Characterization of plasmon and photothermal properties of CuS nanoparticles biorecovered from acid mine drainage

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Introduction

Copper sulfides nanoparticles (CuS) are p-type semiconductor with high availability and low-toxic nature which have emerged as therapeutic agents for biomedical applications due to its surface plasmon resonance (SPR) in the near-infrared range (NIR) and photothermal effects [1-3]. Typical synthesis methods of CuS nanoparticles are chemical techniques such as solvothermal and hydrothermal process. In the presented work, CuS nanoparticles were recovered from a real acid mine drainage by using sulfidogenic bioreactor. The use of sulfidogenic bioreactor is an alternative biotechnology with high ecological and economical impact for the remediation and recycle of metal content in mines wastewaters [4]. The main physico-chemical properties of these CuS nanoparticles were studied, showing plasmon resonance absorption in the NIR and photothermal effect, opening the way to use them as therapeutic agents.

Result

CuS nanoparticles recovered from mine wastewater were characterized by SEM, XRD, UV-vis-NIR spectroscopy and XPS. Morphological characterization showed like-spherical nanoparticles with a mean diameter of 40 $\pm$ 8 nm. Fig 1a shows the XRD pattern which perfectly matches with hexagonal covellite structure. UV-vis-NIR absorption spectrum allows to analyze the semiconductor behavior and the SPR. The band gap was estimated by Tauc plot method as 2.39 eV (Fig. 1b) and the SPR absorption peak in the NIR range was located at 980 nm of wavelength (Fig. 1c). Moreover, the photothermal effect was explored by using a laser beam of 970 nm and 0,1 W/cm^2 of power. Fig 1d shows the temperature profile in water with and without CuS nanoparticles. It can be clearly observed that CuS nanoparticles allow to increase the temperature of the water due to its photothermal capacity.

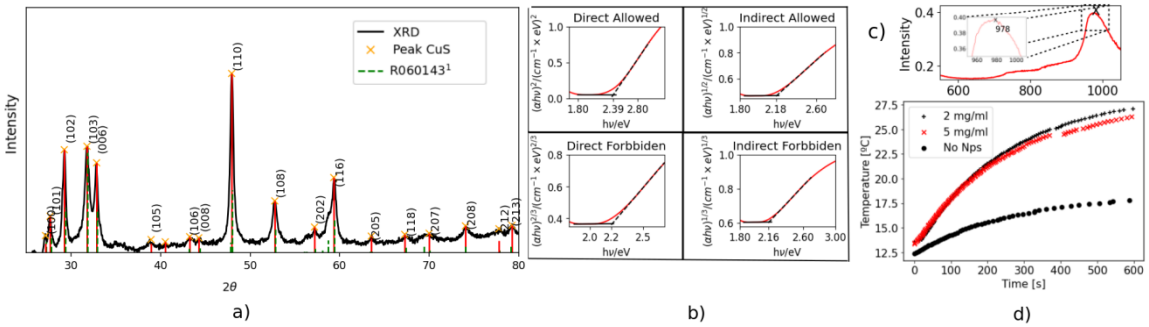

Fig.1: a) XRD pattern, b) Tauc plots, c) UV-vis-NIR spectrum, d) Temperature profile of CuS nanoparticles.

References

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