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Homepage : https://journal.i-ros.org/index.php/JOCSIS
Email : jocsis@i-ros.org
e-ISSN 3089-7564
Vol.3, No.1, March 2027
© 2027 Journal of Current Studies in SDGs

Functionalization of L-Cystein On Magnetite As Magnetic Adsorbent Metals for SDG 14

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DOI : https://doi.org/10.63230/jocsis.3.1.251

Sections Info

Article history:
Submitted: February 09, 2026
Final Revised: April 12, 2026
Accepted: June 06, 2026
First Available Online: July 16, 2026
Publication Date: March 27, 2027

Keywords:
Fe3O4@Cys
L-Cysteine
Magnetic adsorbent
Silica coating, enviromental

ABSTRACT

Objective: *The increasing consumption of gold (Au) in the electronics, catalysis, and medical sectors has led to the depletion of primary ore resources while increasing the accumulation of electronic waste (e-waste) which reaches 62 million tons per year globally. Therefore, the development of selective, efficient, and environmentally friendly Au(III) recovery technology from secondary sources is very urgent. This study aims to synthesize and characterize magnetic adsorbents based on magnetite (Fe_3O_4@Cys) functionalized with L-Cysteine (Fe_3O_4@Cys) and evaluate its performance in the recovery of Au(III) ions from aqueous solutions.* ***Method:*** *L-Cysteine was chosen because it contains a thiol group (-SH) which has a high affinity for Au(III) based on the hard-soft acid-base (HSAB) theory. The synthesis was conducted through silica coating followed by L-cysteine immobilization using GPTMS as a coupling agent.* ***Results:*** *FTIR analysis confirmed the presence of Fe–O, Si–O–Si, and Si–OH groups, indicating successful functionalization. XRD results showed that the magnetite crystal structure was retained after modification, with a crystallite size of 16.43 nm and the presence of amorphous silica.* ***Novelty:*** *The synthesized Fe3O4@Cys exhibited good acid stability, demonstrating its potential as a selective magnetic adsorbent for Au(III) recovery from secondary resources.*

INTRODUCTION

The demand for gold (Au) has increased significantly in recent decades, driven by its widespread use in the electronics industry, catalysis, dentistry, and as a financial investment (Lu et al., 2020; Shukla et al., 2023; Zhou et al., 2021). However, the scarcity of natural resources and the depletion of high-grade gold ore reserves have prompted the need to explore alternative sources, such as mining tailings and electronic waste (e-waste) (Hut et al., 2023; Lahtinen et al., 2017; Neag et al., 2020; Rao et al., 2020; UNITAR, 2024). It is estimated that one ton of used mobile phones contains approximately 340 grams of gold, which is a much higher grade compared to primary ores (Gómez et al., 2023; Kubota et al., 2019). Therefore, the development of efficient and environmentally friendly technologies for the recovery of Au(III) from these secondary sources is crucial.

Various methods have been developed for gold recovery, including chemical precipitation, solvent extraction, ion exchange, and adsorption (Kim et al., 2024; Perez et al., 2019; Yang et al., 2024). Among these methods, adsorption is considered the most promising approach due to its relatively low operational costs, simple process design, and effectiveness at low metal concentrations (Chen et al., 2022; Chillè et al., 2022; Liu et al., 2022). A number of adsorbent materials have been explored, such as activated carbon, resins, biomass, and metal organic frameworks (MOFs) (Chen et al., 2023; Sheraz et al., 2024; Wang et al., 2023). However, the main challenges often encountered are the low selectivity toward Au (III) in the presence of other interfering metal ions (such as Cu (II), Zn (II), and Ni (II)), as well as the difficulty in separating the adsorbent