SUPPORTING INFORMATION

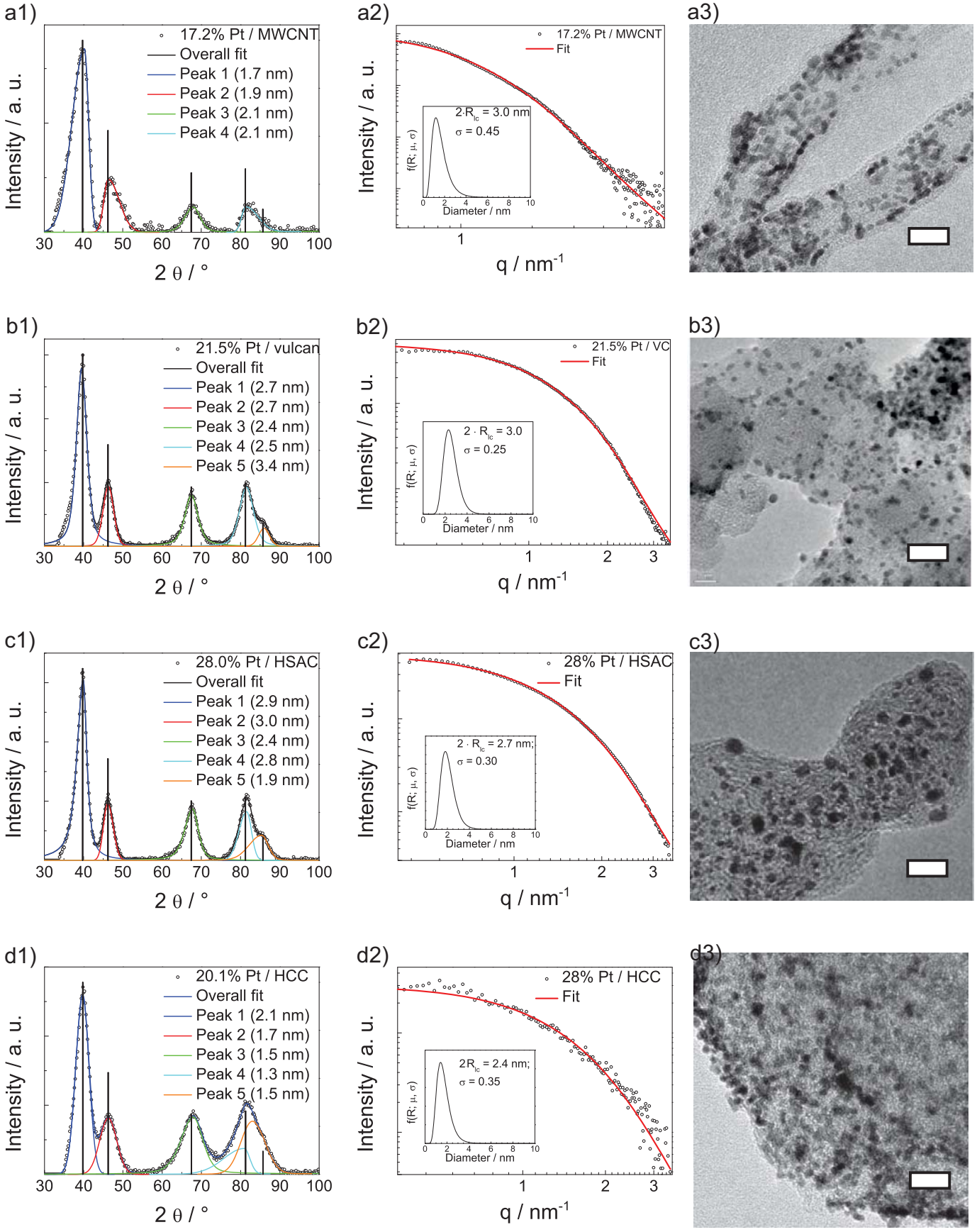

Figure S 1 *Characterization of pristine Pt nanoparticles catalysts supported on a) MWCNT, b) VC, c) HSAC, d) HCC, respectively. Results were obtained using the analytical tools 1) XRD, 2) SAXS, 3) TEM with scale bars corresponding to 10 nm, respectively. Images b3 and c3 were adopted from Hasché et al.*[4,5]

Table S 1 *Electrochemical characterization of the selected catalyst powders.*

Catalyst support	$ECSA_{act}$ in $m^2 \cdot g_{Pt}^{-1}$, H_{upd}CV	ORR_{mass} in $mA \cdot mg^{-1}$, LCV	ORR_{spec} in $mA \cdot cm_{Pt}^{-2}$, LSV
MWCNT	74.5 ± 4.2	133 ± 15	0.178 ± 0.023
VC	61.2 ± 0.5	97 ± 23	0.157 ± 0.019
HSAC	91.2 ± 0.0	168 ± 15	0.184 ± 0.017
HCC	26.5 ± 1.4	83 ± 1	0.315 ± 0.017

Table S 2 *Estimation of the ECSA losses for Pt nanoparticles deposited on different carbon supports.*

Catalyst support	$ECSA_{act}$ in $m^2 \cdot g_{Pt}^{-1}$, H_{upd}CV	$ECSA_{end}$ in $m^2 \cdot g_{Pt}^{-1}$, H_{upd}CV	ECSA-loss in %, H_{upd}CV
VC	61.2 ± 0.5	43.9 ± 1.0	28.2 ± 1.7
MWCNT	74.5 ± 4.2	55.2 ± 2.4	25.9 ± 5.3
HSAC	91.2 ± 0.0	68.2 ± 0.8	25.2 ± 0.8
HCC	26.5 ± 1.4	15.5 ± 2.4	41.5 ± 9.6

Table S 3 *Mean particle size definitions for a distribution f(R) of particle radii R.*

Name	Definition
Mean length or mean radius	$\mu = \langle R^1 \rangle$
Area weighted or intersection length radius	$R_{li} = \frac{3}{4} \langle R^3 \rangle / \langle R^2 \rangle$
Volume weighted or correlation length radius	$R_{lc} = \frac{2}{3} \langle R^4 \rangle / \langle R^3 \rangle$

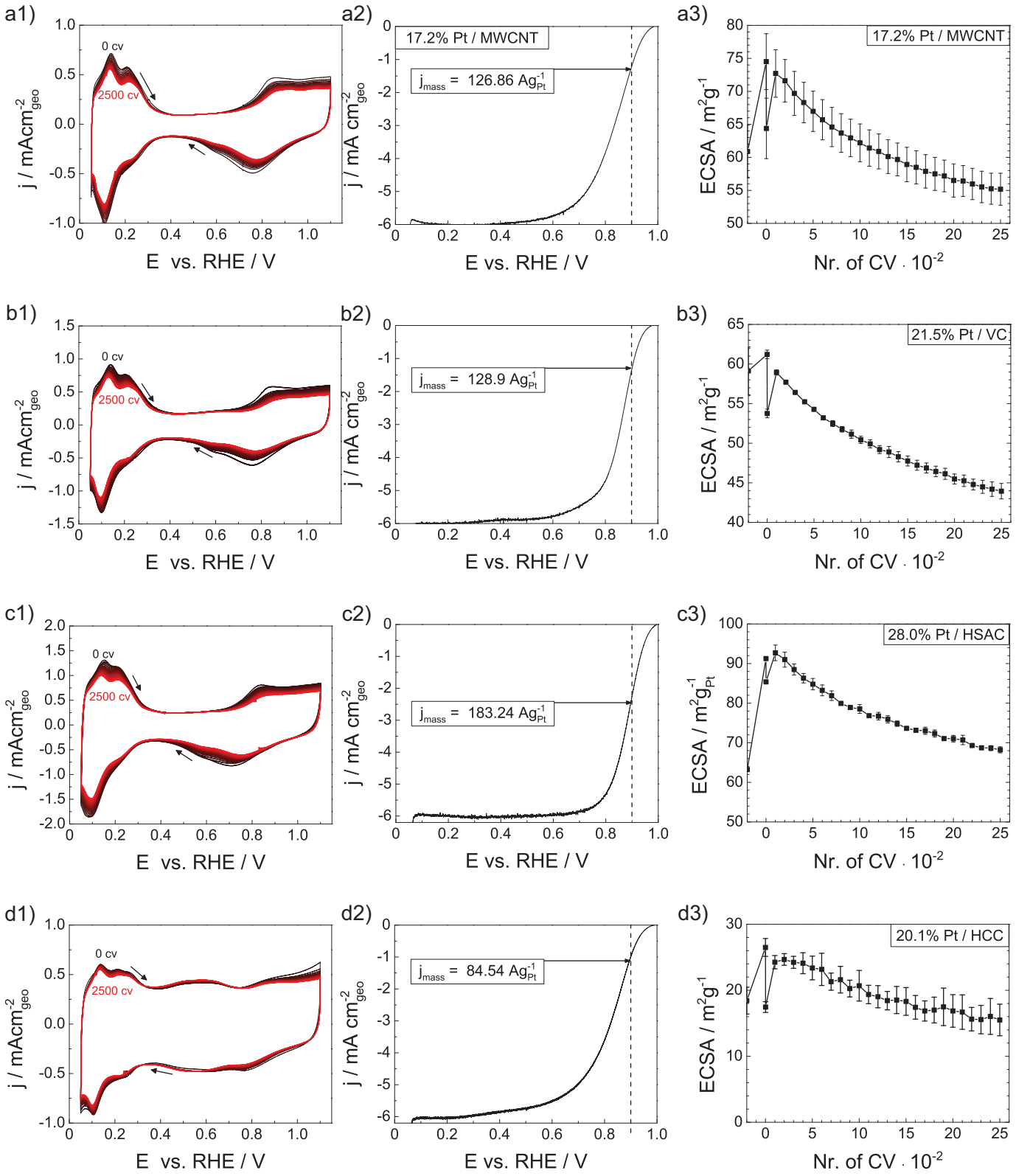

Figure S 2 *Electrochemical characterization of Pt / Carbon. Letters specify the support structure: a) MWCNT, b) VC, c) HSAC, d) HCC. Numbers show to each support corresponding CVs(1) and LSV (2). ECSA (3) loss was calculated from the H_{upd}-range (0.05-1.10 V vs. RHE) of the plotted CVs.*

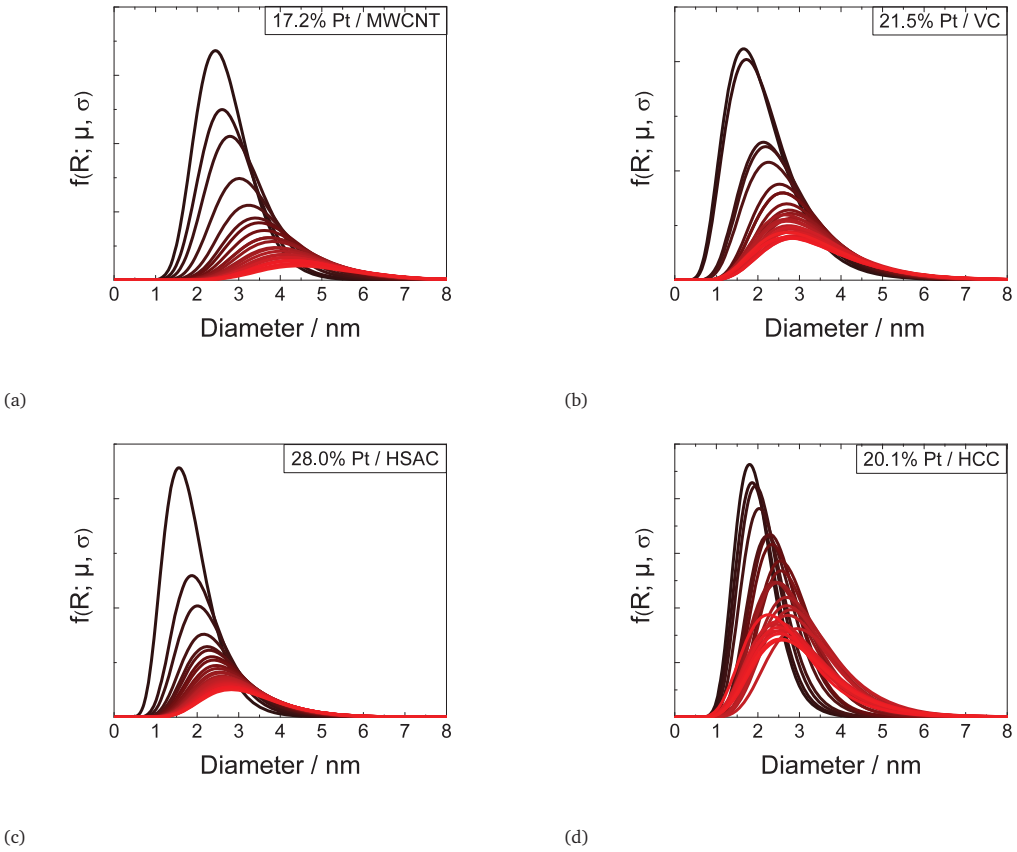

Figure S 3 *From in situ SAXS measurements resulting Lognormal-type probability density functions of particle sizes with progress of AST protocol (from black, 0 CVs, to red, 2500 CVs).*

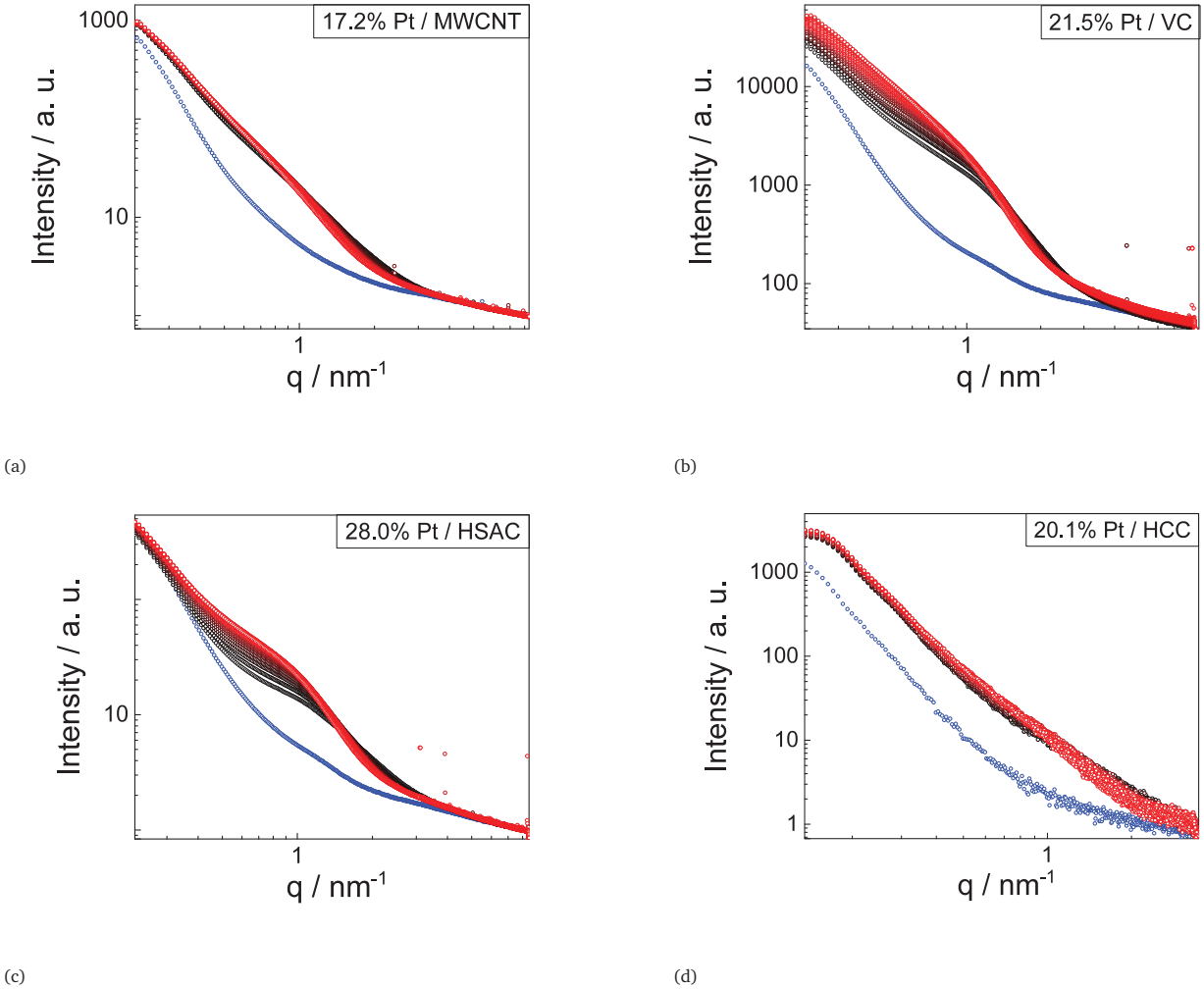

Figure S 4 *Original transmission corrected SAXS-curves for electrodes impregnated with Pt nanoparticles supported on VC(a), HSAC(b), MWCNT(c) and HCC(d) with a corresponding carbon-background SAXS curve (blue curve). The evolution of SAXS-data from pristine wet electrode to electrochemically treated by the AST protocol is highlighted by color change from black to red.*

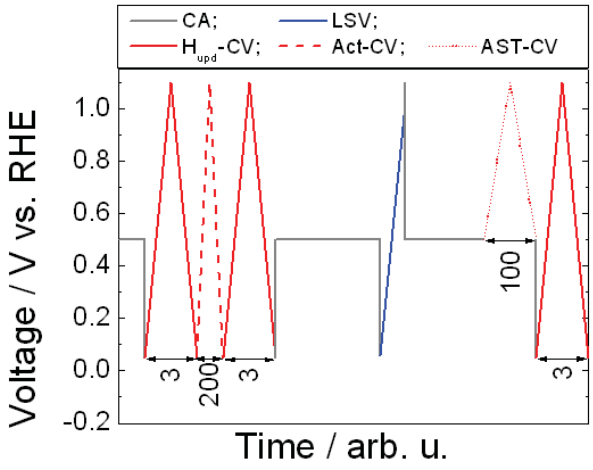

Figure S 5 *Scheme of electrochemical characterization procedure: Chronoamperommetry, CA (solid grey); linear sweep voltammetry, LSV (solid blue); cyclic voltammetry, CV for H_{upd} estimation (solid red), activation cycles (dashed red) and accelerating stress test (doted red). Numbers give the amount of forward-backward scans.*

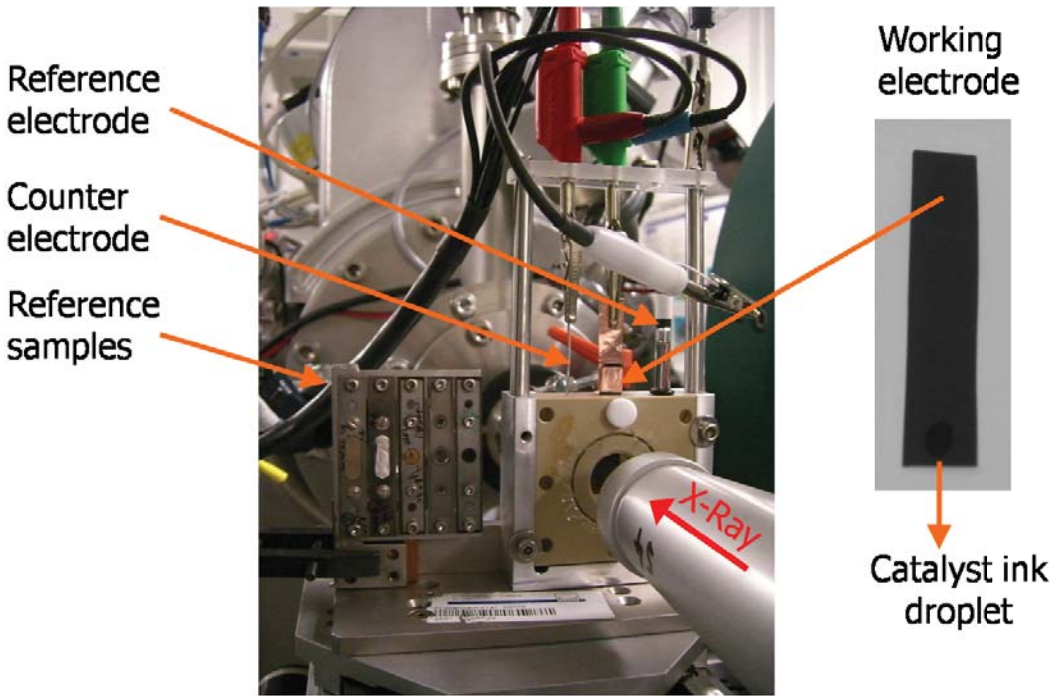

Figure S 6 *Experimental setup for in situ SAXS measurements.*