PHOTOELECTROCATALYTIC MICROREACTOR FOR SEAWATER DECONTAMINATION WITH NEGLIGIBLE CHLORINE GENERATION

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Decontamination of seawater is of particular importance for the waste seawater treatment before its drainage. However, some mature methods to clean waste fresh water cannot be employed to treat waste seawater due to its high salt concentration.[1],[2] Besides, excessive chlorine generation during the seawater decontamination process is toxic for sea creatures. In this work, a microfluidic reactor is designed and fabricated to enable the photoelectrocatalytic effect for highly-efficient seawater decontamination with negligible chlorine production.

Figure 1(a) shows the 3D schematic diagram of the photoelectrocatalytic microreactor. The fabricated microreactor consists of three layers: a blank indium tin oxide glass (ITO) slide, another ITO glass slide coated with the $BiVO_4$ nanoporous film, and an epoxy layer with a planar reaction chamber. [3] Figure 1(b) shows the cross section of the PEC microreactor. The external bias can help the recombination of the electrons and holes and force them to migrate to different directions.

Figure 2 presents the morphology and microstructure of the BVO samples, which are investigated by scanning electron microscopy. As shown in the SEM photo, the BVO film exhibits porous structure. The nanosized particles are with an average size of about 80-100 nm and the thickness of the film is about 1.5 μm.

Figure 3 shows the influence of two different electrolyte (NaCl and Na_2SO_4) in the experiment. Different bias potentials are applied across the reaction chamber to decompose the methylene blue in the saline water. With the bias of ±1.8 V, the results of the degradation rate are nearly the same. Therefore, the generated chlorine is negligible with bias up to 1.8 V.

Figure 4 shows the IV curves of the above two different electrolytes They are smooth and present no obvious redox peaks below 1.5 V. As the electrical potential of generating chlorine (1.36 V), from the curves, we can see there may be no significant generation of chlorine in this reaction system, though the exact amount of chlorine cannot be quantified using this method.

In summary, the high decontamination efficiency and elimination of chlorine generation suggest that the photoelectrocatalytic microreactor device has high potential to be scaled up for industrial applications. This also provides us an ideal platform to study the underling mechanisms and kinetics of seawater decontamination.

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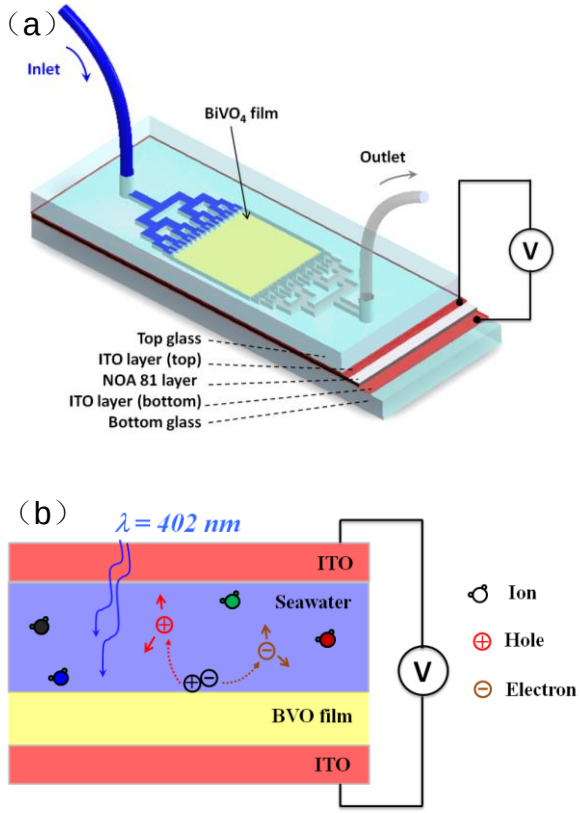

Fig.1（a）Schematic diagram of the microfluidic planar reactor and structures of the catalyst film and the tree-shaped microchannels for inlet and outlet.（b）the cross section of the PEC microreactor.

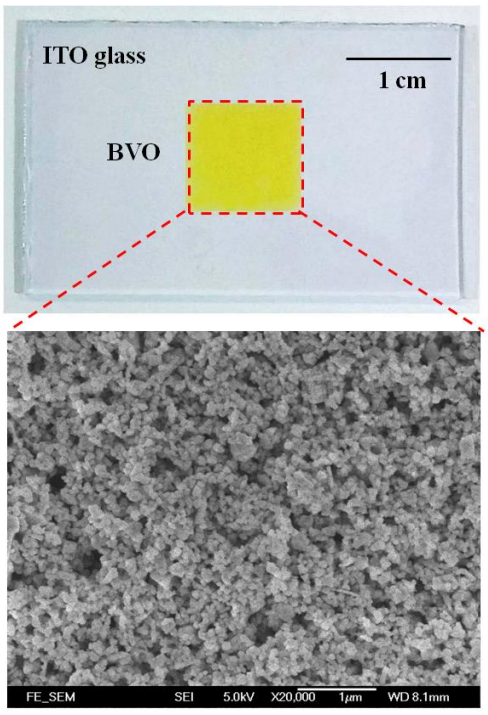

Fig. 2 The upper panel: the $BiVO_4$ film on the ITO glass slide. The lower panel: SEM photo of the $BiVO_4$ film, which shows the nanoporous structure.

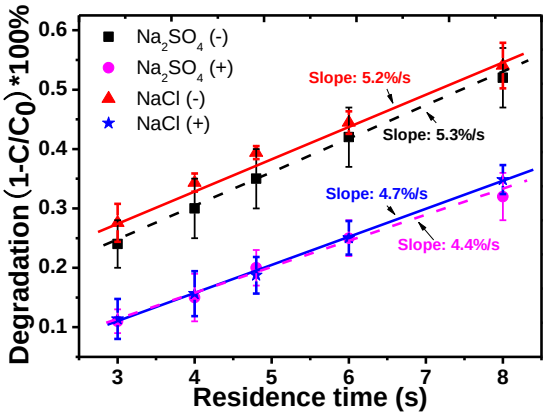

Fig. 3 Influence of the flow rate on the degradation efficiency of microreactor under ±1.8 V external bias by using NaCl (solid lines) and Na_2SO_4 (dash lines) as the electrolyte.

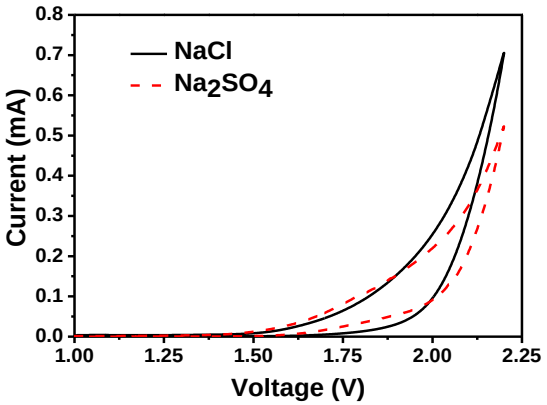

Fig. 4 IV curves of electrolysis by using Na_2SO_4 and NaCl as the electrolytes. (working electrode: ITO, counter electrode: $BiVO_4$ film, reference electrode: calomel)

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