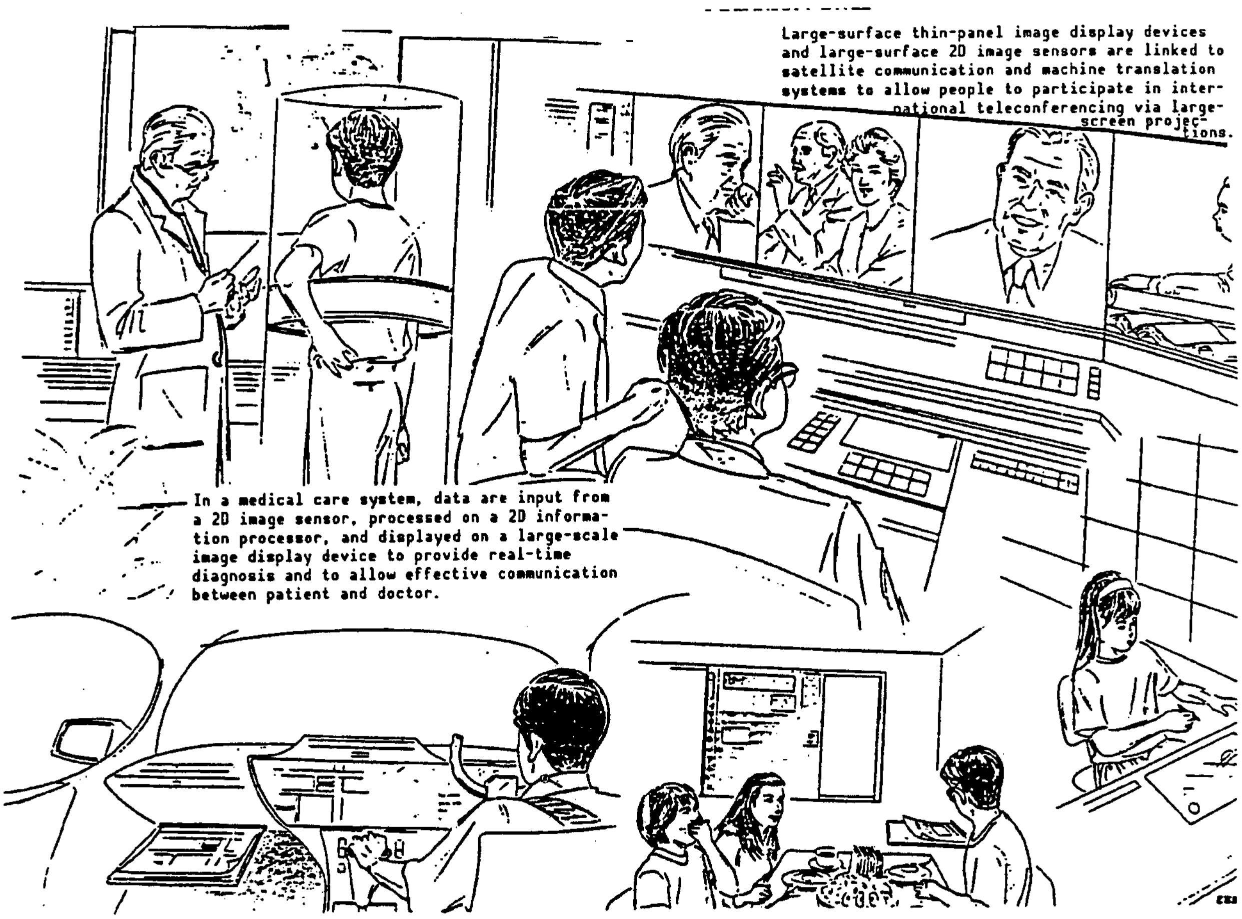
| Field | No. | Topic | FY 1988 funding (in million yen) | Company name | Project summary |
|---|---|---|---|---|---|
| New materials | 1 | R&D on high specific strength alloys (Al-Li alloys) | 90 | Alicium Co., Ltd. (tentative name) | Development of a process for safe and efficient manufacture of Al-Li alloys excelling in specific strength and mechanical properties. R&D involving physical properties, alloy design technology, and melting/casting technologies. |
| Electronics | 2 | R&D on large-surface circuit element base technologies | 200 | GTC Co., Ltd. (tentative name) | Development of the technologies necessary for realizing "large-surface circuit elements" in which active elements are formed on a relatively large substrate. R&D involving highly functional circuit structure technology, silicon film formation technology, and high-fidelity patterning technology. |
| Wireless communication | 3 | Demonstration research on advanced satellite communication utilization technologies | 77 | Satellite Communication Systems Technology Research Laboratories Co., Ltd. (tentative name) | Demonstration research on satellite communication optimal control technology for handling data signals transmitted at different speeds, high reliability communication control technology, technology for dealing with short-pulse disruptions of signals coming from a mobile signal source, and other systems technologies for the realization of advanced utilization of satellite communications. |
| Image transmission | 4 | Demonstration research on advanced High Definition TV image generation, transmission, and display systems | 258 | Advanced Image Technology Research Laboratories Co., Ltd. (tentative name) | Development of basic technologies for the construction of advanced HDTV picture generation, transmission, and display systems necessary to promote HDTV. Demonstration research on advanced HDTV picture generation technology, picture transmission technology, LC projection-type display technology, and picture evaluation technology. |

**New Projects Earmarked for Grants-in-Aid Funding During FY 1988**

| Field | No. | Topic | FY 1988 funding (in million yen) | Company name | Project summary |
|---|---|---|---|---|---|
| New communication media | 5 | R&D of information systems to advance the fashion industry | 19 | Gifu Fashion Community Co., Ltd. (tentative name) | R&D of fashion industry database systems, intended to provide high quality, high profit margin products, to answer the increasing needs for the use of advanced information technologies in the apparel industry. |
| New communication media | 6 | R&D of information systems for the promotion of wide-area industries | 16 | Okayama Wide-Area Industrial Information Systems Co., Ltd. | R&D of wide-area industry promotion systems, necessary for the provision, development support, and management and operation of software systems at information centers, to promote and invigorate local industries in wide geographic areas through the use of information technologies. |
| New communication media | 7 | R&D of comprehensive information systems for the promotion of small business | 25 | New Media Tokushima Co., Ltd. | R&D of production technology support systems intended to increase the efficiency of production-related activities, ranging from design to manufacturing, to promote small business and to improve the production efficiency of regional industries through the use of information technologies. |
| "Teletopia" | 8 | R&D of information systems for the promotion of regional commerce (in the city of Himeji) | 15 | Himeji Media Network Co., Ltd. | Construction of a business news system combining a regional CAPTAIN system and a multifunctional card system, intended to invigorate commercial activities in the Himeji area. Demonstration research on business-oriented card-processing functions on the CAPTAIN system and CAPTAIN terminals with card-processing capability. |
| Total | | (8 projects) | 700 | | |

**New Projects Earmarked for Loan Assistance—FY 1988**

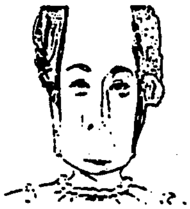
| No. | Field | R&D topic | FY88 loan (million yen) |
|---|---|---|---|
| 1 | New materials | Research on metal-bond, diamond grinding stones for difficult-to-work-with ceramics | 5 |
| 2 | New materials | Research on high-performance structural materials for space-based infrastructure | 7 |
| 3 | New materials | Research on ultra-high temperature, high efficiency flame injection technology | 18 |
| 4 | New materials | Research on heat-tolerant composite ceramics for use in harsh environments | 4 |
| 5 | Biotechnology | Research on utilization of the macrophage chemotactic factor (MCF) | 42 |
| 6 | Mechanical engineering | Research on high-performance, non-circular machine work technology | 79 |
| 7 | Mechanical engineering | Research on efficient, fidelity conversion technology on print tone graduation characteristics in the high ink concentration area | 6 |
| 8 | Mechanical engineering | Research on deep ground measurement and analysis by the centrifugal load method | 10 |
| 9 | Electronics | Research on large-surface projection systems using high-fidelity active matric color LCD's | 15 |




## Advent of the Age of Giant Electronics

| | | | |
|---|---|---|---|
| 10 | Electronics | Research on highly functional future office desks based on integrated human interface | 40 |
| 11 | Electronics | Research on heteroepitaxy conducted on a large-surface glass substrate | 11 |
| 12 | Electronics | Research on junction composite-structure substrates by the numerically controlled planarization method | 13 |
| 13 | Communication processors | Research on ultra-high speed analog/digital signal processing systems | 42 |
| 14 | Networks | Research on directory systems based on mutually convertible network numbering systems | 41 |
| 15 | Networks | Research on distributed processing of electronic mail systems in a wide-area network | 28 |
| 16 | Networks | Research on wide-area multi-stage vertically connected networks for CATV | 6 |
| 17 | Networks | Testing & research on fault prevention techniques in network terminals | 12 |
| 18 | Radio communication | Research on quasi-microwave small directional antennas for use in portable radio communication equipment | 25 |
| 19 | Radio communication | Research on radar systems for remote-sensing probe on soil quality | 16 |
| 20 | Radio communication | Research on prevention of mutual electromagnetic wave interference in the use of multiparty shield antennas | 9 |
| 21 | Image transmission | Research on high-quality, large-capacity digital animation picture store-and-forward technology for broadcasting purposes | 56 |
| 22 | Image transmission | Research on base technology for ultra-long wave band optical signal transmission | 15 |
| | Total | | 500 |

Large-surface high precision glass substrate technology

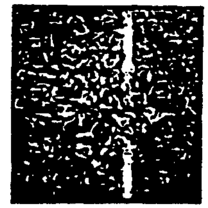


Increases in the surface area of circuit elements require high-precision processing of glass substrates. Such substrates are subject to substrate distortion due to the effects of gravity, causing swelling of the device in the lower part due to the pressure exerted by the liquid crystals, and collapsing of the upper part. Also, the flatness of the glass substrate can be adversely affected, resulting in a distorted screen image.

Large-surface high-fidelity thin-film technology (1)

The performance of a large-surface circuit device is determined at the time of thin-film formation and etching. This requires a high degree of uniformity in film thickness. A nonuniform film thickness can create localized defects on the screen image.

Large-surface high-fidelity thin-film technology (2)



A nonuniform film thickness can affect device operation; especially in the periphery of the screen, the problem can manifest itself as warped or distorted image contours.

Large-surface high-fidelity patterning technology

High-fidelity pattern formation over a large surface area is essential.

Highly-functional LC materials

Improvements in response time and electric resistance are necessary in order to increase the speed of LC operation. A time lag in LC operation can result in poor image display, including double or residual images.

Large-surface high-precision assembly technology

A slight misalignment of the large number of panels to be joined together can result in a misalignment of the entire screen.

**Technical Challenges Associated With Large-Surface Circuit Elements—in the case of a large-surface high-fidelity thin-panel image display device**

/ı)

22161
45

NTIS
ATTN: PROCESS 103
5285 PORT ROYAL RD
SPRINGFIELD, VA 22161



Foreign Broadcast Information Service (FBIS) and Joint Publications Research Service (JPRS) publications contain political, economic, military, and sociological news, commentary, and other information, as well as scientific and technical data and reports. All information has been obtained from foreign radio and television broadcasts, news agency transmissions, newspapers, books, and periodicals. Items generally are processed from the first or best available source; it should not be inferred that they have been disseminated only in the medium, in the language, or to the area indicated. Items from foreign language sources are translated; those from English-language sources are transcribed, with personal and place names rendered in accordance with FBIS transliteration style.

Headlines, editorial reports, and material enclosed in brackets [] are supplied by FBIS/JPRS. Processing indicators such as [Text] or [Excerpts] in the first line of each item indicate how the information was processed from the original. Unfamiliar names rendered phonetically are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear from the original source but have been supplied as appropriate to the context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by the source. Passages in boldface or italics are as published.

## SUBSCRIPTION/PROCUREMENT INFORMATION

The FBIS DAILY REPORT contains current news and information and is published Monday through Friday in eight volumes: China, East Europe, Soviet Union, East Asia, Near East & South Asia, Sub-Saharan Africa, Latin America, and West Europe. Supplements to the DAILY REPORTs may also be available periodically and will be distributed to regular DAILY REPORT subscribers. JPRS publications, which include approximately 50 regional, worldwide, and topical reports, generally contain less time-sensitive information and are published periodically.

Current DAILY REPORTs and JPRS publications are listed in *Government Reports Announcements* issued semimonthly by the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161 and the *Monthly Catalog of U.S. Government Publications* issued by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

The public may subscribe to either hardcover or microfiche versions of the DAILY REPORTs and JPRS publications through NTIS at the above address or by calling (703) 487-4630. Subscription rates will be provided by NTIS upon request. Subscriptions are available outside the United States from NTIS or appointed foreign dealers. New subscribers should expect a 30-day delay in receipt of the first issue.

U.S. Government offices may obtain subscriptions to the DAILY REPORTs or JPRS publications (hardcover or microfiche) at no charge through their sponsoring organizations. For additional information or assistance, call FBIS, (202) 338-6735,or write to P.O. Box 2604, Washington, D.C. 20013. Department of Defense consumers are required to submit requests through appropriate command validation channels to DIA, RTS-2C, Washington, D.C. 20301. (Telephone: (202) 373-3771, Autovon: 243-3771.)

Back issues or single copies of the DAILY REPORTs and JPRS publications are not available. Both the DAILY REPORTs and the JPRS publications are on file for public reference at the Library of Congress and at many Federal Depository Libraries. Reference copies may also be seen at many public and university libraries throughout the United States.