High Surface Area Transparent Conductive Oxide as Effective Scaffolds for Nanostructured Metal Oxide Photoelectrochemical Electrodes

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High surface area electrodes (HSEs) offer an ability to control the interfacial area and increase utilization of the active materials, which are the key parameters for boosting device performance. Transparent conductive oxide (TCO) HSEs substrates serve as broadly applicable platform for functionalization in many applications. In this work, we have developed optically transparent, electrochemically stable, and physically robust indium tin oxide (ITO) HSE substrates with tunable pore sizes for photoelectrochemical (PEC) water splitting application.

PEC cells perform photoelectrolysis of water and directly convert solar energy to hydrogen, which is an energy carrier molecule and a renewable fuel. The challenges in the field lie on developing photoelectrode materials that offer high optical density, efficient charge transfer, great stability in harsh operating conditions, and scalable opportunities. Many metal oxides are very attractive candidates for this application because generally, they are chemically stable, non-toxic, abundant, and low-cost. However, most metal oxides suffer from poor charge transport, which majorly limits the charge collection efficiency of the electrodes. One promising approach to solve this fundamental problem is to integrate metal oxide absorbers to electrically conductive and transparent scaffolds. The HSE substrate allows the device to maintain short carrier path lengths while boosting device optical density. With facile deposition techniques, we demonstrate efficient and low-cost productions of high surface area metal oxide electrodes for solar water splitting.