Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

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Study on solid electrolyte catalyst poisoning in solid acid fuel cells

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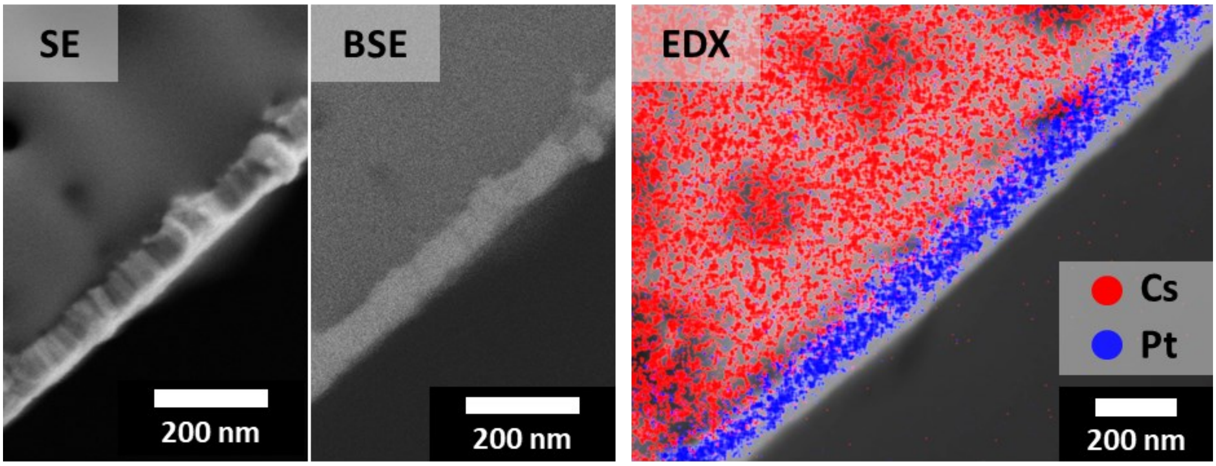
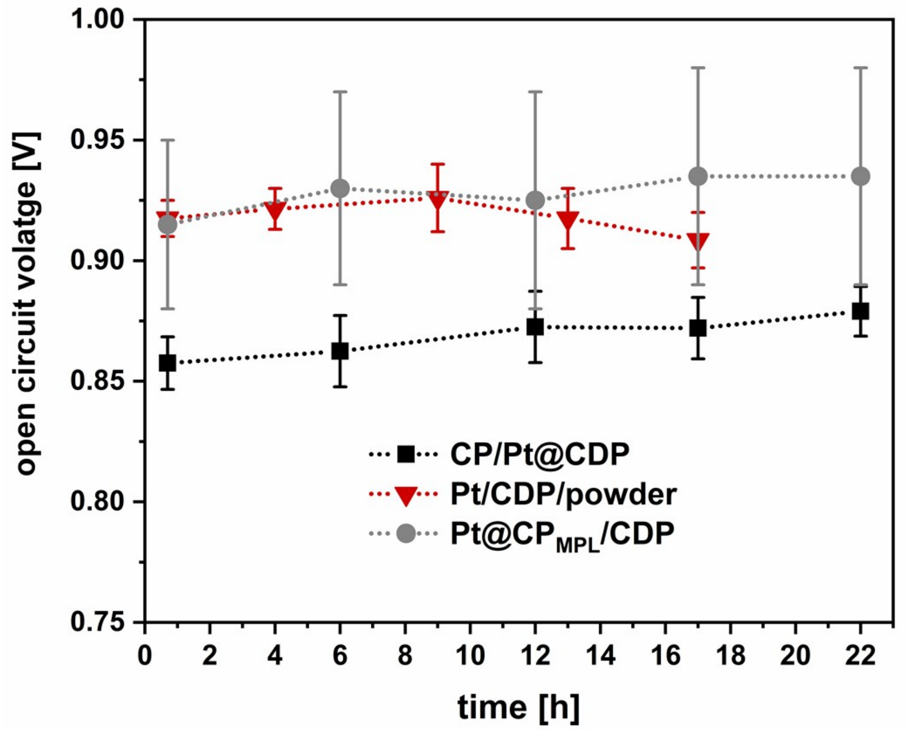
S1: phase identification



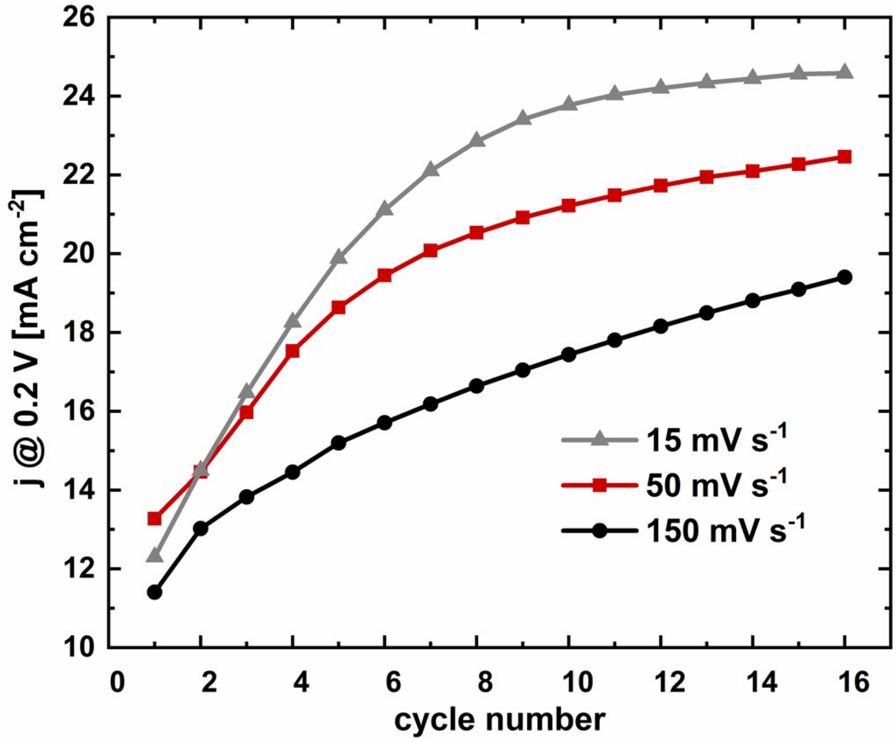
Scanning electron micrographs of an electrode cross-section before electrochemical analyzation taken with a secondary electron detector (SE, left), backscattered electron detector (BSE, center), and an overlay of an SE image with the results of energy dispersive X-ray spectroscopy (EDX, left).

S2: Open Circuit voltage



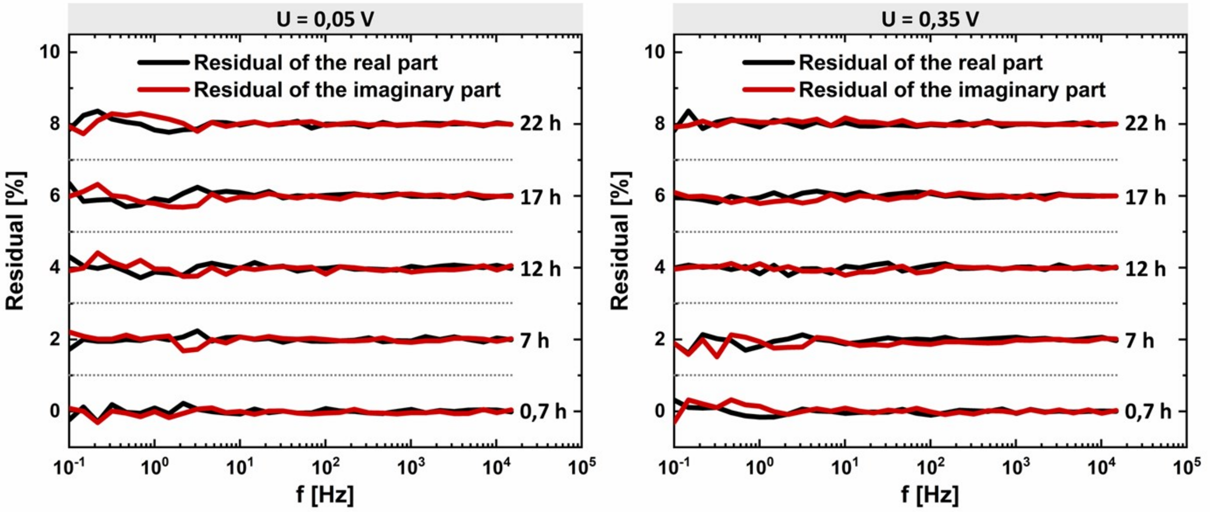
Open circuit potential for all MEA types over time. No significant change in the open circuit voltage was detected within the measurement time.

S3: Influence of the CV scanning speed on the reactivation

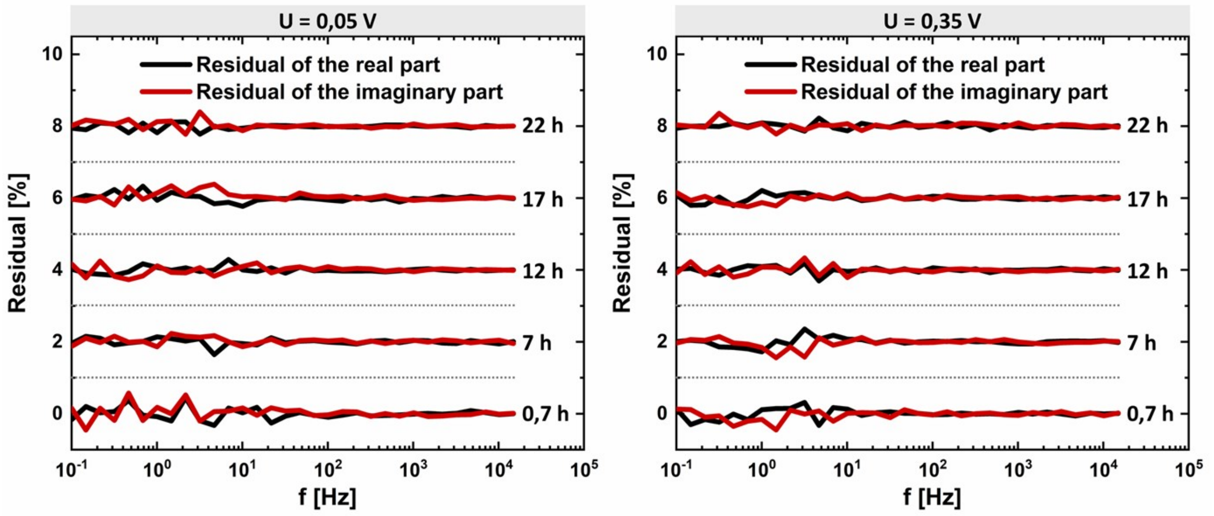


Change in current density at a representative voltage of 0.2 V during CV measurement as a function of scan speeds.

S4: Residuals residues obtained from the linear Kramer-Kronig test

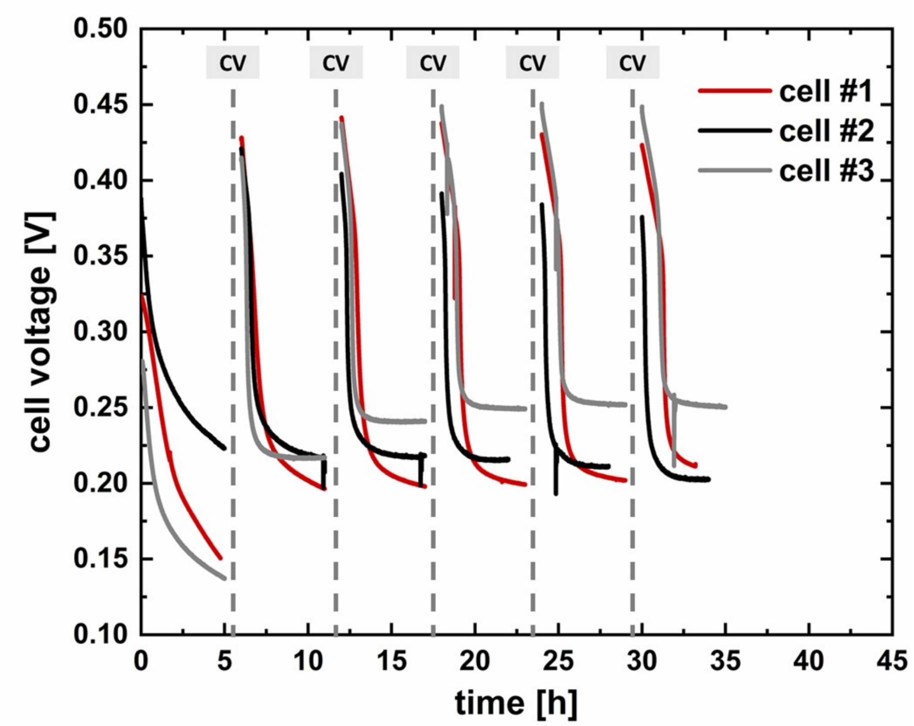


Impedance spectra residuals from the CP/Pt@CDP MEA, according to the Kramer-Kronig relation.[1,2] For better clarity, each time step has an offset of 2%. The dotted grey lines indicate the ±1% validity region



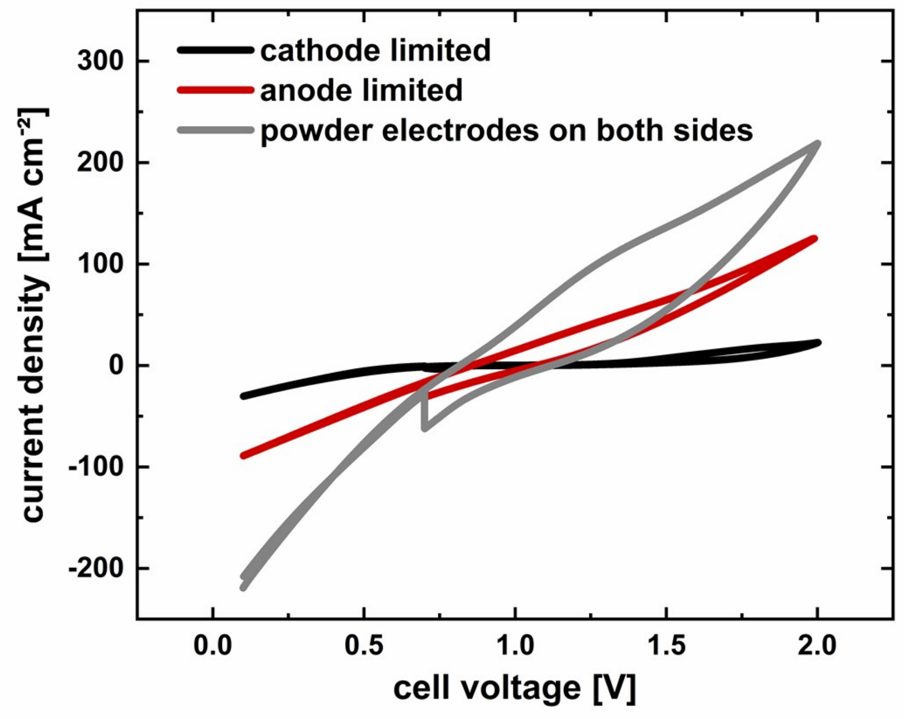
Impedance spectra residuals from the Pt@CP_{MPL}/ CDP MEA, according to the Kramer-Kronig relation.[1,2] For better clarity, each time step has an offset of 2%. The dotted grey lines indicate the ±1% validity region

S5: Reproducibility of reactivation



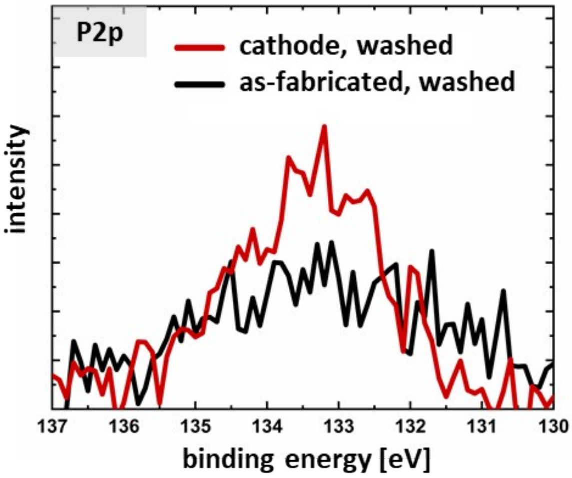
Constant current measurement (10 mA cm^{-2}) of identical in construction CP/Pt@CDP MEAs, intermitted by cyclic voltammetry (CV) measurements, marked as grey dashed lines. The initial degradation during the first five hours has some variation, but the increase after CV measurements and the subsequent degradation is reproduceable. The small irregular appearing peaks are caused by gas flow fluctuations and can be ignored.

S6: porous electrodes



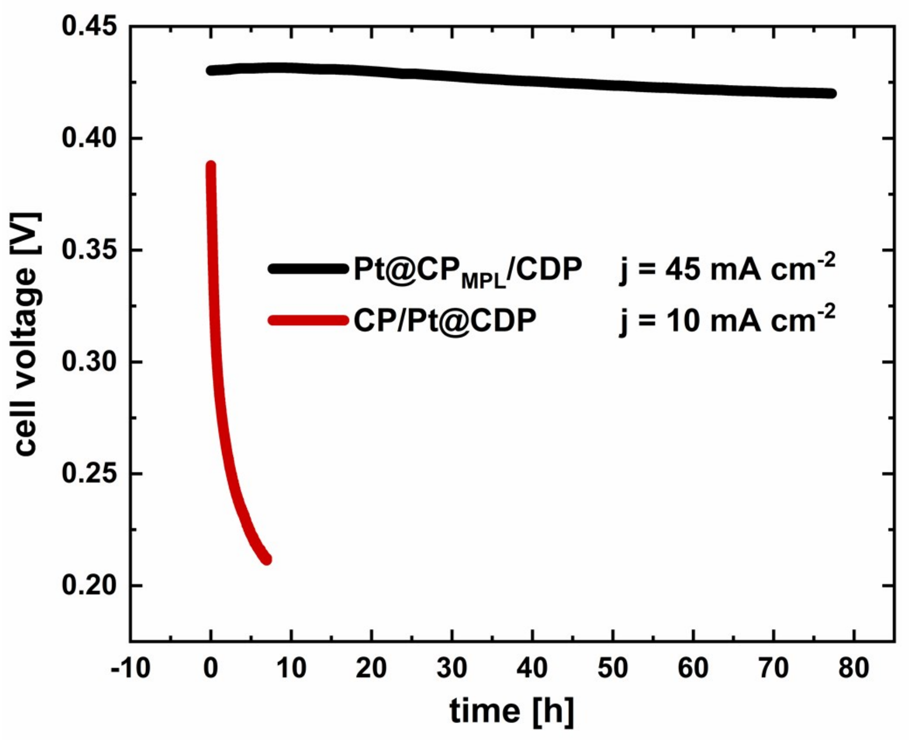
Representative cycles of the cyclic voltammetry measurements used to reactivate the Pt/CDP/powder MEAs. At 0.7 V the voltage remained constant for 30 s to ensure complete reduction of generated PtO_x. Three MEAs are investigated: (1) cathode limited which the powder electrode at the anode (2) anode limited with the powder electrode at the cathode (3) reference which powder electrodes at both the anode and cathode. An increase in activity can be observed for a cell configuration where the powder electrode is placed on the cathode site. A further increase is observed when both electrodes are powder electrodes.

S7: XPS



X-ray photoelectron spectroscopy analysis in the P2p region for the platinum catalyst of the cathode (red) and as-fabricated electrode (grey). The catalyst was separated from the electrolyte by multiple washing cycles with water. No phosphate was detected in the final washing water. The platinum catalyst cells operated for 15 h at a constant current of 10 mA cm^{-2}.

S8: Stability of the Pt@CP$_{MPL}$/CDP MEA



Constant current measurement of a CP/Pt@CDP MEA and a Pt@CP$_{MPL}$/CDP MEA. The current density value of the latter was chosen to achieve a similar operational voltage as for the CP/Pt@CDP MEA. After a short stabilization time, the cell voltage of the Pt@CP$_{MPL}$/CDP MEA decreased slowly. A linear fit of the last 20 h revealed a cell voltage decrease of 123.5 µV*h^{-1} ± 0.2 µV*h^{-1}. This is a significant improvement compared to the CP/Pt@CDP MEA, which showed a rapid, nonlinear decrease of 180 mV over the first 5 h.

References

[1] Schönleber, M.; Klotz, D.; Ivers-Tiffée, E., *Electrochimica Acta*, (2014) **131**, 20.
[2] Boukamp, B. A., *J. Electrochem. Soc.*, (1995) **142**, 1885.