UNDERSTANDING THE PHOTOELECTROCHEMICAL PROPERTIES OF SPINEL-TYPE p-CoM_2O_4 (M: Al, Ga, AND In) COMPOUNDS

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Transition metal oxide-based photoelectrochemical (PEC) splitting of water has attracted wide interest since the discovery of photoinduced decomposition of water on TiO_2 electrodes. To date, most investigations have focused on n-type materials such as TiO_2, ZnO, WO_3 and Fe_2O_3. For spontaneous water splitting, the use of both n-type and p-type semiconductors is desirable, because hydrogen is evolved from the p-type electrode and oxygen is evolved from the n-type electrode. However, most p-type materials developed so far (e.g., Cu_2O, CdSe, MoS_2) are too weak against photocorrosion. There is thus a great need to develop stable p-type oxides for PEC applications.

We have recently investigated experimentally and theoretically cobalt containing spinel oxides as promising p-type candidates for PEC water splitting. We have synthesized different spinel CoM_2O_4 (M: Al, Ga, and In) oxide thin films using reactive RF magnetron co-sputtering. In addition, we have prepared nanoporous $CoAl_2O_4$ electrodes and $CoAl_2O_4$ and Fe_2O_3 nanocomposite electrodes. The effects of doping in nanoporous $CoAl_2O_4$ electrodes have also been studied. First-principles theory was utilized to guide the synthesis and interpret the experimentally observed phenomena. In this talk, we will present our understanding of the PEC properties and stability of this series of unconventional spinel CoM_2O_4 (M: Al, Ga, and In) oxides.