Design for Open-experimental Course of Optoelectronic Materials and Devices

Jian Huang[1, a], Ke Tang[1, b], Haitao Xu[1, c], Jie Zhou[1, d], Beiling Yao[1, e], Lei Zhang[1, f], Yue Zhu[1, g], Linyun Shi[1, h], Linjun Wang[1, i]

[1] School of Materials Science and Engineering, Shanghai University, Shanghai, 200072, China

[a]email: jianhuang@shu.edu.cn, [b]email: tangke26@yahoo.com.cn, [c]email: haitao_xu1989@163.com, [d] email: foxzhou@shu.edu.cn, [e] email: yaobeiling@ shu.edu.cn, [f]email: ladiya@shu.edu.cn, [g]email: zhuyue545@yahoo.cn, [h]email: lyshi@staff.shu.edu.cn, [i]email: ljwang@shu.edu.cn

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Abstract. Recently, the rapid development in the field of optoelectronics attracts widespread concern of all countries. However, the lack of training for the student experiment beginning ability and the neglect of the traditional experiment course for students' subjective initiative promote the establishment of open-experimental course of "optoelectronic materials and devices" which is used for the adaptation of the course of "The basis of photoelectron technology". Students design experimental scheme by themselves to realize the preparation of optoelectronic films - the performance test of films - the fabrication of optoelectronic devices - the performance test of devices, these four stages of experiment. Students should submit the experiment report and devices.

Introduction

In 1960, American scientists T. H. Maiman [1] invent the first ruby laser and in 1966, Charles Kuen Kao put forward the concept of low loss optical fiber [2]. From then, optoelectronic technology as a new technology combined the advantages of optics and electronics technology has been developed rapidly. At present, optoelectronic technique is mainly used in the field of telecommunications, energy, and national defense. At same time, we also more and more feel the comfort and convenience brought by optoelectronic technology, such as LED lighting, all kinds of display technology, imaging technology, optical disc storage technology with progressively increasing capacity and so on. Meanwhile, people for the continuous pursuit of the photoelectric device applications, also brings the rapid development of photoelectric materials. Now the optoelectronic materials which have been used can be mainly divided into laser materials, luminescent materials, optical communication materials, photoelectric storage materials, photoelectric conversion materials, photoelectric display materials and so on [3]. Optoelectronic technology, at present has become a rapidly developing field of research and development by all the countries. Scientific community predicted: the optoelectronic industry will become the largest industry of the world in 21st century.

In order to adapt the trend of the optoelectronics development, we need a large number of professional optoelectronics technology talent struggle for it. At the same time we also see that because of the amazing development of optical communication and information processing industry, the social will offer more related jobs. Faced with such a large optoelectronic industry development situation, we promote the establishment of the course "The basis of photoelectron technology". We give a systematic explanation of the history of optoelectronic technology, the basic knowledge related to the photoelectric field, the characteristic of all kinds of photoelectric materials, the principle and application of all kinds of photoelectric device and the trend of the optoelectronics development. Through several years of teaching, we have trained a large number of students who are much interested in optoelectronic technology and have a strong foundation of knowledge of optoelectronic technology. Besides, there are a number of students who finally enter the related

industry.

However, we also have found that only training of the theoretical knowledge is not enough. In the present course system, there are many defect such as less of experimental teaching, much less comprehensive experiment to cultivate the students' comprehensive abilities, not perfect of teaching method which have a bad effect on students' ability to contact theory with practice. These problems don’t adapt to the objectives of training applied talents of the country. In the following teaching and guiding the graduation thesis, we find that many students feel confused and don't know how to solve this problem when they meet the practical problems in photoelectric testing technology. Many students are very understanding of book knowledge. However, they will become confused when it is related to the actual work. This phenomenon not only exists in the course of photoelectric technology, but also a common phenomenon in science and engineering course lacking of practice. Therefore, the creativity and practical ability of students is a key ring, bringing the experimental teaching becomes critical.

The necessity of establishment of open-experimental course of "optoelectronic materials and devices"

For the traditional experimental course, the experimental scheme, what experiment should be done, how to do the experiment and what results can be obtained are completely decided by teachers. Often after a course of experiment, many students don't know what to do, of course, can't understand why want to choose to do these experiments and what is the relationship between the experiments, which leads to the failure to arouse student interest and the modest effects in experiment.

On the other hand, the current situation of experimental teaching in the universities of our country is not optimistic. At present, in our country, a lot of research and innovated university because of "211 Project" and "985 Project" construction have good laboratory conditions for scientific research, however, for the laboratory conditions of undergraduate teaching is relatively inferior much. In view of the current situation, it is a major subject in the higher engineering education to how to integrate science and substantial research into undergraduate teaching process, to realize the advantages of achievements in scientific research, scientific research resources into the teaching transformation, to achieve higher school teaching and scientific research of the perfect combination and to realize the cultivation of innovative talent [4]. Therefore, it is very necessary to open open-experimental course of optoelectronic materials and devices.

In view of above status, we hope open an experimental course which can consolidate and supplement optoelectronic technology taught on class. Moreover, this experimental course is able to achieve “research teaching” of modern teaching method [5], what means students choose and determine a special topic for research from nature, society and life. And students will absorb knowledge, apply knowledge, solve problem, acquire new experience and present their personality in the processing of initiative exploring, initiative thinking and initiative practicing. As a result, this course will form into a practical activity which enhances students’ quality, creating and innovation. It can maximize the dynamic role of students, and the first place is developing the ability of exploring, practicing and innovating. We hope students will acquire such ability when grasp and consolidate theoretical knowledge through this experiment course: clearing the objective, finding methods, finding approach testing whether objective achieving. This ability is systematic and integral, so it is useful and benefit for every part of students’ lives.

We open this optoelectronic materials and devices experiments course in order to culture students’ practice ability, thinking ability and solving ability, aiming to updating optoelectronic technology status and application, basing on our faculty condition, under the guiding ideology of exploring, practicing and inspiring.

Through the experimental course, students command the basic knowledge of the photonics technology experiments, the basic approach and basic skills (Including the selection and use of laboratory instruments, techniques and methods of measurement, the processing method of the experimental data, inspection results of the analysis and preparation of lab report, etc.); develop

students' ability to work independently and analytic skills; exercise students' ability comprehensive experimental ability in optoelectronic field. The comprehension of optoelectronic concept, law and theory will be enhanced through experimental observing, measuring and analyzing. It will develop the students' serious style of work, scientific attitude of seeking truth from facts, caring of state property and the virtues of discipline.

The Implementation open-experimental course of "optoelectronic materials and devices"

The more detailed implementation open-experimental course of "optoelectronic materials and devices" could be described as follows:

A) Suitable targets: senior undergraduates majored in electronic information materials, students interested in optoelectronic technology and desiring for master's degree or working in relevant field.

B) Pre-course: semiconductor physics, device physics, optoelectronic technology, the measurement and analysis of material.

C) Course content: Students must complete a series of experiments by themselves (the preparation of photoelectric thin films, the performance measurement of thin films, optoelectronic devices fabrication, and the performance measurement of devices). Eventually they must submit report and devices. The experimental equipment will be opened to undergraduates who take this course, which means undergraduates can have the same experimental conditions as graduates. In advance the instructor will prepare basic experiment sections for the above four stages experiment according to the experimental conditions. For example, aiming at the performance measurement of thin films, the teacher can realize the design of surface morphology characterization section, quality characterization section, electric performance characterization section, photoelectric characterization section and so on. Students can choose sections according to their experimental plan.

This course adopt the way of combination of individual and group: there are three or four students as a group, and the experimental plan is decided by group members (which include pre-device, the selection of material, the selection of preparation method, the selection of characterization method, the device processing plan, the scheme of performance test for device and so on.) In the same group every member can have the same experimental plan, but everyone must prepare his own device. Therefore everyone have different results and experimental data. In the end every student submits report and sample respectively.

The main process of the open-experimental course of "optoelectronic materials and devices" is described as shown in Figure 1.

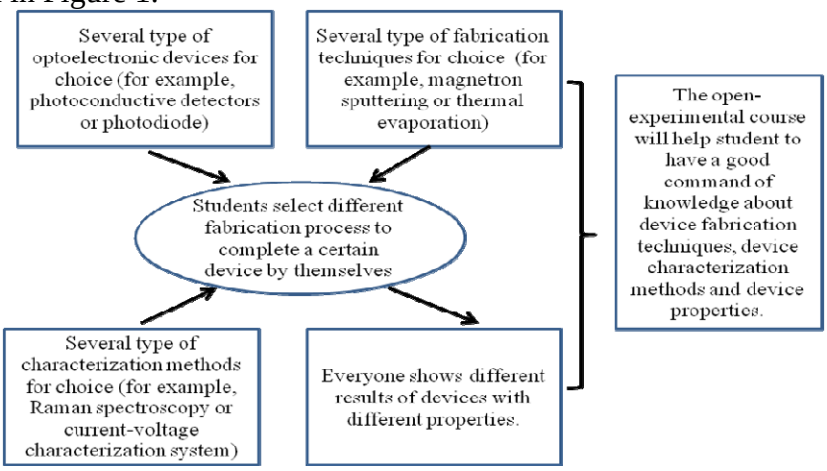

Figure1 The main process of the open-experimental course of "optoelectronic materials and devices"

D) The schedule: in the first week students will be divided into groups, and the teacher will introduce the optoelectronic technology foundation, basic experimental sections, relevant equipments etc. Students investigate relevant field after class and determine the experimental plan. The whole plan can be composed of basic experimental sections offered by teacher, or add new

sections according to practical situation and relevant information. Each group hands the experimental plan at the second week. The teacher gives the related guidance for each plan; especially the newly proposed experimental module should be evaluated. Each group begins the experiment after the preparatory work. We will hold weekly course discussion meetings that each group in turn introduce the experimental progress and plans of this group including weekly experimental goal, contents, expected difficulties. The instructor gives the corresponding comments and suggestions and the group members can also give their views. Each group makes appointment with the instructor for the weekly specific experimental time according to the laboratory timing and the time should be more than 2.5 hours. The experiment should be operated by students mainly and guided by the teacher. Teacher will demonstrate experiment contents, which is dangerous for students operating, and students will observe at the side. In the whole experimental process, students have detail record and initial data which keep back up. In the final week, students should sort out and analyze data and write experiment report.

E) The standard of grading: the assessment has the following parts: a) experimental report; b) the sample; c) the grade which judged on the basis of students' usual performance which includes involvement, hands-on ability, innovation ability etc. In addition, if the student contributes to the discussion or makes constructive suggestions or adopts new section, he will be awarded marks; d) the team members give marks to each other.

Conclusion

In order to maximize the role of students, the open-experimental course of optoelectronic materials and devices is opened with the hope that the students can consolidate the theoretical knowledge and improve the practical ability to improve the ability to grasp things. We hope students can devote to this experimental course and enjoy the opportunities and challenges brought by the open experimental course. Meanwhile the instructors should regard it as an opportunity that can enrich their theoretical knowledge and professionalism, learning to communicate with students and understand the thinking of students, formation of the friend and teacher benign relationship. We hope can achieve the students and teachers' double harvest though the open experiment course.

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References

[1] Maiman T H. Stimulated Optical radiation in ruby [J]. Nature, 1960 (187) 493-494.

[2] Shampo M A, Kyle R A, Steensma D P. Charles K. Kao-Father of Fiber Optics [J]. Mayo Clin Proc., 2011 (86) e45.

[3] Pollack M A. Advances in materials for optoelectronic and photonic integrated circuits [J]. Materials Science and Engineering: B, 1990 (6) 233-245.

[4] Liu D W, Yang G. Study-based Teaching for Experimental Courses of Safety Engineering Specialty and Cultivation of Innovative Talents [J]. China Safety Science Journal, 2010 (20) 157-161.

[5] CAO J. Thoughts on the Research-based Teaching in the University [J]. Modern University Education, 2002 (6) 111-112.