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The Advanced Results are Integrated into the Teaching of Inorganic Chemistry

Qinghong Wang [1], **Zhifang Liu** [2]

1. Jiangsu Normal University, Xuzhou, Jiangsu 221116, China

2. Liaocheng University, Liaocheng 252000, China

Abstract: Integrating cutting-edge scientific research results into classroom teaching is of great significance for promoting the teaching reform of Inorganic Chemistry, improving teaching quality and cultivating innovative talents. The purpose of this paper is to explore how to integrate the latest scientific research results into the teaching of Inorganic Chemistry organically, while promoting students' ability to explore and innovate.

Keywords: Frontier achievement; Inorganic Chemistry teaching; Teaching quality; Learning effect

1. Introduction

The traditional teaching of Inorganic Chemistry is often limited to basic concepts and theories, and the classroom lacks vitality, which requires the reform of teaching mode [1]. With the development of scientific research, many cutting-edge scientific research achievements have made major breakthroughs in the field of inorganic chemistry [2,3], which is of great significance for promoting the reform and development of Inorganic Chemistry teaching and training high-quality chemical talents.

2. Advanced research progress in inorganic chemistry

Nanotechnology can achieve fine regulation of inorganic material properties and efficient chemical reactions, and provide new methods for solving practical problems such as energy, environment and medicine [4]. For example, nano-structured metal materials are used to catalyze REDOX reactions and carbonylation reactions to achieve efficient and highly selective chemical synthesis [5]. New carbon-based nanomaterials such as graphene and carbon nanotubes show excellent electrical conductivity and electrochemical activity, and exhibit excellent performance in energy storage fields such as secondary batteries and supercapacitors [6]. As a drug carrier, nanomaterials have high drug load and targeting, and can be applied in tumor therapy, drug delivery and other fields [7].

Inorganic functional materials are a kind of materials with specific function and application potential, which are widely used in electronic, photoelectric, magnetic, catalytic and other fields. For example, titanium dioxide catalysts have important applications in water treatment, air purification and other fields [8]. Magnetic oxide nanoparticles, magnetic nanowires, etc., have potential applications in magnetic regulation and biomedical applications [9]. Transition metals such as disulfide have the advantages of excellent electron transport performance and rapid charge and discharge, etc., and are used in the fields of energy storage and energy conversion [10]. Semiconductor, metal-organic framework (MOFs) photocatalysts can be used in water decomposition, organic wastewater treatment and other fields [11,12].

For example, the structure and function of metalloproteins and metalloenzymes are revealed by means of biophysical chemistry and structural biology, and their key roles in life processes are revealed [13].

3. Case analysis of the integration of cutting-edge scientific research achievements into the teaching of Inorganic Chemistry

3.1 Case 1: Teaching application of new catalysts

3.1.1 Case Description

In order to help students deeply understand the mechanism of action and application of catalysts, a new type of catalyst - metal-organic framework (MOFs) is introduced as a teaching case. MOFs are a class of porous materials with highly controllable pore structure and surface functionalization, which are particularly suitable for catalytic reactions.

3.1.2 Teaching objectives

①Understand the characteristics and advantages of the new catalyst, such as high specific surface area and controllable pore structure.

② Understand the mechanism of action of catalysts in chemical reactions, such as adsorption, activation of substrates, increasing reaction rate, etc.

③ Discuss the application cases of MOFs in gas adsorption, separation and other fields to deepen the understanding of catalyst application.

3.1.3 Design of teaching activities

① Theoretical explanation: The teacher introduces the structural characteristics, synthesis methods and catalytic mechanism of MOFs, so that students can understand the advantages and application fields of MOFs as a catalyst.

② Experimental operation: Organize students to conduct a simple catalytic reaction experiment to compare the effect difference between using MOFs and traditional catalysts.

Discussion and analysis: Guide students to discuss the experimental results, analyze the advantages and disadvantages of MOFs as a catalyst, and explore its application prospects in different fields.

Case analysis: Analyze the successful cases of MOFs in the fields of organic synthesis and gas separation, and expand the understanding of the application of new catalysts.

3.1.4 Evaluation of teaching effect

① Students can accurately describe the structural characteristics and catalytic mechanism of MOFs.

Students are able to analyze experimental results and compare the differences between MOFs and traditional catalysts.

Students can explore the application cases of MOFs in different fields and put forward their own opinions and thoughts.

3.2 Case 2: Investigation of the properties and applications of carbon-based materials

3.2.1 Case Description

In order to help students deeply understand the structure and application of graphite, an exploratory experiment project is designed to allow students to explore the physical and chemical properties of layered graphite through experiments, and explore its application in the field of lithium-ion batteries.

3.2.2 Teaching objectives

① Understand the basic properties of graphite, such as structure, electrical conductivity, etc.

② Explore the lithium storage properties of graphite, and understand its principle.

③ Improve students' experimental design ability and cultivate their innovative thinking.

3.2.3 Design of teaching activities

① Experimental design: students design experimental schemes to test the physical and chemical properties of graphite; Assemble lithium ion batteries and test their lithium storage performance.

② Students conduct experiments and record the results.

③ Application exploration: Students analyze experimental data, explore the lithium storage mechanism of graphite materials, and put forward their own opinions and thoughts.

④ Results display: Students show experimental results and research results, and share their findings and views.

3.2.4 Evaluation of teaching effect

① Students can accurately describe the basic properties of graphite materials.

② Students can analyze experimental data and explore the application principle of graphite materials in lithium-ion batteries.

Students are able to put forward innovative ideas and thinking, demonstrating scientific research and innovation capabilities.

4. Suggestions on integrating frontier scientific research achievements into Inorganic Chemistry teaching

(1) Cutting-edge scientific research results are updated quickly, so teachers need to learn about the latest research trends and improve their own knowledge reserves by reading literature and attending academic conferences.

(2) The limitations of teaching resources and experimental conditions may affect the teaching effect, so it is necessary to formulate reasonable teaching plans, expand teaching methods and means, and make full use of digital teaching resources and virtual experiment platforms to make up for the shortage of experimental conditions.

(3) Establish clear evaluation criteria to ensure the objectivity and impartiality of evaluation; Teachers give feedback on students' learning results in time to help students improve their learning methods and improve their learning results.

5. Conclusions

Integrating cutting-edge scientific research results into the teaching of Inorganic Chemistry can make students better understand subject knowledge, improve interdisciplinary learning ability, stimulate innovative thinking and exploration spirit, and inject new vitality into subject teaching and student development.

References:

[1] A comparative study of inorganic chemistry textbooks between China and Foreign countries, University Chemistry. 2023,38 (06), Zhao Pingping 1, CAI Ping2, Hu Kai 2, Zhu Yaxian 3, Cheng Peng4, Cheng Gongzhen

[2] Jilin University, Wuhan University, Nankai University. Inorganic Chemistry (Upper and lower) : 3rd edition [M]. Beijing: Higher Education Press, 2015.

[3] Reform of Inorganic Chemistry classroom Teaching Mode: Coordination of learning interest and moral character Cultivation, Hu Fangdongmikan, Liu Fuling, Gao Kefu, Jiang Xiaolei, Chemistry Teaching and Learning, No. 9, 2022,16-19

[4] Yuan Lei, Zhang Jingyu, Liu Haiyan. Synthesis and reaction of nanomaterials Research progress [J]. Shandong Chemical Industry, 2019, 49(20) : 46-47.

[5] Application of nanomaterial-based catalysts in organic synthesis, Liu Guangqing, Yuan Hualong, Liaoning Chemical Industry. 2024,53 (07)

[6] Li Xueqin, Chang Lin, Zhao Shenlong, Hao Changlong, Lu Chenguang, Zhu Yihua, Tang Zhiyong, 2017, 33 (1), 130-148 for carbon-based electrode materials for supercapacitors

[7] Nanoscale metal-organic skeleton materials and their drug-carrying applications, Yanni Wang, Ailing Feng, Rong Xu, Chemical Bulletin, Vol. 82, No. 4, 2019,291-298

[8] Tao Zhang a,†, Xiaochi Han a,†, Nhat Truong Nguyen b, Lei Yang a, Xuemei Zhou, TiO2-based photocatalysts for CO2 reduction and solar fuel generation, Chinese Journal of Catalysis 43 (2022) 2500–2529

[9] Wu Yuanqing, Zhou Jutao, Ding Xujun, He Junyi, Wu Ling, Xiao Zhongliang, Yu Donghong, Cao Zhong, Preparation of magnetic nanomaterials and their applications in Biosensing, Chemical Sensors, March 2023, Vol. 43, No. 1,46-55;

[10] Zhou Hui, Qiu Yan, Zhai Tianli, Wang Fan, Chen Zhenghua, Fang Linxia, Application of transition metal disulfide in energy conversion and storage, Guangzhou Chemical Industry, Vol. 44, No. 21, November 2016, 54-55

[11] Research progress of photocatalytic materials and their applications in wastewater treatment, Zhang Shuangjian, Guo Huiqin, Wang Tao, Applied Chemical Industry, Vol. 49, No. 11, November 2020, 2896-2905

[12] Recent Progress in Solar photochemical conversion of two-dimensional Covalent organic framework materials, Cheng Jun, Wang Lei, Xu Hangxun, Materials Advances in China, Volume 40, No. 9, 2021, September 676-694

[13]. Research progress of artificial metalase, Liu Xiaoyan, Huang Chaoqun, Jin Xuerui, Luo Yunzi, Chinese Journal of Bioengineering, 2023, 43 (10) : 72-84

About the author:

Qinghong Wang , 1985.11, female, Han, Linyi, Shandong, graduated from School of Chemistry, Nankai University, Doctor of Engineering, major in materials physics and chemistry, research direction: new energy materials.

Zhifang Liu , 1986.12, female, Han, Linyi, Shandong Province, graduated from Nankai University, postgraduate, inorganic major, research direction: Chemistry teaching