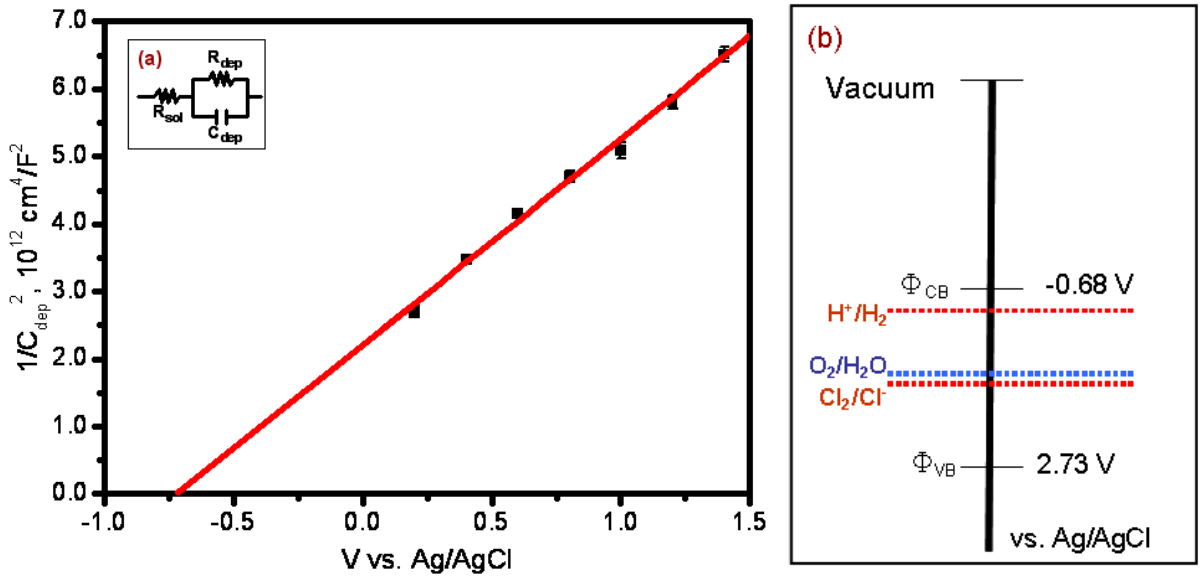
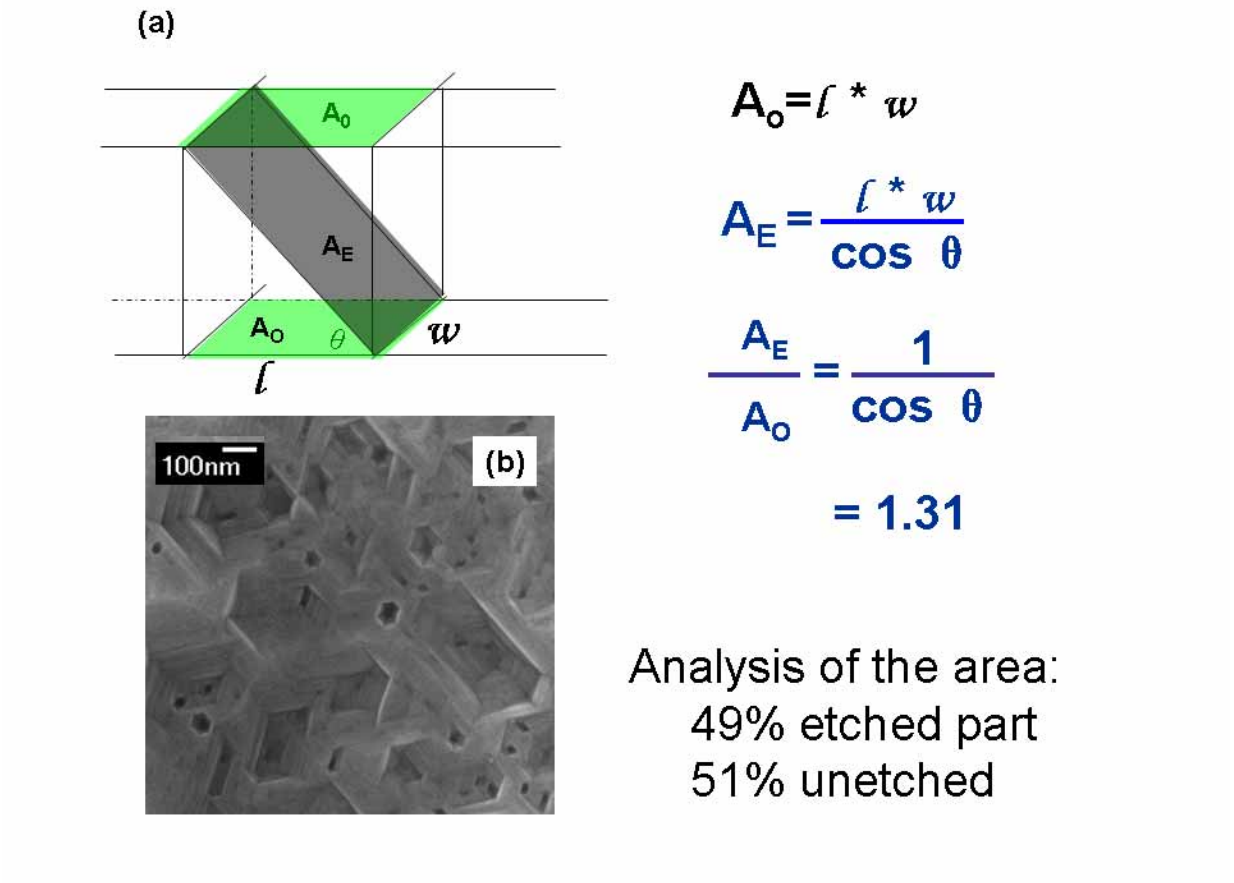
Supplementary Information – Further Experimental Details

Assessment of the suitability of GaN thin film for solar hydrogen gas production was conducted through the determination of its Mott-Schottky plot. The flat band and the corresponding conduction and valence band edges straddle the hydrogen, oxygen, and chlorine band potentials, indicating the capacity of the material for solar hydrogen gas and chlorine gas production.

S1. **(a)** Mott-Schottky plot obtained from the capacitive data derived from impedance fitting (Inset: equivalent circuit used, where R_{sol} is the solution resistance, R_{dep} is the resistance of the GaN film depletion layer and C_{dep} is the capacitance of the depletion layer.) **(b)** The band edge potentials of commercial GaN thin film, where Φ_{CB} is the conduction band, Φ_{VB} is the valence band, versus Ag/AgCl reference electrode in 1.0 M HCl solution. The approximate relative positions of the hydrogen gas, oxygen gas, and chlorine gas evolution potentials are also plotted.



S2. Estimation of the surface area increase after etching. (a) The increase in surface area was evaluated by calculating the ratio of the etched area, A_E compared to the original area, A_o. Since crystallographic etching of GaN thin film produces the specific crystallographic facets $\{10-1-2\}$ and $\{10-1-3\}$, the angle θ between the etched and c-planes may be estimated as 40^o. The resulting increase in surface area for every etched part is about 30%. (b) The extent of surface that was etched was geometrically determined. The net increase in surface area is the product of these two factors (a) and (b), which is about 15%.



S3. Schematic diagram of the photoelectrochemical cell to allow the generation and collection of gases.