



## 应届生(23 级)

姓名: 阮玮  
民族: 汉族  
籍贯: 云南陆良  
住址: 江苏南京

应聘岗位: 研发工程师  
出生年月: 1997.09  
政治面貌: 中共党员  
联系电话: 17361566369  
电子邮箱: 201902033@njnu.edu.cn

## 教育经历

南京师范大学   硕士   排名: 2/33	动力工程及工程热物理	2020.09-2023.07
兰州理工大学   本科   排名: 4/58	建筑环境与能源应用工程	2016.09-2020.07

## 荣誉奖项

<b>硕士:</b> 1、国家奖学金 2、文体活动先进个人称号 3、江苏省大学生节能减排社会实践与科技竞赛 一等奖 (队长) 4、江苏省研究生节能低碳科研创新实践大赛 优秀奖 (队长)	<b>本科:</b> 1、2020 级优秀毕业生 2、国奖励志奖学金 3、“三好” 学生 4、数学竞赛二等奖
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## 实习经历

<b>2021.07-2021.08</b>	<b>南京天加环境科技有限公司</b>	<b>研发技术岗</b>
实习内容: 1、换热器的设计与优化, 包括 creo 三维和 CAD 二维作图设计; 2、空调系统组装及性能测试		
<b>2020.07-2020.08</b>	<b>云南鸿云锅炉有限责任公司</b>	<b>技术管理岗</b>
1、对锅炉各部件的实时压力进行监测; 2、锅炉系统热管理与分析		

## 校园经历

<b>2020.09-2022.09</b>	<b>硕士研究方向</b>
项目名称: 金属有机框架材料设计开发与应用 项目简述: 基于有机合成工艺, 设计开发新型金属有机框架材料, 实验研究其在储能, 催化等方面的性能。 个人职责: 1、前期调研; 2、开展实验研究; 3、整理实验数据, 撰写实验报告及科技论文。 项目成果: 以第一作者发表 3 篇 sci 期刊论文, 1 篇处于审稿阶段; 申请国家发明专利一项; 荣获省级竞赛奖项。	
<b>2018.04-2018.12</b>	<b>甘肃省大学生科学创新项目</b>
项目名称: 智能相变烟气余热回收系统及工艺开发 项目简述: 基于溴化锂吸收式热泵原理, 开发锅炉烟气余热回收工艺系统, 分析了系统的性能及其动态特性。 个人职责: 1、通过动态特性研究, 分析不同运行工况下系统动态特性变化规律。2、制作 ppt, 主要答辩人。 项目成果: 该项目的结项等级为优秀, 此外发表一篇中文期刊论文。	
<b>2021.09-2022.09: 院学生会 文体部 (部长)</b>	<b>2017.06-2018.06: 校学生会 青协 (副会长)</b>
1、策划文体活动, 带领篮球队闯入 4 强 (队长)。 2、策划学术论坛, 开展教育讲座。	1、策划组织志愿活动, 主持日常活动会议。 2、提供志愿服务活动所需知识与技能的培训。

## 个人评价

<b>个人技能:</b> 软件: CAD、Solidworks、Fluent 语言: CET-6 其他: 计算机二级、普通话	<b>自我评价:</b> 学习: 专业知识扎实, 渴望探索新知 工作: 实操能力突出, 注重团队荣誉 生活: 乐观积极向上, 实战抗压倍强
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## 附件

附件主要包括以下材料：

- (1) 学历证明
- (2) 成绩证明
- (3) 各类获奖证明
- (4) 学术成果证明
- (5) 任职证明

# 学历证明



### 本科毕业证



### 本科学位证

## 教育部学籍在线验证报告

更新日期：2021年3月4日

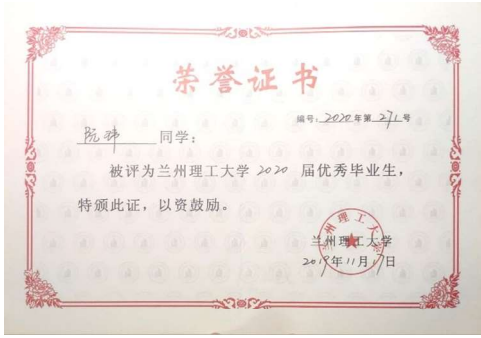
姓名	阮玮				
性别	男	证件号码	532228199709222414		
民族	汉族	出生日期	1997年09月22日		
院校	南京师范大学		层次	硕士研究生	
院系			班级		
专业	动力工程及工程热物理		学号	201902033	
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### 硕士学位在线验证报告





# 获奖证明



优秀毕业生



国家励志奖学金



三好学生



数学竞赛



娃哈哈市场营销大赛



文体活动先进个人



优秀社会工作者



江苏省研究生节能低碳大赛



南师大节能减排大赛



江苏省节能减排大赛

## 学术成果证明

项目	题目
SCI 论文	[1] <b>Ruan W</b> , Liu H, Qi Y, Zhou M, Wu H, Yang H. Post-modification of Uio-66-NH <sub>2</sub> based on Schiff-base reaction for removal of Hg <sup>2+</sup> from aqueous solution: Synthesis, adsorption performance and mechanism. Fuel 2022; 319: 123816. (SCI TOP)
	[2] <b>Ruan W</b> , Liu H, Wu H, Qi Y, Yang H. Fabrication of Uio-66-NH <sub>2</sub> with 4,6-Diamino-2-mercaptopyrimidine facilitate the removal of Pb <sup>2+</sup> in aqueous medium: Nitrogen and sulfur act as the main adsorption sites. Fuel Processing Technology 2022, 236: . (SCI TOP)
	[3] <b>Ruan W</b> , Wu H, Qi Y, Yang H. Removal of Hg <sup>2+</sup> in wastewater by grafting nitrogen/sulfur-containing molecule onto Uio-66-NH <sub>2</sub> : From synthesis to adsorption studies. Environmental science and pollution research.
	[4] <b>Ruan W</b> , Wu H, Yang H. Facile design of Metal-Organic Framework for Hg <sup>2+</sup> pollution remediation from wastewater: Experimental investigation and theoretical analysis. (审稿阶段)
专利	[1] 周长松,杜朝辉, <b>阮玮</b> ,周梦长,杨宏旻,吴昊,张振. 一种低温条件下可循环一体化同时吸附催化脱除 VOCs 的双功能材料、其制备方法和应用[P]. 江苏省: CN114452977A, 2022-05-10.

Full Length Article

Post-modification of Uio-66-NH<sub>2</sub> based on Schiff-base reaction for removal of Hg<sup>2+</sup> from aqueous solution: Synthesis, adsorption performance and mechanism

Wei Ruan, Haoyun Liu, Yuan Qi, Mengchang Zhou, Hao Wu<sup>\*</sup>, Hongmin Yang<sup>\*</sup>

School of Energy and Mechanical Engineering, Nanjing Normal University, Nanjing 210042, China

**ARTICLE INFO**

**ABSTRACT**

**Keywords:** Uio-66-NH<sub>2</sub>/AHMP; Hg<sup>2+</sup> removal; Adsorption performance; Aqueous solution

A novel composite adsorbent, Uio-66-NH<sub>2</sub>/AHMP, was successfully synthesized by post-modifying Uio-66-NH<sub>2</sub> with 4-amino-4-hydroxy-2-mercaptopyrimidine based on the Schiff-base reaction and applied to remove Hg<sup>2+</sup> from aqueous solution. The Uio-66-NH<sub>2</sub>/AHMP was characterized by Field emission scanning electron microscopy (FE-SEM), X-ray diffractometer (XRD), Fourier transform infrared (FT-IR), X-ray photoelectron spectroscopy (XPS) and Brunauer-Emmett-Teller (BET). The characterization results showed that sulfur/nitrogen/oxygen-containing groups were successfully introduced on the zirconium-based MOF, and the pore structure of Uio-66-NH<sub>2</sub>/AHMP mainly contains mesopores. Subsequently, the adsorption and regeneration performance of composite Uio-66-NH<sub>2</sub>/AHMP were investigated by batch experiments, the effect of solution pH, sorbent dose, reaction time, initial Hg<sup>2+</sup> concentration, and coexisting metal ions on the removal performance of Hg<sup>2+</sup> were evaluated. The pH value of solution determined the charge distribution on the adsorbent surface and the form of Hg<sup>2+</sup> in aqueous solution based on experimental results and zeta potential analysis. The obtained equilibrium time and maximum adsorption capacity were 60 min and 222.5 mg/g at pH 6, 298 K, respectively. The adsorption process of Hg<sup>2+</sup> was consistent with the pseudo-second-order kinetic and the Langmuir model. The results of regeneration studies shown that the removal efficiency of 79.2 % could be obtained after four adsorption-desorption cycles. Besides, Uio-66-NH<sub>2</sub>/AHMP exhibited excellent adsorption selectivity for Hg<sup>2+</sup>. XPS analysis indicated that the removal process was dominated by chelation between Hg<sup>2+</sup> and nitrogen/sulfur/oxygen-containing groups. This work indicates that the Uio-66-NH<sub>2</sub>/AHMP has a good application prospect in the removal of Hg<sup>2+</sup> from aqueous solution.

**1. Introduction**

Heavy metals and related compounds in aqueous solution have posed a great threat to public health due to their high toxicity. Toxic heavy metals mainly come from volcanic eruptions, fossil fuel combustion, chemical manufacturing, and mining [1–3]. The biological toxicity of mercury has been considered to be the highest of all heavy metal ions with non-biodegradable. According to the World Health Organization (WHO) and the European Union (EU), the concentration of mercury in pure water should be less than 1 ppb [4] and 1 µg/L [5], respectively. However, global mercury emissions to aquatic systems are estimated at 137 to 260 tons every year, it is urgent to treat mercury-containing wastewater. Currently, chemical precipitation [6], ion exchange [7], membrane separation [8], evaporation [9], electrocoagulation [10], and adsorption [11–13] have been used to tackle mercury pollution. Among them, the adsorption method is considered a reliable method with high removal efficiency, environmentally friendly, and inexpensive [14]. Common adsorbents (activated carbon and resin, etc.) are limited by stability and adsorption performance. Thus, it is of great significance to synthesize adsorbents with large adsorption capacity and high stability.

Metal-Organic Frameworks (MOFs), a new type of adsorbent, have aroused intensive attention due to a series of advantages such as large specific surface area, high water stability, and adjustable structure [15–17]. MOFs is widely used in gas separation [18–20], sensing [21,22], catalysis [23,24], drug loading [25,26], and heavy metal ions adsorption [27–29]. The zirconium-based MOF successfully synthesized by Lillerud et al. shows great potential for the adsorption of heavy metal because of the excellent water stability [30]. Uio-66-NH<sub>2</sub> composed of

<sup>\*</sup> Corresponding author.  
 Email address: 62103@njnu.edu.cn (H. Wu), 62055@njnu.edu.cn, yanghongmin@njnu.edu.cn (H. Yang).  
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Fabrication of Uio-66-NH<sub>2</sub> with 4,6-Diamino-2-mercaptopyrimidine facilitate the removal of Pb<sup>2+</sup> in aqueous medium: Nitrogen and sulfur act as the main adsorption sites

Wei Ruan, Haoyun Liu, Hao Wu<sup>\*</sup>, Yuan Qi, Mengchang Zhou, Changsong Zhou, Zhen Zhang, Hongmin Yang

School of Energy and Mechanical Engineering, Nanjing Normal University, Nanjing 210042, P.R. China

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**ABSTRACT**

**Keywords:** Pb<sup>2+</sup> removal; Uio-DMP; Adsorption behavior; Mechanism

In this work, the Zn-based MOF was successfully fabricated with 4,6-Diamino-2-mercaptopyrimidine (DMP) and a novel adsorbent (Uio-DMP) was synthesized for the immobilization of Pb<sup>2+</sup> in aqueous medium. The morphological and structural characteristics of Uio-DMP were characterized by X-ray diffractometer (XRD), Fourier transform infrared (FT-IR), Field emission scanning electron microscopy (FE-SEM), Brunauer-Emmett-Teller (BET), and X-ray photoelectron spectroscopy (XPS). The characterization results showed that the Uio-DMP maintained a primitive crystal structure and the sulfhydryl group was introduced to Zn-based MOF after chemical functionalization. The adsorption behavior of Uio-DMP for Pb<sup>2+</sup> was investigated in different conditions (solution pH, sorbent dose, Pb<sup>2+</sup> concentration, adsorption time, and co-existing ions). The experimental results indicated that the optimal pH was 6, the maximum adsorption capacity was 296.5 mg/g, and the Langmuir model well fitted the Pb<sup>2+</sup> removal process based on adsorption isotherm studies. The adsorption kinetic experiments revealed that the adsorption equilibrium could be achieved at 30 min and the adsorption process was consistent with the pseudo-second-order model. The co-existing ions had a limited impact on Pb<sup>2+</sup> removal and the removal rate of 71.0% was maintained after five consecutive adsorption-desorption experiments. Furthermore, zeta potential and XPS analysis proved that the removal process of Pb<sup>2+</sup> over Uio-DMP was affected by electrostatic interaction, and nitrogen/sulfur atoms acting as the main adsorption sites. This study provides an insight into the removal of Pb<sup>2+</sup> in aqueous medium and the functionalization of adsorbents.

**1. Introduction**

As a major pollution source to the aquatic system, heavy metals pose numerous threats to human life and health. Among all heavy metals, trace metal lead (Pb) is widely distributed in aqueous medium mainly in the form of Pb<sup>2+</sup> [1,2]. Pb has been identified as the most harmful heavy metal with non-biodegradable and can be accumulated continuously through the food chain [3,4]. It is estimated that about 0.8 million tons of Pb and related compounds have been released into the ecosystem over the past several years, mainly from lead-acid batteries, mining, and metal smelting [5–7]. However, standards set by the World Health Organization (WHO) and the United States Environmental Protection Agency (USEPA) clearly state that the maximum quantity of Pb in drinking water is 0.01 mg/L [8] and 0.015 mg/L [9], respectively. Therefore, minimizing the concentration of Pb in aqueous medium is an urgent task.

In the present studies, all kinds of technologies and methods have been applied to remove heavy metals from aqueous medium, such as ion exchange, electrocoagulation, chemical precipitation, membrane separation, and adsorption [10–18]. Among them, adsorption is regarded as a feasible wastewater treatment method with simple operation, efficient, economic, and environmental protection [19]. Traditional adsorbents such as activated carbon [20], zeolite [21], and hydrogel [22] have been already widely used in the removal of heavy metals. However, these adsorbents usually have the shortcomings of small adsorption capacity, poor stability, and difficulty in regeneration [23,24]. Therefore, the design or synthesis of adsorbents with excellent adsorption performance and high stability is of important significance for binding heavy metals from industrial wastewater.

In recent years, metal-organic framework materials (MOFs) are

<sup>\*</sup> Corresponding author.  
 Email address: 62103@njnu.edu.cn (H. Wu), yanghongmin@njnu.edu.cn (H. Yang).  
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(71) 申请人 南京师范大学  
 地址 210046 江苏省南京市栖霞区文苑路1号

(72) 发明人 周长松 杜朝晖 阮玮 周梦长 杨宏昊 吴昊 张振

(74) 专利代理机构 南京经纬专利商标代理有限公司 32280  
 专利代理人 孙昱

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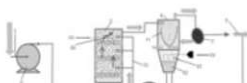
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(54) 发明名称

一种低温条件下可循环一体化同时吸附催化脱除VOCs的双功能材料、其制备方法和应用

(57) 摘要

本发明提供一种低温条件下可循环一体化同时吸附催化脱除VOCs的双功能材料、其制备方法和应用,通过在30-180℃吸附温度下使用铁氧体@多孔吸附树脂材料将VOCs氧化降解,其反应系统包括通过管道连接的:第一气体入口、流化吸附-催化床、真空泵、旋风分离器、第一气体出口、第一气体入口与流化吸附-催化床的进气口连接,流化吸附-催化床的出气口与旋风分离器的进气口连接,旋风分离器的出气口与第一气体出口连通,真空泵的抽气口与流化吸附-催化床的内部连通;本发明的铁氧体@吸附树脂材料中的金属氧化物有效成分可通过价态调整和掺杂改性技术改良,VOCs的降解效率在90%以上,双功能材料可回收循环利用。



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性技术改良,VOCs的降解效率在90%以上,双功能材料可回收循环利用。

专利

兰州理工大学大学生科创基金项目

结项证书



项目类别: 哲社类  
 项目名称: 智能相变烟气余热回收系统及工艺开发  
 项目负责人: 李康婷  
 主要参加人: 刘招珂 李浩强 李全永 阮玮  
 指导老师: 麻宏强  
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教务处 科技处

二〇一八年十二月十六日



科创项目





# Removal of Hg<sup>2+</sup> in wastewater by grafting nitrogen/sulfur-containing molecule onto Uio-66-NH<sub>2</sub>: from synthesis to adsorption studies

Wei Ruan<sup>1</sup> · Hao Wu<sup>1</sup> · Yuan Qi<sup>1</sup> · Hongmin Yang<sup>1</sup>

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## Abstract

The remediation of heavy metal deserves to be on the agenda, with the adsorbent design bearing the brunt of it. In this study, the molecule (4, 6-diamino-2-mercaptopyrimidine, DMP) containing thiol (-SH) and amino (-NH<sub>2</sub>) functional groups was grafted onto Uio-66-NH<sub>2</sub>, and a composite metal-organic framework nanomaterial (Zr(NH<sub>2</sub>)-DMP) was synthesized via a facile post-modification scheme. The morphological characteristics and structural features of the modified adsorbent were characterized by XRD, FT-IR, FE-SEM, EDS, BET, and XPS. The characterization results verified that the post-modification scheme was successfully achieved. The adsorption experiments were carried out to investigate the removal performance of the Zr(NH<sub>2</sub>)-DMP towards Hg<sup>2+</sup> under different influencing parameters. The maximum adsorption capacity of 389.4 mg/g was obtained, and the adsorption equilibrium was achieved within 30 min at pH 6 at room temperature. Adsorption thermodynamic study indicated that the adsorption process was exothermic and spontaneous. The Zr(NH<sub>2</sub>)-DMP exhibited excellent selectivity for Hg<sup>2+</sup>, and also has the potential to remove Cu<sup>2+</sup>, Fe<sup>2+</sup>, and Zn<sup>2+</sup> ions. The introduction of Cl<sup>-</sup> inhibited the removal of Hg<sup>2+</sup> due to the formation of mercuric chlorides (removal efficiency reduced from 97.8 to 95.6%). The removal efficiency of up to 86.7% was obtained after four cycles. The Langmuir isotherm and Pseudo-second kinetic were more suitable for fitting the adsorption process of Hg<sup>2+</sup> by Zr(NH<sub>2</sub>)-DMP. The main removal mechanism could be attributed to the chelation between Hg<sup>2+</sup> (soft acid) and nitrogen/sulfur (soft base) elements. These findings convinced that the successful synthesis of Zr(NH<sub>2</sub>)-DMP provides an option for Hg<sup>2+</sup> removal from wastewater.

**Keywords** Post-modification · Nanomaterial · Hg<sup>2+</sup> · Removal performance · Wastewater

## Introduction

Mercury (Hg) has been considered as a highly toxic heavy metal, which generates a series of risks to biological organs such as the liver, skin, and kidney even at trace levels (Bao et al. 2021). More than 2000 tons of metallic Hg are consumed worldwide every year, which is accompanied by a large amount of Hg emissions from coal-fired power plants, pharmaceutical synthesis, and other industrial processes (Liu et al. 2022; Yang et al. 2019). The fundamental form of Hg includes particle-bound mercury (Hg<sup>p</sup>), elemental

mercury (Hg<sup>0</sup>), and divalent mercury (Hg<sup>2+</sup>) (Chen et al. 2021). Meanwhile, Hg<sup>2+</sup> is the main form in wastewater. Metallic Hg will enter the atmosphere and aquatic systems through conversion and migration, such as the Hg<sup>2+</sup> can be reduced into Hg<sup>0</sup> and escape from wastewater, causing environmental pollution and health problems (Waggoner et al. 1999). Taking into account the hazard of Hg<sup>2+</sup> in industrial wastewater, developing effective methods and technologies to remediate Hg<sup>2+</sup> is imperative.

In previous studies, convenient techniques and approaches (membrane separation (Chen et al. 2021), ion exchange (Zeng et al. 2021a), interfacial evaporation, (Yu et al. 2020), and adsorption (Peng et al. 2020)) have been employed to address metal pollution in wastewater. Owing to the superiorities of the low cost of investment, easy control, and no secondary pollution, the adsorption method earns special consideration for removing Hg<sup>2+</sup>-containing contaminants (Awwal 2017; Kokkinos et al. 2017). However, traditional adsorption materials have

Responsible Editor: Tito Roberto Cadaval Jr

✉ Hao Wu  
62102@njnu.edu.cn

<sup>1</sup> School of Energy and Mechanical Engineering,  
Nanjing Normal University, Nanjing 210042,  
People's Republic of China

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