Construction and Practice of Materials Forming and Processing

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Abstract. Material forming and processing course is a master's degree course and a required course for materials processing engineering. The construction and practice of materials forming and processing from teaching outline, teaching content, teaching methods and innovative practice has achieved good results.

Introduction
Materials processing engineering obtained a master's degree authorization in 2011 and began to recruit graduate students in 2012. The protection packaging theory and technology, functional intelligent packaging materials and technology, anti-counterfeiting packaging materials and technology and green packaging materials and products are the main research field [1].

Materials forming and processing is a major course and a required course for the master of materials processing engineering. The construction of materials forming and processing course is helpful to promote teaching reform and improve teaching quality. So the course construction is very important in the teaching of course.

The construction and practice of materials forming and processing course is carried out from teaching outline, teaching content, teaching methods and innovative practice. The good teaching results have been achieved.

Teaching Outline
The practical teaching outline is developed according to the characteristics of printing and packaging of Beijing Institute of Graphic Communication and the combination with the main research directions of materials forming and processing.

The principles of teaching outline is carried out according to the different types of materials and its molding and processing, which fully reflect the characteristics of forming and processing of different materials, and closely combine the research direction and content.

The practical teaching outline includes seven parts, which are introduction, paper packaging materials, plastic packaging materials, metal packaging materials, glass packaging materials, composite packaging materials and other packaging materials. The introduction mainly deals with the characteristics, classification and significance of materials forming and processing which are related to the printing and packaging. According to the sequence from the raw material, the molding method to function, goal and function of the main operation unit, the forming and processing of one packing material is arranged and instructed in order.

For example, forming and processing of paper packaging material includes overview, slurry’s preparation, purification, screening and exhausting, slurry flowing and accessing to sheet forming and dewatering, wet sheet pressing, sheet drying, sheet calendaring, sheet finishing and other content such as molded pulp products and coating processing. The forming and processing of paper packaging
material is combined with the research direction of green packaging materials and products, the recycling and reuse of packaging materials and related technologies.

The forming and processing of plastic packaging materials include overview, plastic molding principle, extrusion molding, injection molding, blow molding and other molding ways. Plastic packaging materials forming and processing is combined with the research direction of functional packaging materials and technology, smart packaging materials and technology.

The forming and processing of composite flexible packaging materials include overview, dry composite, wet composite, non solvent composite and extrusion composite, etc. Composite flexible packaging materials forming and processing is combined with the research direction of functional packaging materials and technology, smart packaging materials and technology, green packaging materials and products, high barrier packaging materials and technology.

**Teaching Content**

Material forming and processing is a course for graduate students and is a professional degree course and a required course. Therefore the teaching content should reflect the basic theory and knowledge and fully embody the advance and frontier. The sheet forming and dewatering method is taught according to two steps. The first place is the teaching of the basic principles of forming and dewatering of sheet, the second place is the teaching of three kinds of forming and dewatering of sheet. The principle of sheet forming is that slurry dewater in a filter screen with certain network and fibers depose and a wet sheet forms gradually. The cylinder forming method is that slurry dewater and sheet form while the net cage is rotated around the vat. The single dewatering direction of slurry in cylinder net cage causes the different of two sides of sheet. The table net forming method is that slurry is injected to running endless filter net, the slurry dewater to one direction and more use of dewatering and disturbance units, the deposition of fibers lay and wet sheet form gradually. The difference of two sides of sheet from table net former is lower than that from cylinder net former. The two-net-forming method is that slurry is injected into the running two endless filtering net. The bidirectional dewatering of slurry forms the sheet layer, and cause almost non-existent of difference of two sides of the sheet. Thus, dewatering and filtration of slurry is a basic principle of sheet forming. Cylinder net forming is the older former. Table net forming is the development and improvement. Two-net forming is an advanced forming method which belongs to the forefront of technology.

When plastic extrusion is taught, the basic principle of extrusion forming, the extrusion forming of plastic products and plastic products co-extrusion forming are arranged in sequence. Obviously, it is the basic principle of plastic extrusion forming that plastic resin mix and plasticization through extruder, melt plastics flow according to parallel line moving mode from the rotating moving mode after melt plastics go through the head. The required shape of plastic products is obtained after the melt plastics flow a die with certain cross sectional area. Single layer plastics product is formed by using one extruder with one head and one die. Different structure and shape of die determined different shapes of the single layer plastic products. For example, the die for the plastic pipe is circular ring die, and the die for the plastic film is circular ring die or slit shaped die. Multilayer structure plastic products are formed by using more than one extruding machines and more than one head, but only one die. The plastic resin used in each layer of the multi-layer structure plastic product is different, so the performance and usage of the plastic product is superior to the performance of the single-layer plastic product. Therefore, mixing and plasticizing of plastic resin and forming of plastics product through die is the basic principle of plastic extrusion forming. Single layer plastics product which are formed by one extruder, one head and a die is a basic method for extrusion forming. Extrusion forming of multi-layer plastic products using more than one extruding machines, more than one head and one die is an advanced forming method, and it belongs to the frontier technology.
Teaching Methods

Based on the guidance of modern educational technology and the idea of the students as the main body and the teacher as the leading role, the teaching methods combined with teacher’s teaching, discussion in classroom, on-site teaching, case teaching, literature retrieval, research after school and so on are used.

The principles, methods, advances and newly technology of forming and processing are the main teaching content in teacher’s teaching. The used forming method, technological process and its factors, forming device and the idea of future technology for the formation of a certain product are the main content in the discussion in classroom. The teaching or discussion of structure, parts, role, purpose and function of the device and its usage of forming and processing before the place of the device are the main content on-site teaching. Research results as teaching case, the research means, research methods, research process and results as the key and the discussion of solved problem, solution, purpose and meaning and social value of research results are the main content in case teaching. The retrieval, summary and analysis of existing research results and the understanding and master of research status, achievements and prospects for future research for the specific content are the main content for literature retrieval. The investigation for application, demand of properties, teh forming device and technological process and the understanding and mastering to present situation of production and demand and future new technology are the main content of research after class.

For example, the arrangement of literature retrieval includes paper and paper material flow system of molding department, forming part, pressing part, drying part, calendaring part, coating process of paper in the teaching of the forming and processing of paper packaging materials. The five question of polyethylene molding process, polypropylene molding process, PVC molding process, polystyrene molding process, polyester (polyethylene terephthalate) molding process as literature retrieval are arranged in the teaching of forming and processing of plastic packaging materials. The five questions of paper and plastic composite molding process, plastics and plastic composite molding process, aluminum-plastic composite molding process, tape and pre-coated plastic film process, paper-plastic-aluminum composite forming process as literature retrieval of forming and processing of composite packaging material are arranged.

Teaching case involves five categories of cases, which are patents, research papers, paper for degree of master and doctor and their respondent PPT and research report for research project. The cases are divided into the forming and processing of paper packaging materials and plastic packaging materials according to the different types of materials in teaching case.

The respondent PPT of master's thesis of Preparation and Properties Study of Cellulose/Nanometer Composite Material as made by Yu-bin Lv graduated in 2013 is used as example [2]. The innovation of the case is as bellows.

Study on the effect of water retention properties and specific surface area of straw pulp and softwood pulp and skim, which are mercerized and ultrasonic treated. The three layer composite magnetic board is prepared by using the magnetic fiber as the inner layer and the bleached coniferous wood pulp as the outer layer. The composite board can completely cover the inner layer of the black, and satisfy the requirement of printing.

The main conclusions of the study are: as blows.

Fiber mercerization treatment and ultrasonic treatment increase the pulp fiber water retention value and specific surface area. The optimal preparation conditions of magnetic composite fibers are 0.65 material mass ratio of $\text{Fe}^{2+}/\text{Fe}^{3+}$, pH 8~9 of reaction solution, 50$^\circ$C of reaction temperature and 600 rpm of stirring speed. After mercerization treatment and ultrasonic treatment, magnetic particle composite volume increase significantly, ultrasonic treatment of fibers with maximum magnetic particles content. After the composition of magnetic particle, the physical properties of the paper have
varying degrees of decline. The whiteness of the paper is low and not suitable for printing. It can be used as the inner layer three layer composite magnetic board.

**Innovation Practice**

Practical teaching is an important supplement of theoretical teaching, which plays an important role in strengthening and deepening students' mastery of theoretical teaching content. The practice teaching of this course is carried out in the way that students directly participate in the research work of superior students. It’s helpful for students to become familiar with the research direction of their director as soon as possible. Through the superior student's handing on, helping and guiding, the junior students can be quickly familiar with the laboratory environment, laboratory conditions for scientific research and grasp the scientific research method, and facilitate the subsequent more quickly to carry out their research work in future. In the practice teaching, the practice teaching mode is the combination on-site teaching with case teaching, which is helpful for students to know the kind of experimental materials, instruments, equipment and project used in scientific research achievement, and to understand the antecedents and consequences.

For example, the research and development of plastic products for strawberry packaging is one of the research topics of functional packaging materials in recent years. Students can go to the laboratory in the class and participate in the study of senior student's experiment. By participating in the study of students' experiment, the students can understand the physiological requirements of strawberry and the requirements of packaging products, packaging materials and products with reasonable shape and performance can be made with the selection of functional material and plastic resin as raw material and its mixture with appropriate mixing and plasticizing equipment on the set of proper process parameters and the adoption of appropriate forming processing equipment based on set of suitable parameters of forming and processing.

**Summary**

Through the construction of course outline, teaching content, teaching method, innovation practice and so on, the course has been optimized and reflects the characteristics of printing and packaging. The teaching content reflects the classics of teaching content and highlight the advance and frontier nature. The diverse teaching methods enhance the improvement of the teaching effect. The innovative practice cultivates students' research quality.

The achievements of the course construction are applied in the teaching of material forming and processing course. The students both master the knowledge and improve the ability of literature retrieval, summary and analysis. The more importance is that students both master the methods of scientific research and cultivate the spirit of innovation.

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References

[1] Training program for graduates of master degree of Beijing institute of graphic communication, which was edited by graduate office of Beijing institute of graphic communication in August, 2014.