Epitaxial $CuFeO_2$ Thin Film as Photoelectrode for Solar Water Splitting Cell

Sijun Luo, Post-doctoral Research Associate

Molecular Photoconversion Devices Research Division, I^2CNER, Kyushu University

Abstract:

Photoelectrochemical (PEC) water splitting is a promising technique to convert solar energy and water into a storable and transportable chemical energy (H_2). $Cu^{+1}Fe^{+3}O_2$ is believed to be a promising p-type semiconductor as photocathode in solar water splitting cell for hydrogen production due to its optimal characteristics such as suitable band gap (~1.5eV), optimal band alignment of conduction band edge and hydrogen evolution potential, and good stability in aqueous environment. In order to find out the surface terminates dependent PEC properties, it needs to grow epitaxial $CuFeO_2$ thin films with a particular crystallographic orientation. However, growing high quality and pure phase epitaxial $CuFeO_2$ thin film has been a significant challenge because $CuFeO_2$ is a metastable phase in which Cu has a valence of +1 and it is very easy to be oxidized into +2 oxidation state. This work is to first find out the optimal deposition parameters for growing high quality and pure phase epitaxial $CuFeO_2$ thin film on (0001) sapphire substrate by pulsed laser deposition and then to try growing epitaxial $CuFeO_2$ thin film on conductive (100) Nb-$SrTiO_3$ substrate for PEC testing. The high temperature and low oxygen partial pressure are required to obtain high quality and pure phase epitaxial (0001) $CuFeO_2$ thin film on (0001) sapphire. The epitaxial (0001) $CuFeO_2$ thin film grown on (100) Nb-$SrTiO_3$ substrate shows efficient PEC response as photocathode for solar water splitting. The future direction of this work is also discussed.

References

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