Preliminary Study on the Multi-Level and Incremental System of Polymer Composite Course

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Abstract: The course “Polymer Composite Materials” is a compulsory course for undergraduates majoring in polymer materials and engineering, and it is an important theoretical basis for improving students' engineering practical ability. This article starts with the analysis of the current teaching situation of the “Polymer Composite Materials” course, adjusts, supplements and perfects the original teaching system in terms of teaching content, teaching methods, and assessment forms. It reconstructs the basic theory to practical application, and then to The multi-level and progressive course structure of forward-looking exploration aims to improve students' enthusiasm and initiative in learning, strengthen students' ability to use theoretical knowledge to analyze and solve polymer composite materials problems, and cultivate professional talents with innovative spirit and high-end skills.

1. Introduction

Composite materials are an important branch in the field of materials. They are new materials developed on the basis of traditional materials. Polymer composite materials are the only composite materials that have obtained larger applications and mature technologies. The biggest advantage of polymer composites is the strengths of various materials. According to the actual application purpose, various characteristics that a single material cannot be improved through reasonable compounding, resulting in 1+1>2 effects [1].

“Polymer Composite Materials” is a compulsory course for undergraduate students majoring in polymer materials and engineering in our school. The course aims to enable students to fully and systematically master the basic concepts, basic theories and analysis methods of composite materials, and understand the direction of composite materials research. And progress is a highly practical course, which is very important for cultivating students' ability to research, develop and design polymer composite products, and is an important theoretical basis for polymer materials and engineering students to improve their engineering practice ability.

2. Analysis of the Status Quo of the Course “Polymer Composite Materials”

In 1988, Wuhan University of Technology established the National Teaching Steering Committee for Composite Materials in Higher Education Institutions, and my country really started the education and teaching of polymer composite materials [2]. Before the first composite material academic exchange meeting was held, the domestic understanding of polymer composite materials remained purely at the unsaturated polyester reinforced by glass fiber (ie, glass fiber reinforced plastic). And for a long time after that, the so-called “composite material” still refers to “glass reinforced plastic”. To this day, the syllabus of “Polymer Composite Materials” is still based on “Glass Steel”, focusing on reinforcing polymer composite materials, especially fiber-reinforced polymer composite materials, and the properties of matrix materials and reinforcement materials. The relationship between physical and chemical properties and composite component materials and composite processes, the manufacturing method of fiber composite materials and the influencing factors of mechanical properties, the formation of composite materials, interface effects and

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influencing factors, etc.

The 21st century is an era of rapid development of polymer composite materials. With the continuous changes in the types and forms of composite materials and the continuous expansion of composite materials application fields, the development of industry has more and more personalized and diversified requirements for talents in related disciplines. The “Polymer Composite Materials” course teaching system based on “Fiberglass” has been unable to better adapt to the booming and diversified development of the composite materials industry.

The development speed of my country's polymer composite materials in the new century is amazing. “Made in China 2025” proposes that my country's manufacturing industry will face new development trends, and materials, as the focus of “Made in China 2025”, will also have new developments. During the “13th Five-Year Plan” period, the growth rate of my country's new material industry reached 25%, from 650 billion yuan in 2010 to 3.140 billion yuan in 2017, of which polymer composite materials accounted for more than 24% [3]. Modern polymer composite materials have developed into a huge system with a wide variety of complex qualities, and various new composite materials such as nanocomposites, bionic composites, smart composites, liquid crystal composites, ecological composites, and smart composites are emerging one after another. Polymer composite materials are changing and improving people's production and living standards at an unprecedented speed. Polymer composite materials are becoming the first choice to replace traditional materials in the fields of construction, automobile, aviation and wind energy utilization. The matrix of polymer composite materials Earth-shaking changes have taken place in materials, reinforcement (or functional) materials, preparation processes, material morphology and performance, and application fields [4].

Therefore, the course teaching of “Polymer Composite Materials” needs to be re-adjusted and expanded, the content involved in backward production capacity should be discarded or simplified, and the course teaching should be planned according to the new industrial pattern. Through the reform and exploration of the educational system of the “Polymer Composite Materials” course, the school has adjusted, supplemented and improved the original teaching system in terms of teaching content, teaching methods, and assessment forms, and organically integrated and differentiated the teaching process. The process has formed a multi-level and gradual curriculum structure from basic theory to practical application, and then to forward-looking exploration, in order to cultivate professional talents with innovative spirit and high-end skills to better serve the local economy and society.

3. Multi-Level and Progressive Course Design of “Polymer Composite Materials”

3.1 The First Level: Basic Teaching System

First of all, the teaching content of fiber-reinforced thermosetting resin-based composites has been fully compressed, and the original 32 hours have been reduced to 22 hours. The teaching process emphasizes basic theories and basic knowledge, and requires students to master the basic concepts and basic properties of polymer composites. And common preparation methods, familiar with the preparation methods, main features and common surface treatment methods of common fiber materials, as well as the surface treatment required for reinforcing fibers, understand the common molding processes and molding equipment of polymer composites, as well as interface properties and their Influence on the mechanical properties of composite materials.

In particular, because the mechanical properties of fiber-reinforced thermoset composites represented by “glass reinforced plastic” are the focus of traditional teaching, but at present, a very mature theoretical model has been established for fiber-reinforced thermoset composites, and the production of more advanced fiber-reinforced thermoset composites The quotient can already calculate and simulate the mechanical properties through a large computer. Simply introducing relevant theories and formulas has lost the meaning of teaching and the interest of students. Therefore, the mechanics basis of anisotropic elastic materials, the elastic properties of single-layer plates, the strength theory of single-layer plates, the mechanical performance test of composite

materials, the strength criteria of each component of unidirectional composite materials, the composite Unidirectional laminates of uniform and homogeneous materials, strength theory of materials, fatigue behavior of fiber composite materials, and failure modes of fiber composite materials, etc., have been greatly compressed, from the original 10 hours to 4 hours, and after class Introduce the video explanation of the theory of fiber-reinforced thermoset composite single-layer board as an aid to classroom teaching.

In addition, in traditional teaching, the part of matrix material is mainly to introduce thermosetting resin, and the part of reinforced material is mainly to introduce glass fiber. The composite material manufacturing method, mechanical properties and interface are also reinforced with glass fiber. Thermosetting resin is the background, and the teaching content of thermoplastic resin matrix and high-end fiber materials is less. However, due to the advantages of thermoplastic resin matrix materials in molding processing, production costs and waste recycling, especially in the context of global environmental protection and conservation, thermoplastic resin composite materials have been widely used, for example, glass fiber reinforced nylon It has been used in automobile engines and fuel tanks, textile machine bearings and gears, spray gun housings and connectors, and power tools. [5, 6]

Moreover, the development of polymer composite reinforcement materials is very rapid. Carbon fibers, ultra-high molecular weight polyethylene fibers, aramid fibers, whiskers and other reinforcement materials have all been industrialized in the civil industry. Therefore, in the matrix material and reinforcement The teaching content of materials has expanded the introduction of thermoplastic resin matrix and non-glass fiber reinforced materials, from the original 8 class hours to 10 class hours.

3.2 The Second Level: Expansive Teaching System

In our traditional “Polymer Composite Materials” course, polymer-based functional composite materials are introduced for only 3 hours. The teaching content mainly focuses on optical, electrical and magnetic functional composite materials. The “Expandable Teaching System” of “Polymer Composite Materials” expands the teaching of new polymer-based functional composite materials on the basis of photoelectromagnetic functional composite materials. The three parts of materials, biocomposites and aerospace composites each occupy one credit hour.

Various polymer-based functional composite materials are very different from each other in terms of structure, form, composition, performance, preparation technology, etc. [8], it is difficult to conduct systematic and complete teaching in one course, and there is no one A teacher can have a comprehensive and systematic understanding of various polymer-based functional composite materials at the same time. Therefore, after the lecturer introduces the development and application of functional composite materials in the teaching of “New polymer-based functional composite materials” in the course of “Polymer Composite Materials”, a lecture on “Photoelectromagnetic Function” will be given as a guest lecturer. Various new polymer-based functional composite materials such as “composite materials”, “nano composite materials”, “biological composite materials” and “aerospace composite materials” are introduced. The guest professors hired are all experts, scholars and technicians in the field of various functional composite materials. They can conduct a comprehensive analysis and key explanations on the general situation, current situation and development trend of their research fields. New polymer-based functional composite materials have a clear understanding.

The extended teaching system draws on the teaching model of the flipped classroom [7], and divides it into non-class teaching time and classroom teaching time according to the law of learning. During non-classroom teaching time, the lecturer will publish the knowledge points that the course must master, summary papers and academic reports of guest professors, etc. to students in advance through the course website, so that students have an understanding of the background of the special lectures; classroom teaching time is mainly It is to arrange guest professors to give special reports, and the report allows students to communicate and discuss the content of the special reports with lecturers and visiting professors.

3.3 The Third Level: Forward-Looking Teaching System

Materials are the main pillar of human development. From the Stone Age, the Bronze Age, the Iron Age, the Cement Age, the Steel Age, and the Silicon Age to the current era of new materials, every essential change in materials has promoted technological progress by leaps and bounds. . Due to the unsustainability of natural resources and the insufficient performance of single materials, composite materials have become the most important part of materials. The performance of composite materials is not simply superimposed and averaged, but exhibits a composite effect of one plus one greater than two. Therefore, it is possible to obtain unprecedented new performance through composite. It is no exaggeration to say that the future of technological change and industrial change depends on fundamental changes in composite materials.

In the “Prospective Teaching System” of “Polymer Composite Materials”, the “functional and structural integrated composite materials”, “gentle process bionic composite materials” and “intelligent composite materials” that are still in the theoretical research stage are introduced into the teaching content. In the class, students are guided to develop their thinking, expand their associations, and not to stick to the existing properties of existing materials, to give new life to polymer-based composite materials, and to put forward the forward-looking design of “ideal” composite materials. For example, in the “functional structure integrated composite material” it is mentioned that carbon nanotubes have a huge aspect ratio and super high mechanical strength. Students were inspired by it to design a single-armed carbon nanotube with a single-layer graphene coiled structure. Made of composite materials that can connect the earth and the moon. In the classroom teaching, the lecturer will provide several video materials of science fiction movies, let the students work in groups, conduct group discussions and research on the “super functions” involved in the video materials, and form a feasibility plan for material design to realize the “super functions”.

4. Conclusion

In order to adapt to the rapid development of the composite material industry and cultivate polymer majors with engineering practical ability, the “Polymer Composite Materials” course organically integrates and differentiates the traditional teaching mode with fiber-reinforced thermosetting resin as the main teaching content. , Constructed a multi-level and progressive course structure of basic teaching, expansive teaching and forward-looking teaching:

(1) In the basic teaching system, the teaching content of fiber-reinforced thermosetting resin-based composite materials has been compressed, the thermoplastic resin matrix and non-glass fiber reinforced materials have been expanded, and the environmental issues and response strategies of composite materials have been added to make Students have a systematic and in-depth understanding of traditional fiber-reinforced polymer-based composite materials, and cultivate engineering students' overall view of the whole process of materials and a sense of social responsibility for the future.

(2) In the extended teaching system, three new parts of nanocomposite materials, biocomposite materials and aerospace composite materials have been added. The form of guest professors’ lectures allows students to learn about new polymer-based materials within a limited teaching time. With a clear understanding of functional composite materials, students can fully and systematically understand the functional composite materials involved in actual production, life, and research and development, and design composite materials that meet specific functional requirements through investigation and research.

(3) In the forward-looking teaching system, introduce the “functional and structural integrated composite materials”, “gentle process bionic composite materials” and “intelligent composite materials” that are still in the theoretical research stage, and train students to deal with problems scientifically and rigorously. The spirit, not limited to the existing properties of existing materials, provides forward-looking design for the future of composite materials.

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