Nitrogen Doping of Reactively-Sputtered Tungsten Oxide Films for Photoelectrochemical Applications

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Reactively-sputtered tungsten trioxide (WO_3) thin films are being developed at the University of Hawaii (UH) specifically for use in “hybrid photoelectrodes”, which are integrated photoelectrochemical/solid-state devices for direct solar water splitting. A key issue in the development of these films is the optimization of the IPCE, which is limited by the high bandgap of WO3. One promising optimization pathway being investigated relies on bandgap lowering of the films through nitrogen doping. The doping technique is a straightforward extension of the reactive-sputtering process in which metered amounts of nitrogen-containing gas are introduced along with the inert argon and reactive oxygen. Through nitrogen doping, modified WO_3 films have been deposited with measured optical bandgaps ranging from 3.0 eV down to 2.1 eV. In this paper, the mechanisms of bandgap lowering are discussed, the effects of using ammonia versus pure nitrogen as the doping agent are described, and the implications of nitrogen-doped WO_3 films for use in photoelectrochemical water splitting devices are presented.