



# Glycine-assisted hydrothermal synthesis and adsorption properties of crosslinked porous $\alpha$ -Fe<sub>2</sub>O<sub>3</sub> nanomaterials for p-nitrophenol

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## HIGHLIGHTS

- The porous  $\alpha$ -Fe<sub>2</sub>O<sub>3</sub> was prepared by glycine-assisted hydrothermal synthesis method.
- The  $\alpha$ -Fe<sub>2</sub>O<sub>3</sub> possess hierarchical porous structures and unique surface activity.
- The product exhibit high adsorption affinity towards p-nitrophenol in water.

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## ABSTRACT

The porous  $\alpha$ -Fe<sub>2</sub>O<sub>3</sub> nanomaterials were prepared using glycine as structure-directing agent via a simple hydrothermal synthesis followed by calcination. The as-prepared samples were characterized by X-ray diffraction (XRD), field-emission scanning electron microscopy (FE-SEM), nitrogen adsorption–desorption isotherms measurement. The as-obtained  $\alpha$ -Fe<sub>2</sub>O<sub>3</sub> presents crosslinked hierarchical pore structure on small meso (ca. 15 nm), large meso (ca. 40 nm) and macro (ca. 100–200 nm) length scales. The equilibrium adsorption data of p-nitrophenol on the as-prepared samples were well fitted by the Langmuir isothermal model. The adsorption kinetics was found to follow the pseudo-second-order equation. The Fe<sub>2</sub>O<sub>3</sub> samples are found to be effective adsorbent for the removal of p-nitrophenol from wastewater as a result of their high surface area and accessible diffusion pathways of porous network.

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## 1. Introduction

Nitrophenol is considered potentially carcinogenic for humans as well as negative impacts for ecosystems. Their discharge into the environment mainly comes from many industrial effluents, such as pesticides, pharmaceuticals, wood preservatives and petrochemicals industries [1]. Exposure to nitrophenol can cause skin and eye burns. It has a delayed interaction with blood and forms methaemoglobin which is responsible for methemoglobinemia, potentially causing cyanosis, confusion and unconsciousness. Removal of nitrophenol from contaminated water by a range of techniques such as coagulation or flocculation [2], membrane filtration [3], biological degradation [4], photocatalysis [5], adsorption and chemical oxidation [6] have been reported by numerous researchers. Actually, adsorption is a widely applicable technology due to its merits of high efficiency, simplicity and low cost [7,8]. The adsorption performance is highly dependent on the chemical

composition and physicochemical characteristics of adsorbent such as shape, size and dispersion of particles [9,10]. Therefore, the search for adsorbents for the removal of pollutants from aqueous solution is driven by the desire to synthesis new materials with high surface area, porous structure and strong adsorption affinity.

Iron oxides are well known to be chemically reactive and are extensively studied during the past decades because of their diverse applications including magnetic recording media, pigments, catalysts, gas sensors, optical devices, and electromagnetic devices [11]. Up to now, a variety of iron oxides nanostructures such as nanocrystals [12,13], particles [14–16], cubes [17], rods [18,19], wires [20], tubes [21], flute-like [22], hollow spheres [23] and nanocups [24] have been fabricated. Evidence indicates that iron oxides are promising adsorbent to remove heavy metals, dyes and organic pollutants in wastewater [25]. Particularly, some studies revealed that in aqueous systems the surface of iron oxides coordinates with hydroxyl ions or water molecules and forms chemically reactive entities at the surface of the solid, which significantly improve its adsorption performance. However, it is still a challenge to develop a facile approach to prepare iron oxides with porous nanostructures and versatile surface functionalities.

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