Abstract Submitted
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High photoactivity in ultrathin as-grown hematite films prepared by atomic layer deposition[1] JEFFREY KLUG, NICHOLAS BECKER, SHANNON RIHA, ALEX MARTINSON, JEFFREY ELAM, MICHAEL PELLIN, THOMAS PROSLIER, Argonne National Laboratory — Nanostructured hematite (α-Fe_2O_3) has been widely studied for use in a variety of thin film applications including solar energy conversion, water oxidation, catalysis, and gas sensing. Among established deposition methods, atomic layer deposition (ALD) is a leading technique for large-scale, controlled synthesis of a wide range of nanostructured materials. In this work, ALD of Fe_2O_3 is demonstrated using $FeCl_3$ and H_2O precursors at growth temperatures between $200 - 350°C$. Self-limiting growth of Fe_2O_3 is observed with a growth rate of ~ 0.06 nm/cycle. As-deposited, films are nanocrystalline with low Cl impurities and a mixture of α- and γ-Fe_2O_3. Post-deposition annealing in O_2 leads to phase-pure hematite with increased out-of-plane grain size. Photoelectrochemical measurements under simulated solar illumination reveal high photoactivity toward water oxidation in both as-deposited and post-annealed films. Planar films deposited at low temperature (235°C) exhibit remarkably high photocurrent densities ~ 0.71 mA/cm^2 at 1.53 V vs. the reversible hydrogen electrode (RHE) without further processing. Films annealed in air at 500°C show current densities of up to 0.84 mA/cm^2 (1.53V vs. RHE).

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