ABSTRACT (Anglais)

Hydrogen is an energy carrier that has already demonstrated its ability to replace oil as a fuel. However, the means of production currently used remain highly emitting greenhouse gases. Photo-electrolysis of water is a process that uses solar energy to separate the elemental compounds of water such as hydrogen and oxygen using a semiconductor with adequate physical properties. Hematite (α-Fe_2O_3) is a promising material for this application because of its chemical stability and ability to absorb a significant portion of light (with a band-gap between 2.0 - 2.2 eV). Despite these advantageous properties, there are intrinsic limitations to the use of iron oxide for the photoelectrochemical cracking of water. The first constraint is the position of its conduction band, which is lower than the water reduction potential. This constraint can be overcome by the addition in series of a second material, in tandem, which will absorb a complementary part of the solar spectrum and bring the electrons to a higher energy level than the potential of hydrogen release. The second obstacle comes from the disagreement between the short diffusion length of the charge carriers and the long light penetration depth. It is therefore necessary to control the morphology of the hematite electrodes on a scale of similar size to the transport length of the hole.

In this thesis a new concept is introduced to improve the photoelectrochemical performances. Using the hydrothermal method we deposited thin layers of Cr-doped hematite on conductive glass substrates. We also electrochemically prepared a p-CuSCN / n-Fe_2O_3 heterojunction by sequentially depositing α-Fe_2O_3 and CuSCN films on FTO (SnO_2: F) substrates. Finally, we have used uniform and dense thin layers of iron oxide (α-Fe_2O_3) as an electron transport layer (ETL) in place of titanium dioxide (TiO_2) conventionally used in photovoltaic cells based on perovskites $CH_3NH_3PbI_3$ (PSC). This latter concept showed a 20% increase of the photocurrent and an IPCE 30 times greater than the simple hematite, suggesting better conversion of high wavelengths (> 500 nm).

Keywords:

Photoelectrochemistry, Water Splitting, Hydrogen Production, Oxygen Evolution, Metal-Oxide Semiconductors, Hematite, Iron Oxide, Nanostructures, Surface.