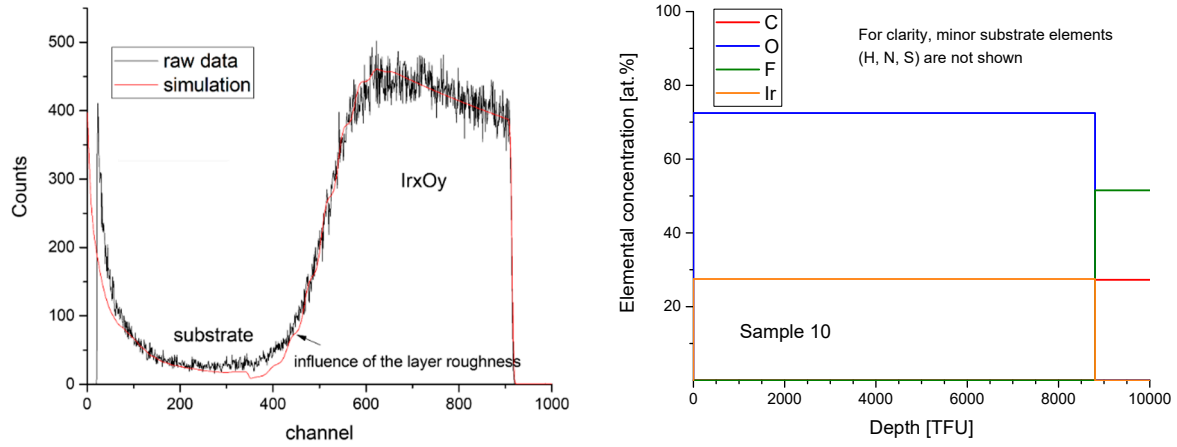
Supporting information

Spark Ablation for the Fabrication of PEM Water Electrolysis Catalyst-Coated Membranes

Foteini M. Sapountzi [1,*], Marek Lavorenti [2,3], Wilbert Vrijburg [4], Sofia Dimitriadou [4], Beata Tyburska-Pueschel [2], Peter Thüne [5], Hans Niemantsverdriet [1], Tobias V. Pfeiffer [4] and Mihalis N. Tsampas [2,*]

[1] Syngaschem BV, Syncat@DIFFER, 5600 HH Eindhoven, The Netherlands
[2] Dutch Institute For Fundamental Energy Research (DIFFER), 5612 AJ Eindhoven, The Netherlands
[3] Department of Chemical Engineering and Chemistry, Eindhoven University of Technology, 5600 MB Eindhoven, The Netherlands
[4] VSPARTICLE BV, 2612 HL Delft, The Netherlands
[5] Fontys University of Applied Sciences, 5612 AP Eindhoven, The Netherlands
* Correspondence: foteini@syngaschem.com (F.M.S.); m.tsampas@differ.nl (M.N.T.)



(a) (b)

Figure S1. (a) RBS raw data (black line) and simulation data (red line) for anode-coated spark ablation CCM. The estimated actual Ir loading of 0.77 mg cm^{-2} ± 3.5 % is in excellent agreement with the nominal (predicted) loading of 0.8 mg cm^{-2} . (b) Elemental concentration in at% for C, O, F, Ir (C and F are attributed to the Nafion membrane, Ir and O to the catalyst layer) versus the film thickness in thin film units (tfu). The IrO_x film has a thickness of 8800 tfu.

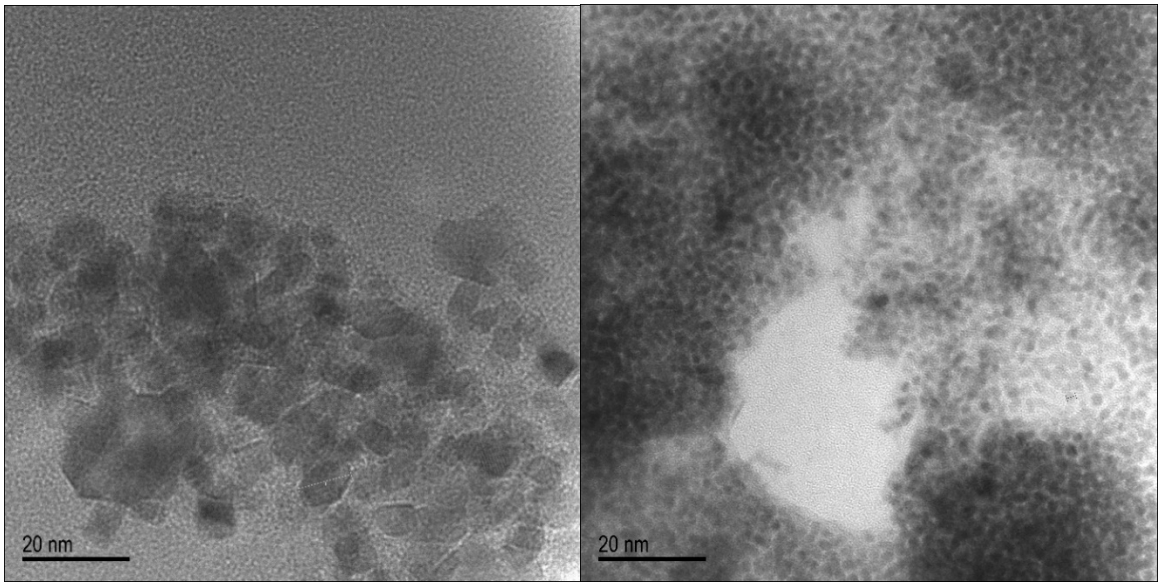


Figure S2. TEM images at 400 k magnification of IrO_x coated Nafion CCMs. Left: commercial CCM; typical grains with diameter of 10 nm are observed. Right: spark ablation CCM; typical grains with 2 nm diameter are observed.

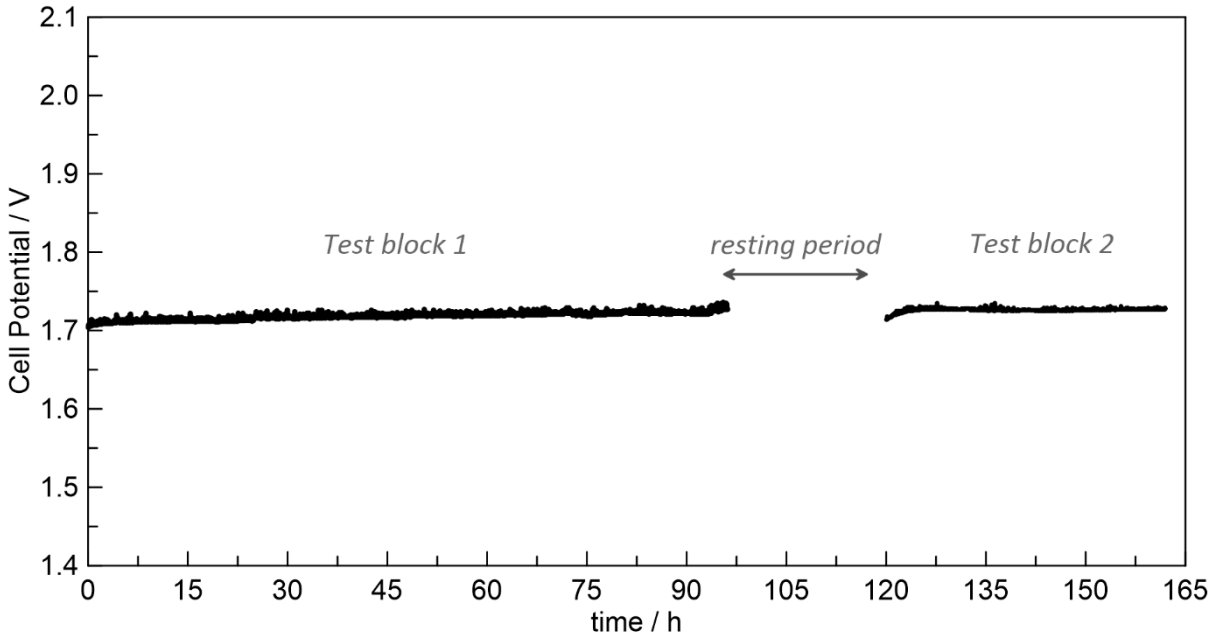


Figure S3. Time evolution of cell potential during two test blocks of constant load (CL) operation at 200 mA cm^{-2} at 60 ºC with a commercial (benchmark) CCM. 2 mg cm^{-2} $IrRuO_x$ coated Nafion 115 interfaced to a Pt/C-cloth (4 mg cm^{-2}).

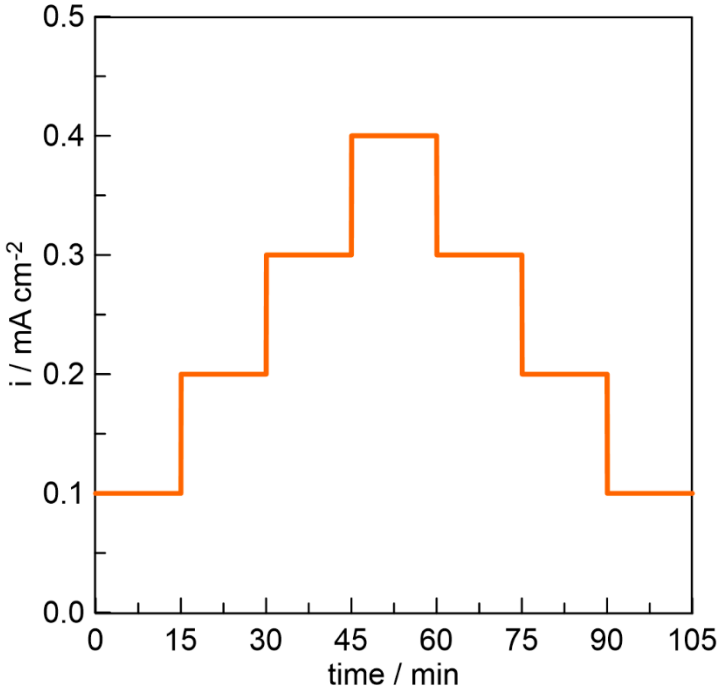


Figure S4. The testing block followed during accelerated stress test (AST). The AST profile consists of successively performing this testing block for 85 times.

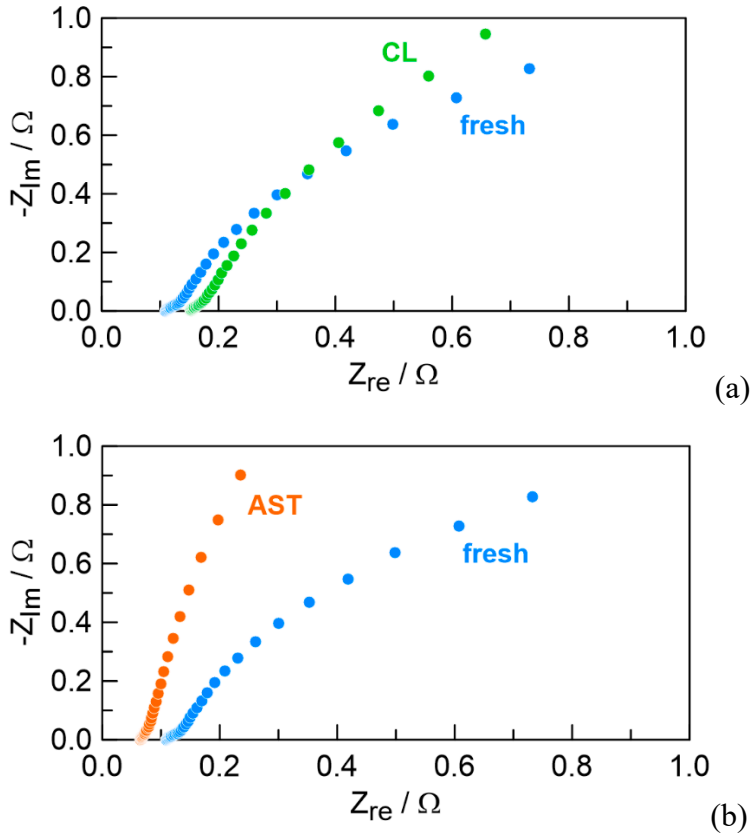


Figure S5. Nyquist spectra before and after (a) the CL (constant load) durability profile, (b) the AST (accelerated stress test) durability profile. IrO_x-coated spark ablation CCM (0.8 mg cm^{-2}), Nafion 115, 4 mg cm^{-2} Pt on C-cloth cathode.

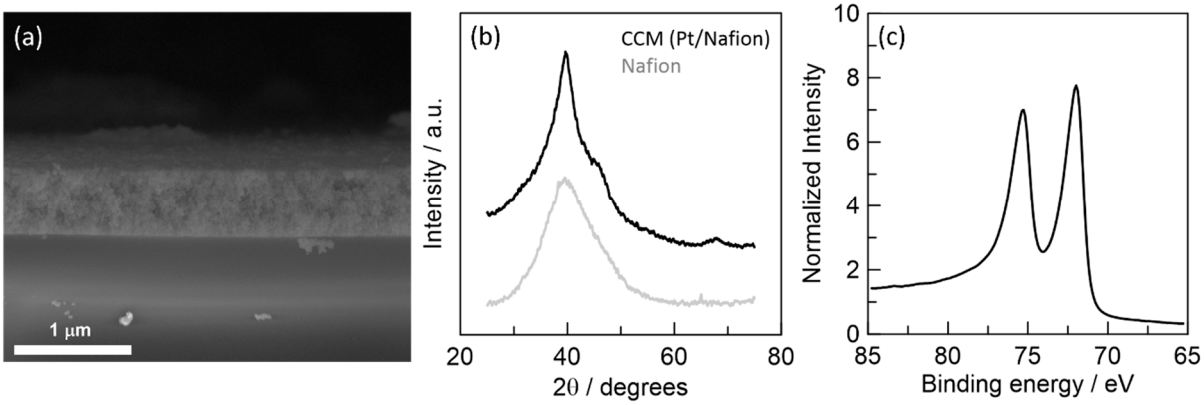


Figure S6. Physicochemical characterization of the Pt film which served as cathode for the spark ablation full CCM study. (a) Cryo-fractured SEM cross-section showing the uniformity and thickness of the Pt layer, (b) XRD pattern of Pt/Nafion side, (c) XPS Pt 4f spectrum.

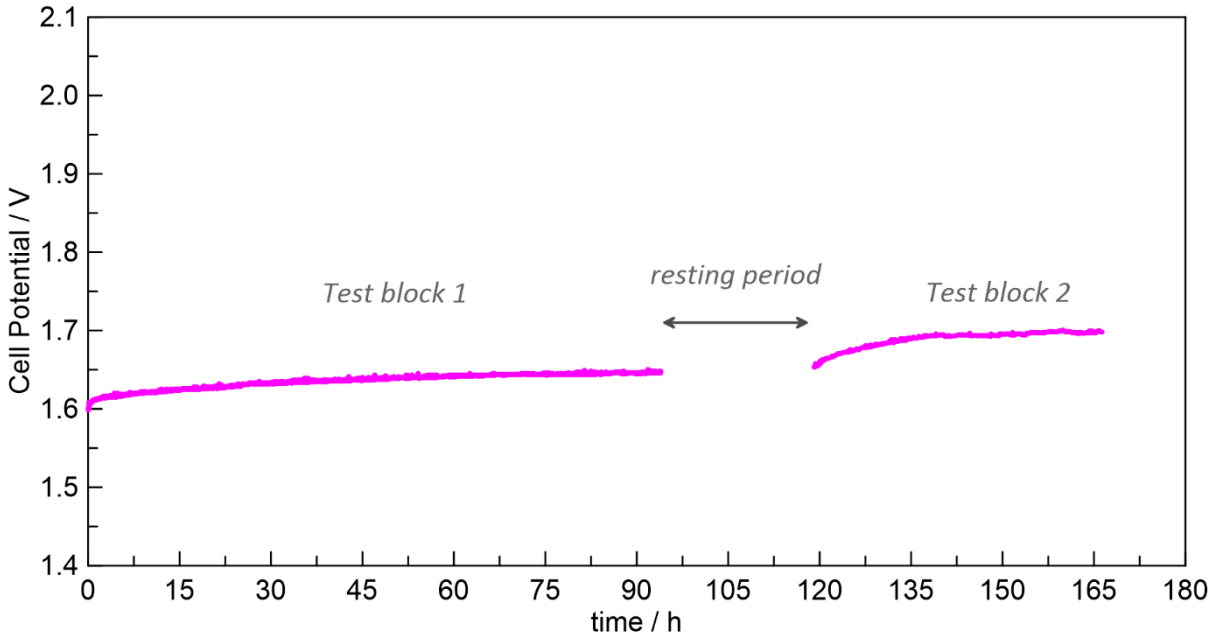


Figure S7. Time evolution of cell potential during two test blocks of constant load (CL) operation at 200 mA cm^{-2} at 60 °C with a spark ablation fully coated CCM (0.8 mg cm^{-2} IrO_x, 0.5 mg cm^{-2} Pt, Nafion 115).

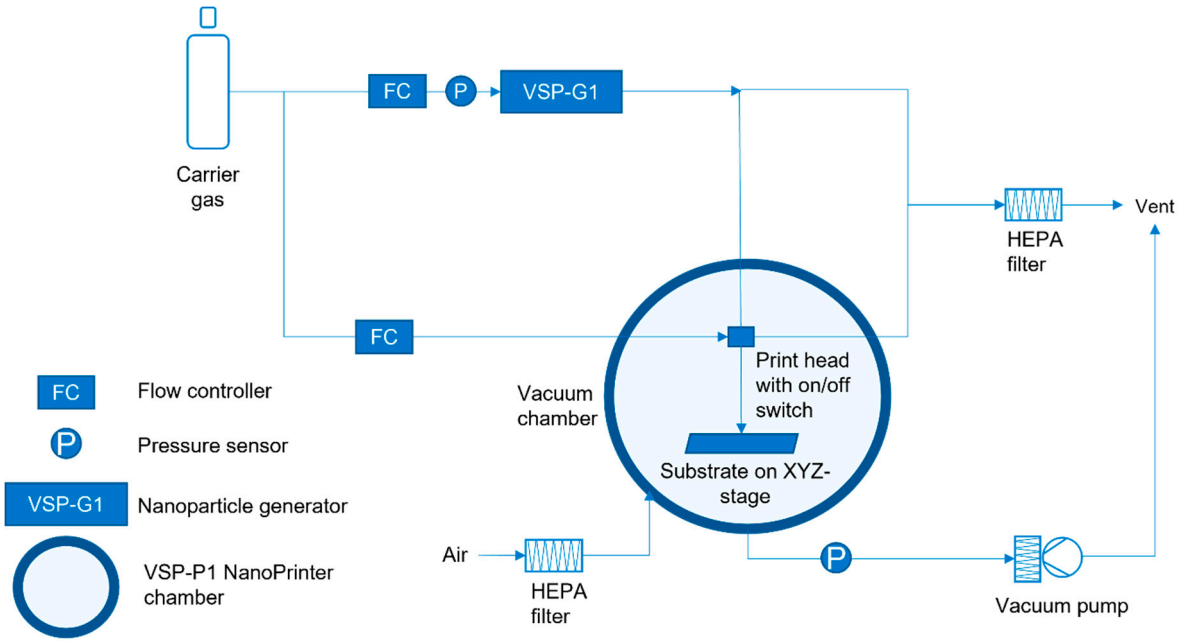


Figure S8. Process flow of nanoparticle generation via spark ablation and printing via impaction.