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Reliable utilization of solar power on a large scale requires affordable energy storage technology, cheaper than batteries, in order to synchronize the variable power production with the changing demand. Likewise, there is a need for renewable fuels to replace fossil fuels. These challenges can be achieved, potentially, by splitting water into hydrogen and oxygen, $H_2O \rightarrow H_2 + \frac{1}{2}O_2$, using solar power to drive this endergonic reaction uphill. The hydrogen can be stored and converted to electricity and heat on demand. Alternatively, it may serve as feedstock for the production of liquid fuels for transportation by reaction with CO_2, paving the road to carbon-neutral synthetic fuels, so-called solar fuels. The first and foremost challenge toward this ambitious goal is the development of chemically stable, efficient and affordable photoelectrodes for water splitting.

Photoelectrodes for solar-powered water splitting must employ a semiconductor material with exceptional stability against corrosion, as well as visible-light absorption. On top of that, it should also be abundant, inexpensive and non-toxic. Iron oxide (α-Fe_2O_3, hematite) is one of few materials meeting these criteria, but its poor transport properties and ultrafast charge carrier recombination present a challenge for efficient charge carrier generation, separation and collection.

We explore an innovative solution to this challenge using ultrathin (20-30 nm) quarter-wave films on back reflector substrates. This simple optical cavity design effectively traps the light in otherwise nearly translucent films, amplifying the intensity close to the surface wherein photogenerated charge carriers can reach the surface and split water before recombination takes place. This is the enabling key towards the development of high efficiency photoelectrodes that could potentially lead to affordable solar energy storage and solar fuel production.

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