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Research Article

Structural, morphological, optical, magnetic and antimicrobial activity of charged surface acting agents (SAA) and growth regulator (GR)-assisted nanostructured Co_3O_4 particles via microwave-assisted precipitation method

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ABSTRACT

Cobalt oxide (Co_3O_4) nanoparticles were synthesized using the different surface-acting agents (SAA) and growth regulator (GR)-assisted microwave synthesis followed by precipitation process. The structural, morphological, particle size, elemental composition, optical, magnetic and antimicrobial activities of the CTAB, SDBS and ethylene glycol-assisted synthesized Co_3O_4 samples were examined using various analytical techniques. Powder XRD patterns of the SAA-and GR-assisted Co_3O_4 samples revealed the face-centered cubic (FCC) crystal structure. The FTIR spectra of the CTAB, SDBS and ethylene glycol-assisted Co_3O_4 samples showed two sharp bands at ~547 and 661 cm^{-1} are ascribed to the Co–O vibrations. The morphological changes and particle size reduction of the Co_3O_4 samples were effectively influenced by the SAA and GR through confirmed using the SEM studies. EDX and XPS of the CTAB-assisted synthesized sample results showed cobalt oxide formation. The mesoporous structure was confirmed through BET analysis. TEM analysis of CTAB-assisted Co_3O_4 sample confirmed the well dispersed fine particles with average particle size range between 11 and 15 nm. The recorded light absorption spectra of synthesized Co_3O_4 showed one absorption edge in the UV portion and another absorption edge in visible region, which is ascribed to the $O^{2-} \rightarrow Co^{2+}$, and $O^{2-} \rightarrow Co^{3+}$ charge-transfer transitions, respectively. The RT-PL emission spectra and chromaticity features of SAA and GR-assisted Co_3O_4 nanostructures were discussed in detail. Room temperature VSM analysis revealed that the synthesized CTAB-assisted Co_3O_4 sample exhibits weak ferromagnetic behaviour. The antimicrobial activity of the Co_3O_4 sample was tested against the *Escherichia coli* (Gram-negative), *Streptococcus pneumoniae* (Gram-positive), *Pseudomonas aeruginosa* (Gram-negative), *Klebsiella pneumoniae* (Gram-negative), and *Candida albicans* (fungal), using the well diffusion method and their results presented in detail.

1. Introduction

Transition metal oxides are chemical compounds formed by the combination of transition metals and oxygen, and they exhibit remarkable properties such as semiconductivity, catalytic activity, antibacterial properties, chemical sensing, electro-optics and magnetism [1–8]. Surfactants play a very important role in the formation of nanoparticles due to their strong dispersion effect, stabilization of nanomaterials, control over crystal growth, templating effects during synthesis, prevention of aggregation, and microemulsion formation [9]. Cobalt oxide (Co_3O_4) is a p-type semiconducting transition metal oxide with antiferromagnetic properties, a narrow optical band gap, and a spinel crystal structure [8,10]. Various ionic surfactants and surface modifiers were used to wet chemically synthesized Co_3O_4 nanostructures by many researchers as well as extensively studied for their electrochemical sensing, gas sensing properties and optical features for potential applications such as charge storage, electrochemical devices, optical detectors, gas sensing, and catalytic activity etc. [11–23]. Few reports available only studied the structural properties of Co_3O_4 nanostructures using a surfactant-mediated wet chemical synthesis route [24–28].

Mainly, Co_3O_4 particles with various nanodimensions through anionic, cationic, non-ionic and surface modifier-assisted wet chemical

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