

Editorial

# Special Issue on “New Materials and Techniques for Environmental Science”

Gang Wei <sup>1,\*</sup>  and Aiguo Wu <sup>2,\*</sup> 

<sup>1</sup> Faculty of Production Engineering, University of Bremen, 28359 Bremen, Germany

<sup>2</sup> Cixi Institute of Biomedical Engineering, CAS Key Laboratory of Magnetic Materials and Devices, & Key Laboratory of Additive Manufacturing Materials of Zhejiang Province, Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, Ningbo 315201, China

\* Correspondence: wei@uni-bremen.de (G.W.); aiguo@nimte.ac.cn (A.W.); Tel.: +49-421-218-64581 (G.W.)

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## 1. Introduction

Water is the source of life and one of the most important material resources for human survival and development. Although 71% of the Earth’s surface is covered with water, freshwater resources that can be directly used by humans, such as river water, freshwater lakes, and shallow groundwater account for only 0.03% of the total water. Moreover, due to the rapid development of industries and increasing human activities, including metal plating, fertilizers, tanneries, mining, paper, batteries, and pesticides, many harmful inorganic and organic pollutants are released into water, which seriously endangers the freshwater resource and ecological environment. Therefore, it is significant to analyze and remove these inorganic and organic pollutants from wastewater.

In recent years, various analytical methods, such as colorimetric, fluorescent, electrochemical, and electronic sensors, have been utilized to determine toxic ions, small molecules, biomacromolecules, and others from water system [1]. In addition, a lot of nanomaterials (polymer, nanoparticles, carbon materials, two-dimensional materials, and others) [2,3] and purification techniques (chemical precipitation, adsorption, ion exchange, membrane filtration, electrochemistry, and phytoremediation) [3,4] have been used to remove both inorganic and organic pollutants from water for wastewater purification.

Therefore, in this special issue we would like to collect recent studies on the using of new materials and techniques for environmental science in the subjects of materials design, sensors/biosensors, water system analysis, water purification, and other related fields. Totally 22 papers were submitted and 10 of them were published through one to two rounds of peer-reviewing (with an acceptance rate of 45.5%).

## 2. New Materials for Environmental Science

There are six papers focused on the design and synthesis of new materials for environmental science applications in this issue, in which two papers reported the synthesis of new sorbents for removal of Pb<sup>2+</sup>. The first paper that contributed by Li et al. [5], introduces the design and synthesis of a low-cost Pb<sup>2+</sup> sorbent by modifying biocompatible alginate (Alg) with chemically stable melamine (Mel). It was found that the conjugation of Mel with Alg could greatly improve the chemical and physical stability, and enhance the reuse ability of the synthesized Alg-Mel sorbent. The hybrid sorbent revealed a removal efficiency of 95.4% towards Pb<sup>2+</sup> from Pb<sup>2+</sup>-containing solutions with a maximum adsorption capacity of 1.39 mmol/g (287.7 mg/g), which shows obvious advantage compared to that of most previously reported Pb<sup>2+</sup> sorbents. In addition, the authors demonstrated that the adsorption mechanism of the synthesized Alg-Mel sorbent is ascribed to both chemical coordination and ion exchange effects of materials. In another paper authored by Petrella and co-workers [6], a

silico-aluminate material (perlite) was used as an alternative and cheap sorbent for removing  $Pb^{2+}$  ions from the industrial wastewater. It was found that the increasing of the amount of perlite improved the metal removal efficiency obviously, and the best  $Pb^{2+}$  ions retention of 0.3 L/h with 4 g of perlite and 10 mg/L metal solution. In addition, this study indicated that the perlite material can be further used for constructing environmentally friendliness industrial materials like plaster or panels.

$TiO_2$ -based nanomaterials exhibited great potentials for the photocatalytic degradation and adsorption of organic pollutants from wastewater systems. Two papers in this issue are related to the design and synthesis of new  $TiO_2$ -based nanomaterials for oil-water separation [7] and photocatalytic degradation of methylene blue [8]. The first paper by Zuo et al. reported the design and synthesis of silane-modified  $TiO_2$  pillared montmorillonite (Ti-Mt-APTES) for the demulsification of acidic oil-in-water emulsion [7]. They found that the fabricated Ti-Mt-APTES materials showed improved demulsification efficiency (94.8%) when 2.5 g/L of sorbent was added into the acidic oil-in-water emulsion after 5 h. In addition, the materials characterizations and control tests proved that the electrostatic interaction between materials and oil droplets as well as the intercalation of titanium hydrate play main roles in the oil adsorption and demulsification. In the other paper, Fu et al. reported the synthesis of graphene oxide (GO)/ $TiO_2$  composites for photocatalytic degradation of methylene blue [8]. It is clear that the 2D GO enhanced the photocatalytic activity of  $TiO_2$  towards methylene blue, and the addition of 15 wt% GO caused highest photocatalytic efficiency. It was found that the degradation rate towards methylene blue reached 95.8% after 2.5 h by using 200 mg composites and 200 mL methylene blue (10 mg/mL). The reported GO/ $TiO_2$  hybrid materials show promising application for the facial removal of organic dyes from wastewater.

Besides photodegradation,  $TiO_2$  materials can also be used for other environmental applications. Li and co-workers [9] introduced novel waterproof aerated bricks based on the hydrophobic surface modification of stone powder waste with  $TiO_2$  nanoparticles, which created a super-hydrophobic surface on the aerated bricks. It is clear that using of super-hydrophobic  $TiO_2$  nanoparticles inhibited the absorption of rainwater and dust, promoting the reusing of wasters and holding high potential for large-scale construction and buildings.

The construction of environmentally friendliness materials with reinforced properties is also very important for environmental science. Yang et al. [10] reported in this issue the industrial synthesis of self-sensing, self-monitoring intelligent carbon nanofibers (CNFs)-reinforced polyurethane cement (CNFPUC) materials. The using of CNFs for the fabrication of CNFPUC materials improved the varistor characteristics of materials, making CNFPUC as smart materials. In addition, the addition of silica fume to CNFPUC improved the sensitivity coefficient and piezoresistive effect of materials by reducing the variation coefficient of hexahedron CNFPUC.

### 3. New Techniques for Environmental Science

There are another four papers focused on the new techniques for environmental science applications in this issue.

In the aspect of the technique for wastewater treatment, Guo and co-workers proposed a classification and disposal strategy for the excess sludge in the petrochemical industry [11]. They first analyzed the dioxin, flammability, corrosivity, reactivity, and leaching properties of the sludge and then suggested corresponding methods for the disposal of the sludge based on the type of waste. Through both experimental and theoretical studies, it can be proved that the proposed strategy is useful for the selection of reasonable petrochemical excess sludge disposal methods, which is of great significance for environmental protection and sustainable development.

To diminish the consumption of water and sulfuric acid for treating corncobs, Wang et al. [12] demonstrated a new approach for economical pretreatment of corncobs for producing value-added chemical and biofuels. Their results indicated that the cost-effective pretreatment of corncobs can be achieved by re-using extremely dilute sulfuric acid as the pretreatment liquid, and the optimal

re-use of the pretreatment liquid is crucial for the effective removal of soluble proteins and metal ions from corncobs.

Based on their previous study on the synthesis of CNFPUC materials [10], Yang and Sun contribute another paper on the self-monitoring of bending fatigue cumulative damage of CNFPUC [13], in which detailed characterizations on the resistivity of CNFPUC by adjusting bending strain, stress level, cycle times, and temperate were performed. In addition, the relationship between the fatigue cumulative damage and the change of the resistivity of materials was further analyzed.

In the paper authored by Choe et al. [14], a facile method was reported to produce dried powder from red mud (RM) sludge with 40–60% water content without heating process. The physical and chemical properties of the synthesized RM materials were studied through multi-techniques, and the compressive strength, porosity, and water absorption rate of the mortar were further evaluated. This work presents a potential way to transform industrial wastes into useful raw materials for sustainable development and environmental protection.

#### 4. Outlooks

The development of new materials and techniques are crucial for the energy and environmental science. We believe that the above-mentioned papers in this issue are helpful for readers to understand the design of new materials and the development of new techniques for environmental science applications. In the future, more in-depth studies in the synthesis of large-scale materials such as polymer hybrid films, nanoporous membranes, and three-dimensional aerogels for water purification and desalination are suggested. In addition, advanced analysis and detection techniques like colorimetric, electrochemical, fluorescent, and electronic sensors/biosensors for water pollutant monitoring should also be considered.

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