Oxide thin-films for protection and functionalization of photocathodes in tandem water-splitting devices.

Peter C. K. Vesborg, Brian Seger, Ib Chorkendorff, Ole Hansen

Many light-harvesting semiconductors with good optical end electronic properties cannot be directly used in PEC water-splitting systems due to poor stability under working conditions. In recent years there has been a large interest in protecting sensitive absorber materials such as silicon or Cu2O [1-3] with thin films of highly stable oxides such as TiO2 and similar materials.

We show that such oxides can be deposited so that they provide month-long stability under continuous PEC operation on sensitive absorbers in corrosive electrolytes. We also show, that since electrons may transport through such oxides via the conduction band, they can be made thick (> 100 nm) and thus very durable without causing problematic voltage loss. Finally we show that the oxides may serve a double purpose of simultaneously providing corrosion protection and screening the semiconductor from the electrolyte while setting up a space-charge region in the underlying semiconductor to facilitate electron-hole separation paving the way for high open-circuit voltage photoelectrodes.

REF:
[1]
Hydrogen Production Using a Molybdenum Sulfide Catalyst on a Titanium-Protected n+p-Silicon Photocathode,
Brian Seger, Anders B. Laursen, Peter C. K. Vesborg, Thomas Pedersen, Ole Hansen, Søren Dahl, Ib Chorkendorff,
Angewandte Chemie International Edition, Volume 51, Issue 36, pages 9128–9131, September 3, 2012, DOI: 10.1002/anie.201203585
[2]
Using TiO2 as a Conductive Protective Layer for Photocathodic H2 Evolution,
Brian Seger, Thomas Pedersen, Anders B. Laursen, Peter C. K. Vesborg, Ole Hansen, and Ib Chorkendorff
J. Am. Chem. Soc., 2013, 135 (3), pp 1057–1064
DOI: 10.1021/ja309523t
[3]
Highly active oxide photocathode for photoelectrochemical water reduction,
Adriana Paracchino, Vincent Laporte, Kevin Sivula, Michael Grätzel and Elijah Thimsen
Nature Materials 10, 456–461 (2011) doi:10.1038/nmat3017