Preparation and characterization of a carbon-based magnetic nanostructure via co-precipitation method: Peroxidase-like activity assay with 3,3′,5,5′-tetramethylbenzidine

Navvabeh Salarizadeh; Minoo Sadri*

Department of Biochemistry and Biophysics, Education and Research Center of Science and Biotechnology, Malek Ashtar University of Technology, Tehran, Iran

ABSTRACT

Objective(s): Natural and artificial enzymes have shown important roles in biotechnological processes. Recently, design and synthesis of artificial enzymes especially peroxidase mimics has been interested by many researchers. Due to disadvantages of natural peroxidases, there is a desirable reason of current research interest in artificial peroxidase mimics.

Methods: In this study, magnetic multiwall carbon nanotubes with a structure of Fe_3O_4/MWCNTs as enzyme mimetic were fabricated using in situ co-precipitation method. The structure, composition, and morphology of Fe_3O_4/MWCNTs nanocomposite were characterized using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), and transmission electron microscopy (TEM). The magnetic properties were investigated by the vibrating sample magnetometer (VSM). Peroxidase-like catalytic activity of nanocomposite was investigated using colorimetric and electrochemical tests with 3,3′,5,5′-tetramethylbenzidine (TMB) substrate.

Results: The obtained data proved the synthesis of Fe_3O_4/MWCNTs nanocomposite. The average crystallite size of nanostructures was estimated about 12 nm by Debye–Scherer equation. It was found that Fe_3O_4/MWCNTs nanocomposite exhibit peroxidase-like activity. Colorimetric and electrochemical data demonstrated that prepared nanocomplex has higher catalytic activity toward H_2O_2 than pure MWCNT nanocatalyst. From electrochemical tests concluded that the Fe_3O_4/MWCNTs electrode exhibited the better redox response to H_2O_2, which is ~ 2 times larger than that of the MWCNTs.

Conclusions: The synthesis of Fe3O4 nanoparticles on MWCNTs was successfully performed by in situ co-precipitation process. Fe_3O_4/MWCNTs nanocatalyst exhibited a good peroxidase-like activity. These biomimetic catalysts have some advantages such as simplicity, stability and cost effectiveness that can be used in the design of enzyme-based devices for various applied fields.

Supplementary Information

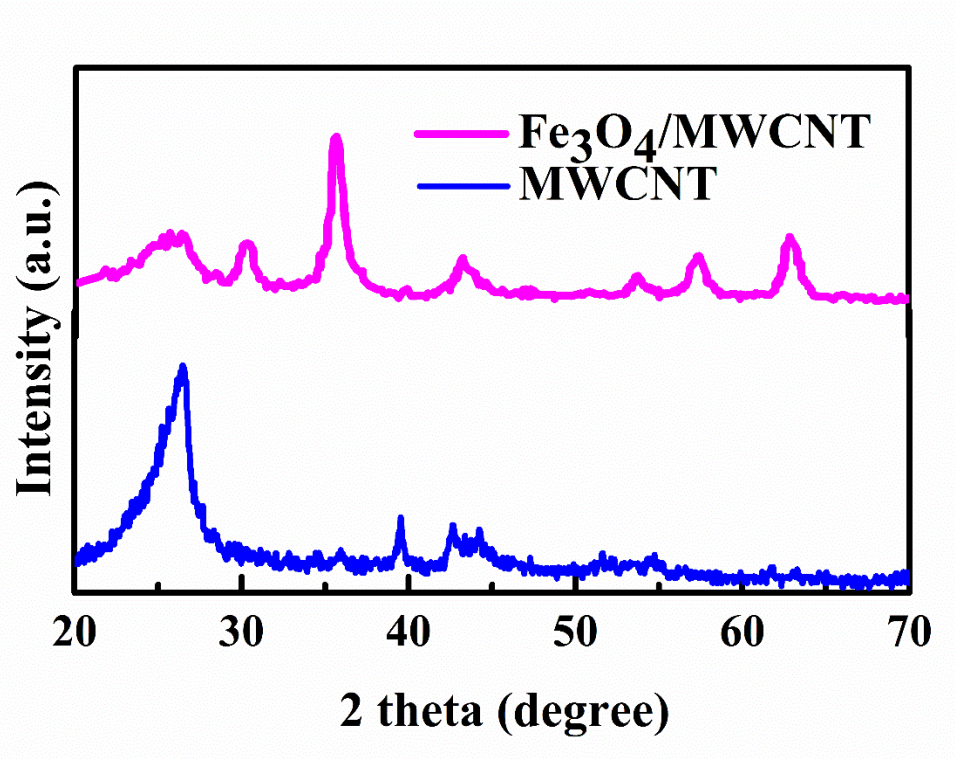

Fig. 1s. XRD patterns of Fe_3O_4/MWCNTs and MWCNTs

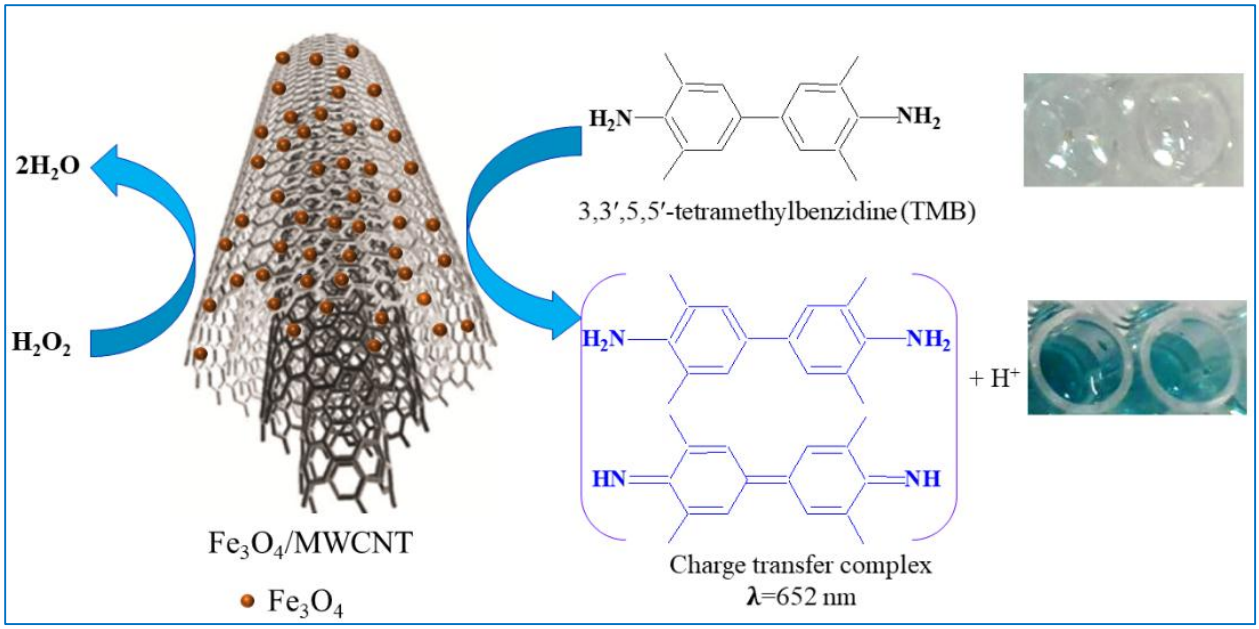

Fig. 5s. A Schematic diagram of catalyzed reaction by Fe_3O_4–MWCNTs nanocomposite in the presence of *TMB* and H_2O_2 substrates.

Fig. 6s. Colorimetric investigations of different concentrations from substrates (TMB and H_2O_2) (low concentrations to high concentrations: from left to right) using Fe_3O_4/MWCNTs