FY2014

Development of Flexible Nitride Semiconductor Devices with PSD

Making it possible to manufacture low-cost and high-quality LEDs and transistors

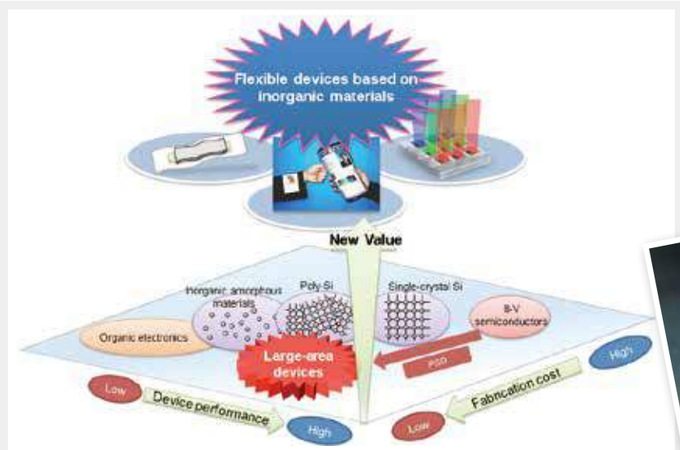
The electronic equipment we use in our daily lives is composed of core devices such as integrated circuits on wafers* made from single crystal semiconductor materials. This single crystal wafer, however, is stiff and brittle, which means it can easily crack even with minor impacts. Furthermore, there are many issues with manufacturing high-quality devices, as they require extremely high temperatures of at least 1000 degrees Celsius, expensive materials that can withstand high temperatures, and it is difficult to make large-area devices.

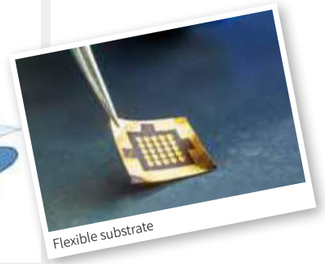
A method that can solve all these problems at once is our unique PSD method, which can provide high-quality crystals at low temperatures. This enables the manufacturing of large-area devices at a much lower cost, and we have already succeeded in the trial production of full color LEDs using low-cost glass substrates.

* Thin substrate made from a semiconductor used for manufacturing integrated circuits. This was named after a kind of western confectionery, or wafer.

Bringing technological innovation to electronic devices

The ACCEL project attempts to make single crystals by using the PSD method on large-area and low-cost substrates such as glass or flexible substrates that can be easily bent. By combining devices thus made such as LEDs and transistors, the project aims to develop new electronic devices that have unprecedented characteristics such as light weight and flexibility. In the future, it may be possible to have computers or displays that can be rolled up and carried like paper by integrating functions such as computation, memory, display, and sensors on a sheet of paper.




Flexible substrate

PSD method (Pulsed Sputtering Deposition)

PSD (Pulsed Sputtering Deposition) is a type of sputtering deposition method that grows high quality crystals on a substrate by supplying the source material in pulses. Using this method, we have developed a thin film deposition technology for gallium nitride (GaN), which offers superior qualities as a semiconductor material.

Research Director

Hiroshi Fujioka

Professor, Institute of Industrial Science, The University of Tokyo

Having been involved in research on semiconductors for 30 years, I would like to bring about another “new revolution” that will completely change our lives in the same way the internet has. The PSD method is a way to cover material surfaces with a thin film made of a semiconductor. Previously, it was considered impossible to use this method to generate high-quality crystals. However, by improving the conditions and procedures of crystal growth and transcribing a carbon sheet called graphene on a substrate, we succeeded in creating a high-quality crystal layer on it.

Our current task in the ACCEL project is to generate high-quality crystals on flexible substrates. In addition, I am improving the performance of the LEDs and transistors made by the PSD method. I am working towards making electronics even more free with the help of a program manager who provides a bridge to society.

Program Manager

Akira Usui

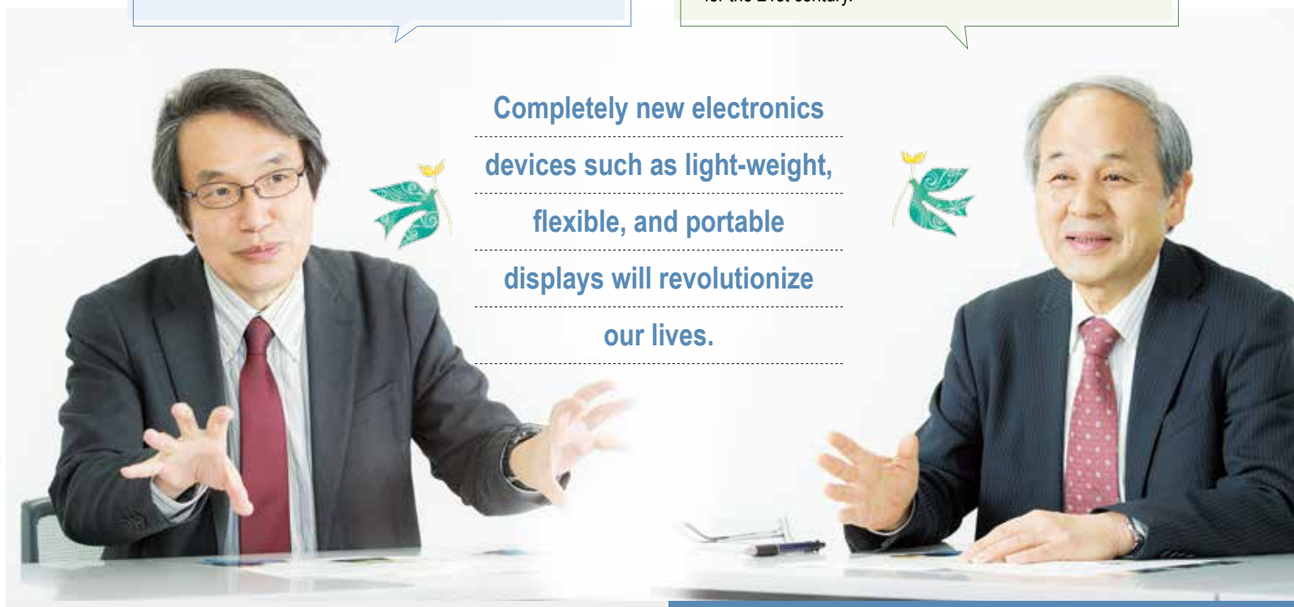
ACCEL Program Manager, Japan Science and Technology Agency

To create a new thing, a new method is required. I feel fascination and a sense of accomplishment when undertaking missions to carry out research from practical standpoints and apply the results to society.

In the ACCEL project, it is my task to plan a strategy to realize the PSD devices and disseminate them to society. At this stage, I am contacting companies and attempting to match them with the university. Once low-cost devices can be manufactured stably, the PSD method will become a key technology to incorporate LEDs and transistors into products or systems that semiconductors have never been used in, and these products could spread into the fields of electronics and medicine, or potentially even into our daily lives. Technology that enriches our lives and contributes to society’s prosperity. This is truly innovative technology.

I am aggressively struggling to generate astounding ideas to start a new era that would never arise just based on the continuation of conventional technology.

The PSD method is a technology that defies the common wisdom of the semiconductor manufacturing process. It will contribute to the development of a sustainable society for the 21st century.



Completely new electronics devices such as light-weight, flexible, and portable displays will revolutionize our lives.

PROFILE HIROSHI FUJIOKA

1984: Graduated from the Department of Industrial Chemistry, The University of Tokyo. Joined Fujitsu Limited; 1996: The University of Tokyo after the University of California, Berkeley; in current post since 2004. Research into semiconductor integrated circuit manufacture processes and heterocomplex material growth. Ph.D.

PROFILE AKIRA USUI

1970: Graduated from the Department of Chemical Engineering, Tohoku University. Joined NEC Corporation; worked for Furukawa Co., Ltd. R&D on compound semiconductors, and launching new business related to semiconductors. Ph.D. (Engineering)