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## LABORATORY COMMUNICATIONS

### Brief introduction to State Key Laboratory of Silicon Materials

The State Key Laboratory of Silicon Materials, originally named as the State Key Laboratory of High Purity Silicon and Silane, was established in 1985 with the approval of and the investment from the State Planning Commission of China. The Laboratory has since been a center for scientific research on silicon and other semiconductor materials.

#### 1 Main goals and research areas

The Laboratory boasts on its extensive basic and applied researches on silicon and other semiconductor materials in the following areas: (i) the growth of silicon crystals with large diameters, and the defects and impurities in the silicon materials; (ii) the preparation, characterization and application of silicon-based thin films; (iii) composite semiconductor optoelectronic materials; (iv) composite functional materials.

#### 2 Main achievements

Since the 1950s the Laboratory has been focusing its attention on the research of semiconductor materials and has made great achievements in this field. In the past 40 years, the Laboratory won 3 National Invention Awards and more than 10 Science and Technology Awards rewarded by Zhejiang Province or by Chinese Government. It has acquired more than 10 patents and published more than 300 research papers in the academic journals at home and abroad. In the 1980s the Laboratory invented the technology of growth of Czochralski silicon under reduced pressure in a nitrogen atmosphere, which won the second-class National Invention Award and was recognized as one of the China's greatest scientific achievements in 1987. This technology has been adopted by the Zhejiang Semiconductor Technology Corporation, and the silicon product is welcome in American and Europe an markets. The total annual output values more than 100 millions yuan RMB. Furthermore, the researchers have also been working together with scientists from other countries to study the behavior of nitrogen in silicon materials. In this area, a series of new discoveries have been made.

In recent years, the research areas of the Laboratory have been expanded. On the one hand, the research fields of the silicon-based thin films and optoelectronic semiconductor materials have been developed. An apparatus of ultra high vacuum chemical vapor deposition (UHV/CVD) built at the beginning of the 1990s has been employed to grow high quality silicon epilayers layer and thin films (such as GeSi, SiC) on silicon substrates at low temperatures. On the other hand, the Laboratory is expanding into the fields of organic semiconductor materials as well as the composites of organic and

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inorganic materials used for laser devices, and many new achievements in these areas have been made.

The Laboratory has undertaken more than 60 projects in recent years, including one significant project supported by the National Natural Science Foundation of China, 1 key project and over 40 projects supported by provincial or ministerial foundations, and 7 projects of international collaboration. At the same time, it has also undertaken several "Torch Projects" from both the state and the province, with the total research funding of tens-million yuan RMB.

### **3 Cultivation of staff and training of talents**

The Laboratory has paid great attention to the cultivation of staff and the training of talents. Most of its research staff studied or worked abroad for a period of time. Seven staff members are authorized as doctoral supervisors in the field of semiconductor materials. The Laboratory has also devoted great effort to the training of young scientists. Up to now it has conferred one postdoctoral fellow, more than 20 doctor degrees and 50 master degrees. In order to bring up more outstanding young researchers, the Laboratory not only emphasizes their academic developments but also provides some benefits to improve their living status.

### **4 Cooperation and communication**

The Laboratory has been open to domestic scholars since its establishment. Up to now, they have undertaken 72 open projects approved by its Academic Committee with total grants up to more than one million yuan RMB. The Laboratory has conducted joint research programs with some universities in the USA, Japan, Germany, Sweden, and other countries. Just now, a group is cooperating with MIT and Kansas State University of USA for doing the researches on low temperature silicon epitaxy and GaN films. The cooperation with Peking University, Sichuan University, Shandong University, Fudan University and Shanghai Institute of Metallurgy, CAS, is extensive. The academic cooperation with some famous universities in Hong Kong and Taiwan is now in progress.

The Laboratory is active in international academic communication. Every year 2 or 3 researchers attend international conferences abroad. Our researchers present many papers to the national and international conferences each year. The Laboratory successfully organized the national academic conference on silicon materials and integrated circuit in 1993, to which more than 300 scholars attended. In addition, several national conferences on thin solid films and low temperature silicon epitaxy were also organized by the Laboratory.

### **5 Main instrumental facilities**

After many years' construction, the Laboratory has been well equipped with a series of advanced semiconductor material growth systems and analytical instruments. The instruments for crystal growth and film preparation include CG6000 large diameter CZ silicon crystal grower, ultra-high vacuum CVD system, liquid phase epitaxial system, thin film growth systems by magnetron and thermal evaporation, etc. The instruments for materials characterization include electron spectrometer, X-ray double crystal diffractometer, CF35 scanning microscope, SSM-35-spreading resistivity measurement system, FTIR spectrometer, advanced CM200 high resolution transmission electron microscope and HL

5900 hall effect measurement.

**State Key Laboratory of Silicon Materials Science**

Add: Zhejiang University, Hangzhou 310027, China

Tel: 86-571-7951667

Fax: 86-571-7951954

E-mail: smlab@ldns.zju.edu.cn