Photocatalytic water-splitting and simultaneous gas segregation from dual-sided photocatalytic membrane.

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It is now well understood that efficient solar fuel technologies require increasingly robust semiconductor systems that are capable of generating the necessary photovoltages for transformation of precursors like H_2O and CO_2 into valuable chemicals such as hydrogen and methanol. Heterostructured membranes and co-catalyst systems have shown the most promise in this respect. Also, the separation of H_2 and O_2 becomes a significant safety and efficiency concern in water splitting, if these gases are to be stored and used later for hydrogen fuel cell operation.

CdTe and WO_3 are both capable of utilizing the Sun's abundant insolation. Electrodeposition of thin films of both semiconductors has been performed on either side of a flexible stainless steel substrate (Figure 1); after specific heat treatments, the perforations in the stainless steel plates were filled with Nafion®, to allow for a sustainable electrolyte pH gradient in each half-cell. Utilizing a 1000 W Xe arc lamp to illuminate both sides, unassisted water-splitting in 0.1 M H_2SO_4 was achieved, producing H_2 on the CdTe photocathode, and the WO_3 photoanode producing O_2. Typical gas product yields measured using an Inficon GCMS leak detector showed 44 ppm cm^{-2} H_2 and 39 ppm cm^{-2} O_2. The unexpectedly higher O_2 content was thought to be due to contamination from air. Our current research efforts are to calibrate a self-purging continuous argon flow system. The semiconductors are also being characterized using SEM-EDX, XRD and cyclic voltammetry.

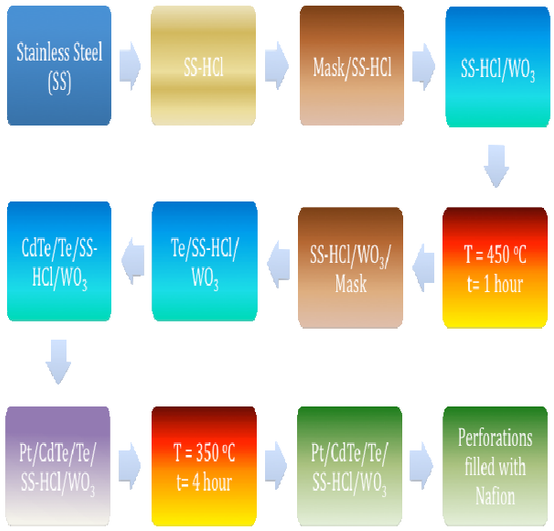

Figure 1. Process fabrication diagram for dual-sided photocatalytic membrane.