Discussion on Teaching Reform of Materials Phase Transformation Course

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[**Abstract**] Materials phase transformation is a course for graduate students and undergraduates in the field of materials science. The content of this course mainly focuses on the research and engineering application of metal materials, to understand and master the process of metal phase transformation and hot working technology. By optimizing the course teaching system, improving the course teaching methods, and using the way of combining theory with practice and interacting with class, students' learning enthusiasm can be improved. Through group discussion and reporting, students have a deeper understanding of the course, so as to obtain better teaching results and improve the teaching quality of the course. Through the rational and effective use of multimedia teaching and education methods, the relevant teaching content can be enriched, the teaching effect can be improved, the learning initiative and enthusiasm of students can be stimulated, their experimental ability and innovative thinking can be cultivated, and the teaching of materials phase transformation course can be promoted to a more modern and intelligent direction. Through the practical activities of the project, students' innovation ability and teamwork spirit can be effectively cultivated, and effective support and guarantee can be provided for the teaching reform of materials phase transformation course.

[**Key words**] teaching reform; materials phase transformation; teaching methods

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1 Introduction

Materials phase transformation is an important professional course for undergraduates and postgraduates in the field of materials science. This course is based on the explanation of material solid phase transformation, which is closely related to other courses of this major. After years of teaching practice verification by experts, the *Principle of Metal Solid Phase Transformation* published by Science Press and edited by Xu Zhou is selected as the main reference textbook of this course. The main content of the course is to understand the structure and related properties of metals under temperature, pressure and other conditions. It mainly includes: (1) Classification of phase transformations: Mainly includes first-order phase transformations, and second-order phase transformations; (2) Crystal structure: Study the effect of metal crystal structure and crystal defects on phase transformation, such as lattice distortion, grain boundaries, dislocation, etc. (3) Phase transformation kinetics: Explore the dynamic process of metal phase transformation, including diffusion, nucleation, growth and other mechanisms, as well as the relationship between phase transformation rate and temperature, strain rate and other factors. (4) Thermodynamic properties: Analyze the thermodynamic characteristics of metal phase transformation, such as phase diagram, heat capacity, thermal expansion, etc., and the correlation with temperature, pressure and other conditions. (5) Material engineering applications: The application of phase transformation principle to design new materials and optimize processes, such as alloy design and heat treatment process control. Through the explanation of these research contents, students participating in this course will have a deep understanding of the nature of metal phase transformations and their applications in the field of materials science and engineering. The design of the syllabus of this course is very helpful for students to learn professional knowledge in this direction, but because this course is not only a theoretical course, but also a subject course combined with practice. Only relying on the

explanation of relevant concepts in the course cannot make students fully grasp the core content of the course. Therefore, it is necessary to explore novel teaching modes to improve students' cognition of relevant knowledge. For example, to provide relevant knowledge outside the textbook or experimental cases to broaden the knowledge of students in the field of materials science. Develop heat treatment processes integrated with engineering material processing. Strengthen the experimental teaching matching with theoretical knowledge, and cultivate the level and ability of materials science students to solve relevant engineering practical problems with the knowledge acquired in this major.

2 Course content

At present, the duration of the course "materials phase transformation" is 32 class hours, and how to let students fully grasp the course "materials phase transformation" through teaching in a relatively short time is the main research direction. According to this goal, a reasonable teaching content system should be established. In the course of "materials phase transformation", the reference textbooks and related materials mainly rely on are the *Principles of Material Organization Structure Transformation* published by Liu Zongchang in 2006, the *Principles of Metal Solid Phase Transformation* published by Xu Zhou in 2004, and the *Thermodynamics of Alloys* published by Shi Lin in 1992. The above textbooks are classic textbooks in this field.

At the same time, the establishment of appropriate syllabus is more conducive to students' mastery of the course. In the teaching process, students should first explain the basic knowledge, according to the syllabus of "materials phase transformation", the basic knowledge is summarized as follows: (1) Metal crystal structure. (2) Definition and classification of metal phase transformation. (3) Classification of metal solid phase transformation: According to the different temperature and pressure conditions, introduce the classification of solid phase transformation, such as recovery, exothermic, endothermic, etc. (4) Phase transformation kinetics: The kinetic processes of diffusion, nucleation and growth are introduced. The relationship between phase transformation rate and temperature, strain rate and other factors is discussed. (5) Thermodynamic properties: Explain the phase diagram, heat capacity, thermal expansion and other thermodynamic characteristics. The correlation with temperature, pressure and other conditions was discussed. (6) Crystal structure changes during phase transformation: The influence of crystal structure changes such as lattice distortion, grain boundaries and dislocation on phase transformation is analyzed. After explaining and teaching the above basic knowledge, in order to further deepen the students' understanding of the knowledge, the method of combining theory with practice should be adopted to continue the demonstration teaching. The detail includes: (1) Application and case: Show the application of metal materials phase transformation in materials engineering, such as alloy design, heat treatment process control, etc. The practical application cases of phase transformation theory in the fields of metal processing and material design are discussed. (2) Experiment and practice: Design relevant experiments to deepen students' understanding of phase transformation principles. Provide practical cases for students to practice or simulate.

3 Curriculum reform practice

3.1 Combine theory with practice to strengthen learning and cognition

In the course of teaching metal solid phase transformation, it is essential to link theory with practice. Theoretical knowledge provides the basis for practical application, therefore, it is necessary to accurately grasp the basic knowledge of phase transformation principle, tie the professional foundation, and establish a good foundation for engineering application. By learning the theoretical knowledge of metal solid phase transformation, including phase transformation classification, thermodynamic properties, phase transformation dynamics, etc., students can establish a basic understanding of metal phase transformation process. This theoretical knowledge lays the foundation for subsequent practical applications, enabling students to gain a deeper understanding of the behavior and properties of metal materials under different conditions. Through the introduction of practical cases, students

can connect theoretical knowledge with real situations. For example, in explaining the process of metal phase transformation, it can be combined with the metal processing technology in actual production to explore the influence of changes in material properties under different phase transformation conditions on product quality. Students can learn that by adjusting parameters such as heating and cooling rates, the process of metal phase transformation can be controlled to obtain materials with specific properties. The introduction of practical cases can also stimulate students' learning interest and initiative. By demonstrating the application of metal solid phase transformation in various fields, such as aerospace, automobile manufacturing, electronic devices, etc., students of this course can realize the application value of materials phase transformation knowledge and improve their learning concentration. Students can be inspired by real cases, further explore the connection between metal phase transformation theory and practice, and use creative thinking when solving practical problems. Through the combination of theory and practice, students' comprehensive ability and problem-solving ability can be cultivated. Students can not only master the theoretical knowledge of metal solid phase transformation, but also apply it to practical problems to solve. In the course design, experimental projects or comprehensive papers can be set up. In the course of teaching, this part of the content will be conducted by giving lectures. By contacting experts in the field and hiring them to give professional lectures, we can provide real cases related to metal phase transformation, aiming at the role of metal phase transformation in practical research and industrial production, so that students can analyze and solve the problems, and cultivate students' ability to solve practical engineering problems. By improving the practical teaching conditions inside and outside the school and in-depth cooperation between the school and the enterprise, it can provide more diversified practical opportunities and resource support for the teaching reform of materials phase transformation course, improve students' practical ability and innovation consciousness, promote the industry-university-research cooperation between the school and the enterprise, and promote the development and application of the field of materials science and engineering. By improving the practical teaching conditions, the school can also set up more diversified experimental projects, covering different aspects of the field of materials phase transformation, such as the preparation of phase transformation materials, performance testing, application research, etc., to provide students with a richer practical experience. Schools and enterprises can jointly build laboratories and scientific research bases, share experimental equipment and scientific research resources, carry out scientific research projects and technology R&D in the field of materials phase transformation, and promote the deep integration of industry, university and research. Through close cooperation between schools that focus on theoretical cognition and factories that are good at practical manufacturing, students' knowledge of phase transformation processes involved in real materials and the field of real production is improved.

3.2 Interactive teaching, thematic discussion

The interactive teaching of materials phase transformation course and the discussion of related materials phase transformation process are important links to improve students' thinking. Through the interaction between students, teachers and technicians, we can exchange and communicate, improve students' independent learning ability and participation in discussion. Interactive teaching, as the name suggests, aims to improve the ability to build knowledge and cognitive depth understanding through the active interaction between students and instructors. In this mode of interactive teaching, students are not only the receivers of knowledge, but also the explorers and builders of knowledge. They actively participate in the class by participating in various teaching activities, such as discussion, problem solving, group activities, etc., so as to better understand and apply what they have learned. In the classroom with interactive teaching, students' participation is higher, and the improvement of learning effect is relatively obvious. First of all, in the interactive teaching process, teachers can spread theoretical knowledge based on questions about materials phase transformation knowledge and students' answers to the questions in class. Teachers can put forward specific questions according to the professional content of materials phase transformation

course, and then guide the students of materials science to think about the problems and finally give answers, so as to test the students' understanding of knowledge. At the same time, students can also ask questions about their doubts in class, discuss with teachers and classmates, and promote the collision of ideas and knowledge exchange. Secondly, interactive teaching can also be achieved through group discussions and collaborative projects. In addition to interactive teaching in the classroom, thematic discussions are also an important part of the materials phase transformation course. In the thematic discussion, teachers can select hot issues or frontier areas related to the course content and organize students to carry out in-depth discussion and research. Students can prepare the discussion content by reading literature and collecting information, and then exchange their own views and insights in the discussion, so as to deepen their understanding and mastery of knowledge. In the interactive teaching topic, questions and discussions are used to guide students to think and explore some concepts in the course of metal solid phase transformation. In the workshop, students were divided into groups and advanced theories on metal phase transformations were presented to each group. After class, students search and think about the problem, and finally combine the theory with the phenomenon, and have a class discussion through group reporting, so as to cultivate their ability to find and solve problems. At the same time, instructors still need to actively encourage students learning materials phase transformation courses to participate in discipline competitions related to the field of materials science, such as Challenge Cup and other competitions that can demonstrate professional quality, so as to further cultivate students' ability to combine theory with practice, engineering practice and innovative spirit. Through interactive teaching and thematic discussion, students can not only actively participate in relevant issues and activities in the teaching class of materials phase transformation, but also cultivate their thinking and ability in the field of materials science. At the same time, this interactive materials phase transformation teaching can also break the traditional teaching mode, improve their learning motivation, and then achieve better teaching results.

3.3 Application innovation of multimedia teaching means

The application innovation of multimedia teaching means is an important frontier in the discussion of the teaching reform of materials phase transformation course. With the rapid development and progress of contemporary information technology in the present situation, multimedia teaching means is not only increasingly popular, but also more and more important and gives full play to its effect. In the materials phase transformation course, reasonable and effective use of multimedia teaching methods and models in materials phase transformation course can not only greatly broaden the teaching content, improve the teaching effect and influence of materials phase transformation course, but also improve the learning initiative of students in the field of materials science. Cultivate students' practical experimental operation ability and rigorous innovation ability and thinking method in the field of materials science. The application innovation of multimedia teaching means is of great significance in the teaching reform of materials phase transformation course. Multimedia teaching means can be used to present teaching content, including text, pictures, animation, video and other forms. Through the multimedia demonstration, the phase transformation process, the structural characteristics of phase transformation materials, and the principle of phase transformation can be displayed intuitively, helping students to understand the abstract theoretical knowledge more intuitively. This form of simulation experiment can not only save laboratory resources, but also provide a more intuitive and vivid experimental demonstration, helping to deepen students' understanding of the phase transformation process. Using multimedia teaching means to develop an interactive learning platform, students can explore the phenomenon and principle of phase transformation through independent learning. Students can conduct simulation experiments on the platform, observe experimental results, and operate and control through an interactive interface to gain a deeper understanding of the phase transformation process. Through online teaching in class, students' understanding of materials phase transformation knowledge can be improved. At the same time, the learning of materials phase transformation course can further improve their understanding of professional knowledge

with the help of network resources such as video, so as to realize the combination of online learning and offline knowledge acquisition, and improve the teaching effect and learning experience.

3.4 Project practice

The project practice can not only help students to combine the knowledge of material basic theory related to phase transformation learned in the class of materials phase transformation with the practical problems encountered in the process of material preparation and production, but also improve their spirit of solidarity and mutual aid. In the actual process of material production and preparation, students in the field of materials need to learn from each other and cooperate together, divide labor and cooperate in some experiments and knowledge exploration, and solve the actual problems encountered in the process of material preparation, which will promote the communication and cooperation between them, and cultivate the sense of teamwork and communication ability. In addition, project practice can also stimulate students' creativity and curiosity, allowing them to explore, discover and innovate in practice. Designing new phase transformation materials, students can be divided into groups, each group is responsible for designing a new type of phase transformation material. This kind of project requires students to first investigate and analyze existing phase transformation materials to understand their principles, properties and application areas. Then, they need to come up with a new material idea and design the corresponding preparation process. In this course, students will learn how to translate theoretical knowledge into practical material design solutions, developing their innovative thinking and problem-solving skills. Another practical direction of the project is to optimize the preparation process of existing phase transformation materials. Students can analyze the problems and shortcomings of existing phase-change material preparation methods, and propose improvement plans. For example, they can try to adjust the parameters in the preparation process, optimize the structure and properties of the material, or explore new preparation methods. Through such projects, students will learn how to apply scientific methods to the design of materials phase transformation and related experiments, and gradually analyze the obtained data, cultivate their hands-on ability and experimental operation ability, and improve the innovation ability for materials phase transformation problems. At the end of the project practice, students' performance and project effectiveness should still be evaluated and fed back. This can be quantitatively assessed through student reports, presentation of results and experimental data, as well as qualitatively through student self-evaluation and teacher evaluation. According to the evaluation results, timely feedback and guidance will be given to students to provide experience and reference for future teaching reform.

4 Conclusion

Material phase transformation is an important course in materials science and engineering, which mainly explains the phase transformation phenomenon and process of metal materials in solid state. It covers the crystal structure and property changes of metals under conditions of temperature and pressure, including phase transformation classification, crystal structure, phase transformation dynamics, thermodynamic properties and materials engineering applications. In order to enable students to fully grasp the course, the syllabus emphasizes the combination of theory and practice, and helps students understand the nature of metal phase transformation and its application in materials engineering through basic knowledge explanation, practical case application and experimental teaching. In the reform practice of the course proposed in this paper, the course structure is reasonable, and the content system is complete. Relying on a variety of classic textbooks and relevant materials, the teaching process pays attention to interactive teaching and thematic discussion, and adopts questions, discussions, group activities and other methods to promote students to think deeply. The application innovation of multimedia teaching means, such as multimedia demonstration, simulation experiment, interactive learning platform and online teaching resources, has further improved the teaching effect and students' learning interest. In the project practice, students can design new phase transformation materials or optimize the preparation process of

existing materials through teamwork to enhance innovative thinking and problem solving skills. By improving the practical teaching conditions inside and outside the school and in-depth cooperation between the school and the enterprise, we will provide rich practical opportunities and resource support to promote the development of students' comprehensive ability and the application in the field of materials science and engineering. Through part of the reform and practice of the course "materials phase transformation", a systematic teaching-learning-research education method has been initially established. It can better improve the interest and participation of students, cultivate the comprehensive strength of students, so that the teaching of this course can keep up with the pace of the times, improve the participation of every student, so that every student can obtain useful professional knowledge, and improve students' practical ability and application ability.

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