

Supplemental Information

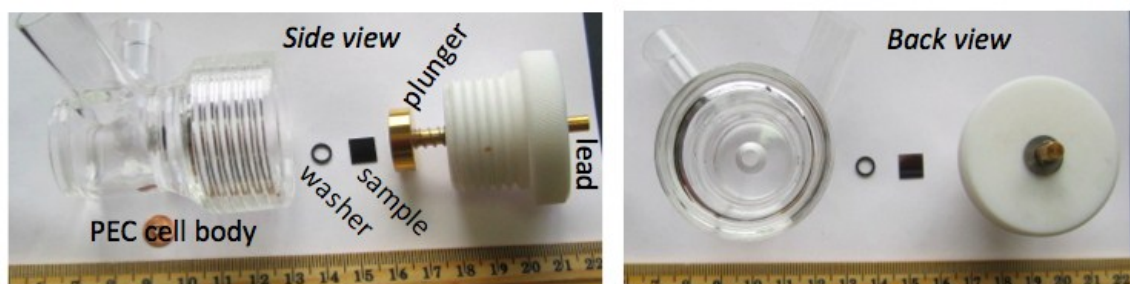


Fig. S1 PEC compression cell

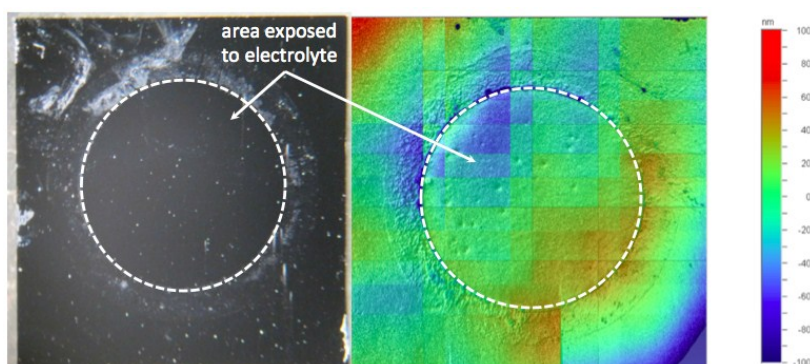


Fig. S2 Stereo microscope image (left) and optical profilometry (right) of p-GaAs after 96 hours in 3M sulfuric acid at open circuit. The area exposed to the electrolyte is enclosed by the dashed white circle.

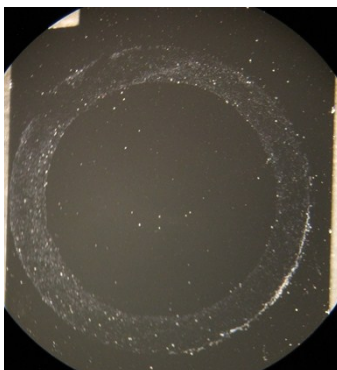


Fig. S3: Stereo microscope image of sample after 24 hours durability test showing a specular surface without any observable corrosion features.

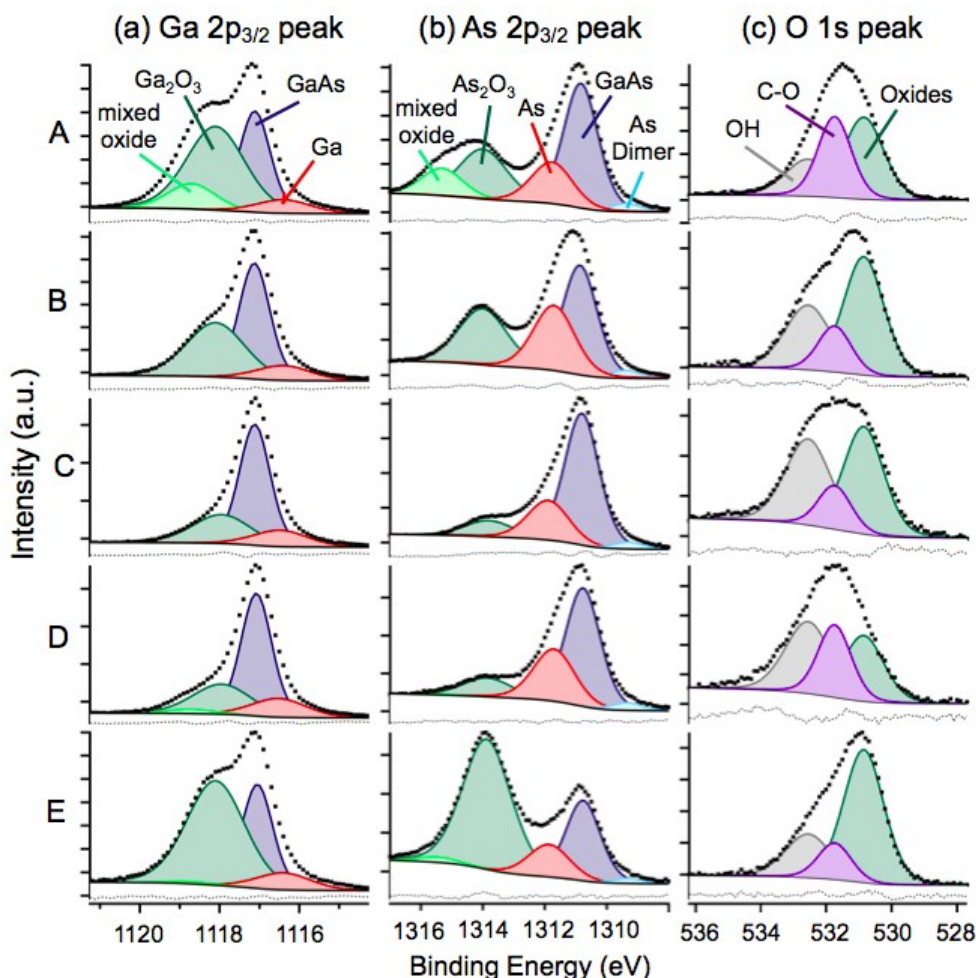


Fig. S4 Full XPS spectra of the (a) Ga 2p_{3/2} (b) As 2p_{3/2} and (c) O 1s peaks are shown in three columns with the curve fitting and feature assignments. The five rows, labeled A-E, correspond to samples A (solvent wash), B (1 hr electrolyte soak), C (1 hr durability test), D (24 hr durability test), and E (96 hr durability test).

Additional description for Figure S4: Four Ga peaks were included in the model, corresponding to elemental Ga (1116.4 eV), GaAs lattice (1117.1 eV), Ga₂O₃ (1118.0 eV), and a mixed oxide (1118.7 eV) [1]. The As 2p_{3/2} spectra are fit with five peaks including As dimers (1321.3 eV), lattice As (1322.7 eV), As⁰ (1323.7 eV), As₂O₃ (1325.8 eV) and a mixed oxide (1327.2 eV). The As 2p_{3/2} peak near (1321.3 eV) is tentatively assigned to As surface dimers following similar As 3d spectral features. The mixed oxide Ga 2p_{3/2} peak (1118.7 eV) and As 2p_{3/2} peak (1327.2 eV) are native oxide, which is removed once soaked in the electrolyte. The O 1s spectra are fit using three peaks assigned to surface oxides (530.9 eV), C-O bonds (531.7 eV), and hydroxyl groups (532.6 eV) [2]. Surface oxide contributions to the O 1s spectral regions are observed to trend with the Ga₂O₃ and As₂O₃ in the Ga 2p_{3/2} and As 2p_{3/2} regions respectively. The C-O and O-H peaks are observed to increase and decrease with the total carbon content indicating that these are due to residual surfactant Triton X-100, which has both C-O bonds and hydroxyls (product information sheet for Triton X-100 available at Sigma: https://www.sigmaaldrich.com/content/dam/sigmaaldrich/docs/Sigma/Product_Information_Sheet/1/t8532pis.pdf).

Table S1: GaAs surface composition determined by XPS. Relative peak areas reported for each spectral region.

XPS region	Ga 2p _{3/2}				As 2p _{3/2}					O 1s		
Peak assignment	mixed oxide	Ga ₂ O ₃	Lattice GaAs	Elemental Ga	mixed oxide	As ₂ O ₃	Elemental As	Lattice GaAs	As surface dimers	O-H	C-O	Ga and As oxides
Peak energy (eV)	1118.7	1118	1117.1	1116.4	1327.2	1325.8	1323.7	1322.7	1321.3	532.6	531.7	530.9
Solvent wash	12	49	31	7	12	25	17	44	2	22	35	43
1 hr soak	3	39	47	11	0	29	28	40	2	32	17	51
1 hr durability	0	27	59	14	0	11	23	63	2	41	15	44
24 hr durability	3	26	56	15	1	13	28	56	2	39	29	32
96 hr durability	1	59	31	9	1	60	12	26	1	23	14	62

Supplemental Information References

- [1] C. L. Hinkle, M. Milojevic, B. Brennan, a. M. Sonnet, F. S. Aguirre-Tostado, G. J. Hughes, E. M. Vogel, and R. M. Wallace, "Detection of Ga suboxides and their impact on III-V passivation and Fermi-level pinning," *Appl. Phys. Lett.*, vol. 94, no. 16, pp. 1–4, 2009.
- [2] C. D. Wagner, D. A. Zatko, and R. H. Raymond, "Use of the oxygen KLL Auger lines in identification of surface chemical states by electron spectroscopy for chemical analysis," *Anal. Chem.*, vol. 52, no. 9, pp. 1445–1451, 1980.