External Magnetic Field Enhanced Plasmonic Au-WO3 Thin Films for Photoelectrochemical Water Splitting

Alangari, Saleh (School: Riyadh School for Boys and Girls)

In the evolving world of sustainable energy, hydrogen production by photoelectrochemical (PEC) water splitting stands out as a highly promising approach. Yet, challenges like limited light absorption and complex electron flow management often prevent achieving maximum efficiency. In this study, these challenges are addressed through two key aspects. The first is the plasmonic phenomenon, which significantly enhances light absorption by localized surface plasmon resonance (LSPR). This electromagnetic mode arises from the interaction between the free electrons of gold and light photons, forming an efficient light-harvesting mechanism. Furthermore, a crucial element is applying an external magnetic field that exerts a substantial influence on the behavior of electrons. The magnetic field applies the Lorentz force, which organizes the electron spin and significantly reduces recombination rates. The hypothesis of this research is that integrating an external magnetic field with the plasmonic effects in PEC systems will significantly enhance light absorption, optimize electron spin, and consequently elevate hydrogen production. Experiments were conducted on two sets of FTO glass substrates: one with WO3 deposited first, then gold nanoparticles coated on top, and the other in reverse order. Significantly, in comparison with pure WO3, the Tauc plot confirmed a decreased band gap in WO3-Au thin films, from 2.75 eV to 2.59 eV, markedly enhancing light absorption capabilities. When subjected to a magnetic field, LSV measurements demonstrated that the stable WO3-Au thin films exhibited double the efficiency compared to pure WO3. This approach aims to overcome existing barriers and boost the efficiency of PEC systems.