Environmental Science and Pollution Research (2021) 28:5430–5442
https://doi.org/10.1007/s11356-020-10820-1

RESEARCH ARTICLE

Rapid photodegradation and detection of zolpidem over β-$SnWO_4$ and α-$SnWO_4$ nanoparticles: optimization and mechanism

Somayeh Mirsadeghi[1] · Hamed Zandavar[2] · Hamed Farhad Tooski[2] · Mostafa Rahimi[2] · Esmail Sohouli[3] · Mehdi Rahimi-Nasrabadi[4,5] · Mohammad Reza Ganjali[6,7] · Seied Mahdi Pourmortazavi[2]

Received: 10 June 2020 / Accepted: 10 September 2020 / Published online: 23 September 2020

Abstract

We reported the tin (II) tungstate nanoparticles as the photocatalyst and sensor modifier that were synthesized via chemical precipitation reaction and optimized thru the Taguchi design method. The method predicted the best synthesis conditions that led to smaller particles and desired morphologies. Different techniques were used to characterize the chemical structure, morphology, and purity of the nanoparticles. The photocatalytic behavior of different crystalline forms of the $SnWO_4$ nanoparticles (α and β) was considered by photodegradation of methylene orange and zolpidem under UV light irradiation, while the average size of β-$SnWO_4$ and α-$SnWO_4$ nanoparticles prepared in optimum conditions is about 17 nm and 20 nm, respectively. Efficiencies of degradation of methyl orange and zolpidem on β-$SnWO_4$, in the presence of UV irradiation, were 93% and 98% and in the presence of α-$SnWO_4$ were 73% and 82% after 2100 s, respectively. Voltammetric sensing of zolpidem was designed by modification of carbon paste electrode via β-$SnWO_4$ nanoparticles and investigated for determination of the drug in aqueous solution.

Keywords Tin (II) tungstate nanoparticles · Crystalline form · Photocatalyst · Voltammetric sensing · Taguchi design method · Zolpidem

Introduction

Multi-metal oxide semiconductors have a unique crystal structure and attractive properties compared with traditional metal oxides. These properties made them highly relevant for photocatalytic research. Tin tungstate ($SnWO_4$) as multi-metal oxide, with incredible physicochemical properties, has excellent potential in the use of solar energy, decontamination of waste, etc. (Liu et al. 2017; Raj et al. 2016; Warmuth and Feldmann 2019; Zhang et al. 2018; Zhu et al. 2017).

Tin tungstate with two distinct phases, α-$SnWO_4$ at low temperatures and β-$SnWO_4$ at high temperatures, is a multi-

Responsible Editor: Sami Rtimi

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s11356-020-10820-1) contains supplementary material, which is available to authorized users.

✉ Somayeh Mirsadeghi
sshmirsadeghi@sina.tums.ac.ir

✉ Seied Mahdi Pourmortazavi
pourmortazavi@yahoo.com; pourmotazavi@mut.ir

[1] Endocrinology and Metabolism Research Center, Endocrinology and Metabolism Clinical Sciences Institute, Tehran University of Medical Sciences, Tehran 1411713137, Iran

[2] Faculty of Chemistry and Chemical Engineering, Malek Ashtar University of Technology, P.O. Box 16765-3454, Tehran, Iran

[3] Young Researchers and Elites Club, Science and Research Branch, Islamic Azad University, Tehran, Iran

[4] Chemical Injuries Research Center, Baqiyatallah University of Medical Sciences, Tehran, Iran

[5] Faculty of Pharmacy, Baqiyatallah University of Medical Sciences, Tehran, Iran

[6] Center of Excellence in Electrochemistry, Faculty of Chemistry, University of Tehran, Tehran, Iran

[7] Biosensor Research Center, Endocrinology & Metabolism Molecular-Cellular Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran