

Supporting Information

Figure S1.

Powder XRD patterns of as-synthesized (Mg,Co,Ni,Cu,Zn)O and of the same sample after one month in laboratory conditions and after 24h in water.

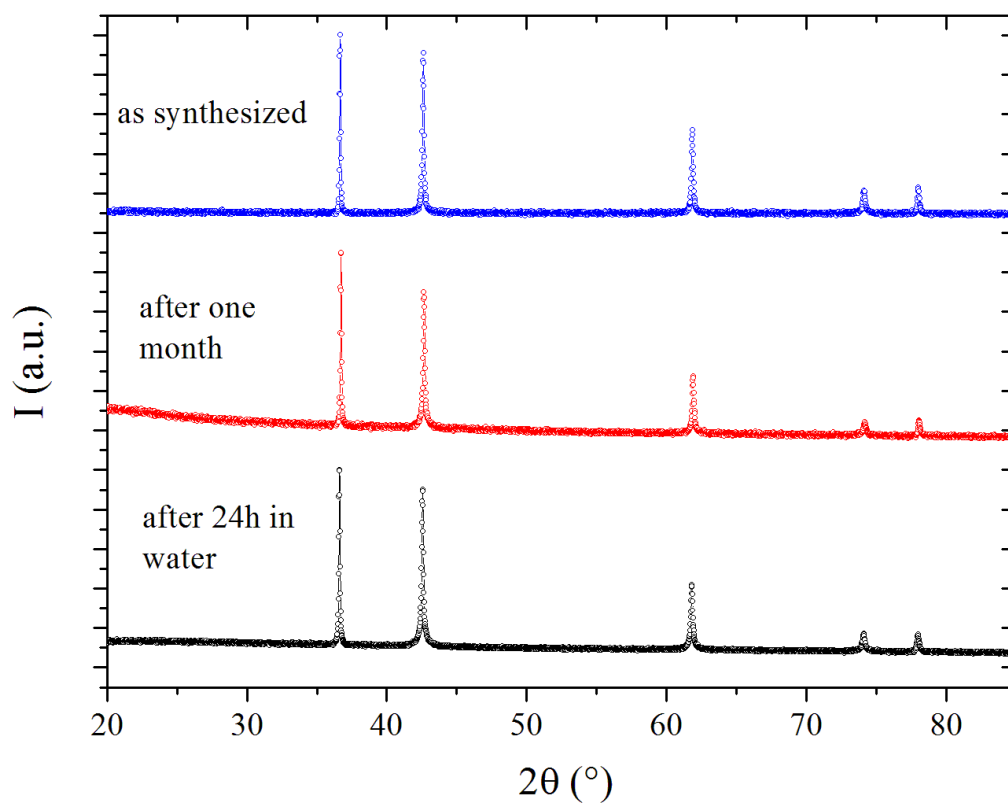


Figure S2a.

Lattice parameters for Na substituted compounds.

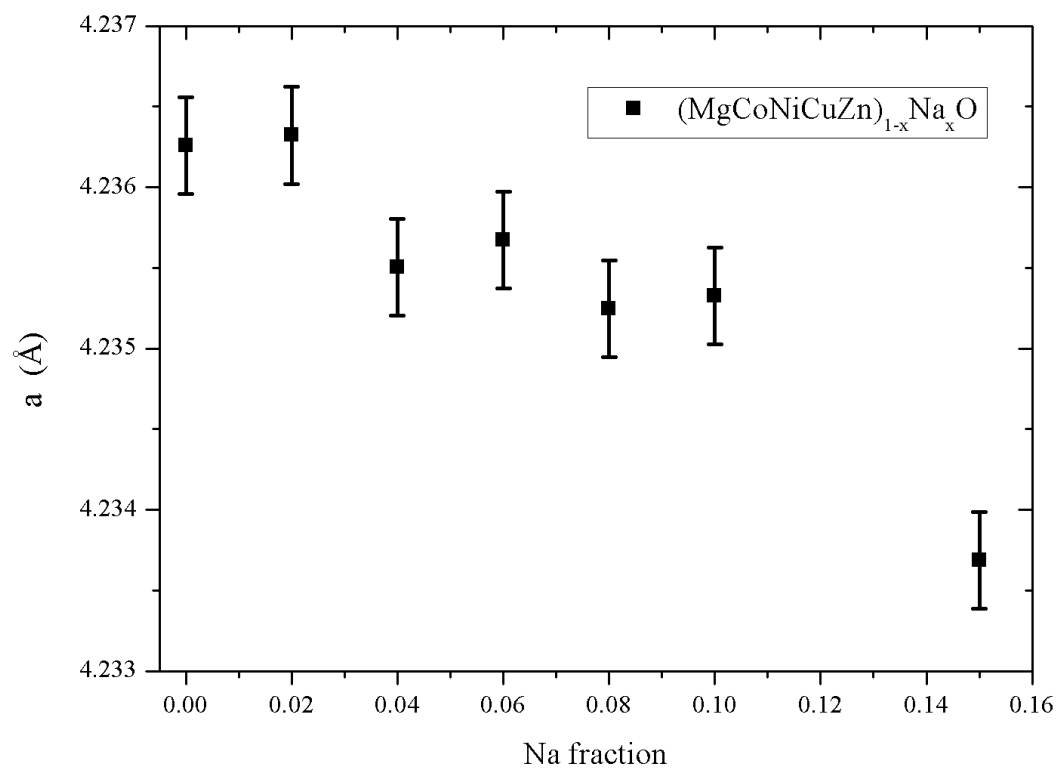


Figure S2b.

Powder XRD of selected Li, Na and K doped HEOx samples.

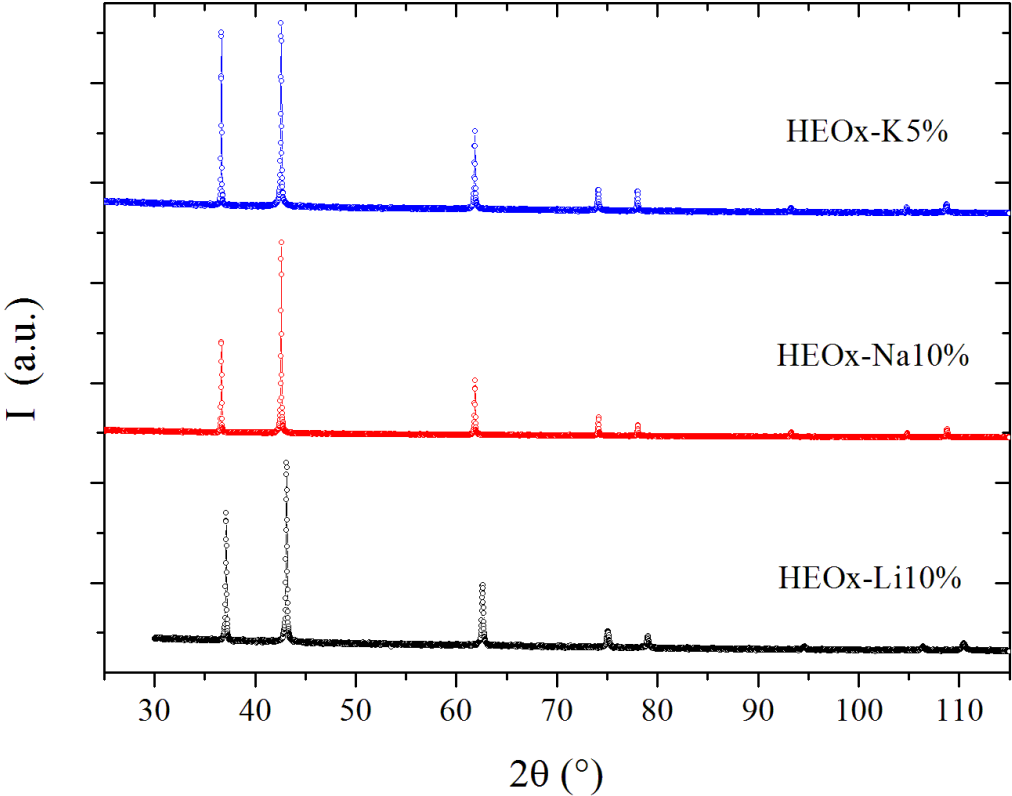
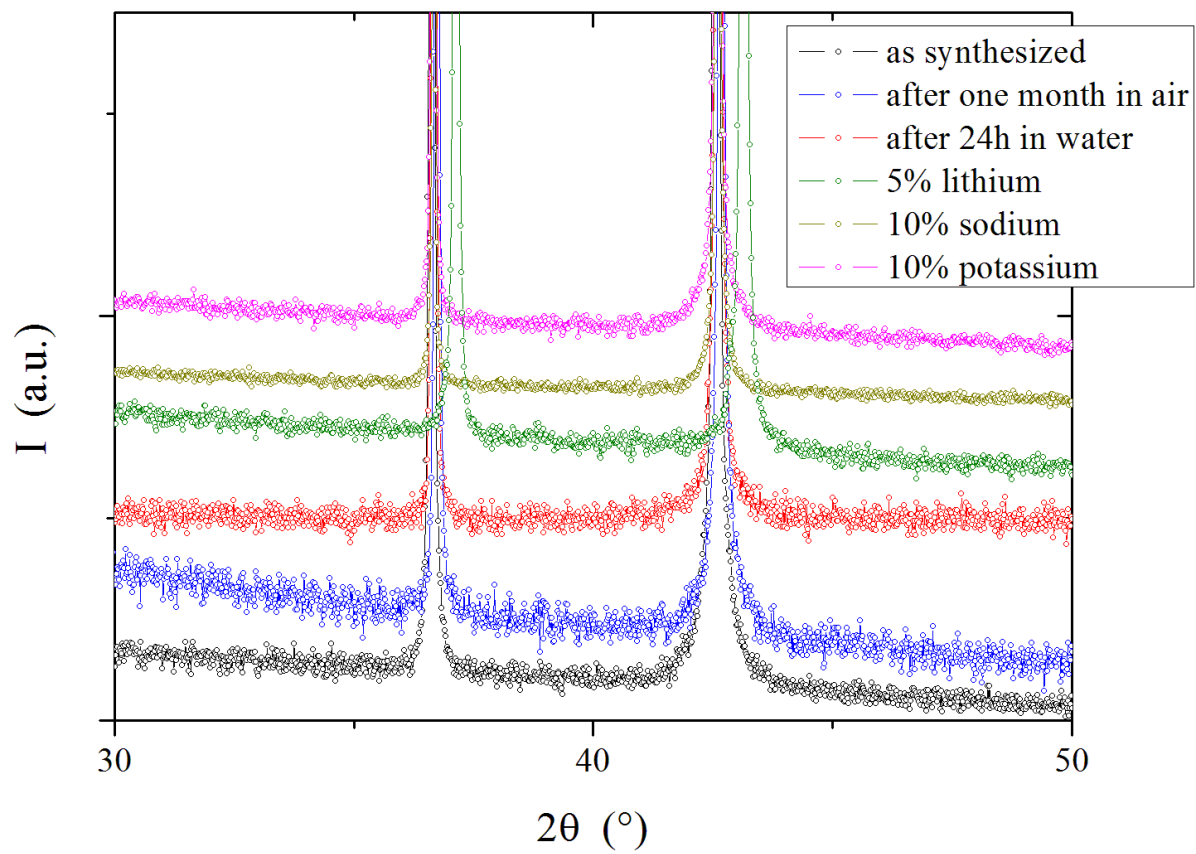


Figure S2c.

Zoom of powder XRD data (*10).



S3. The evolution of the current density, during a 1 V potential step.

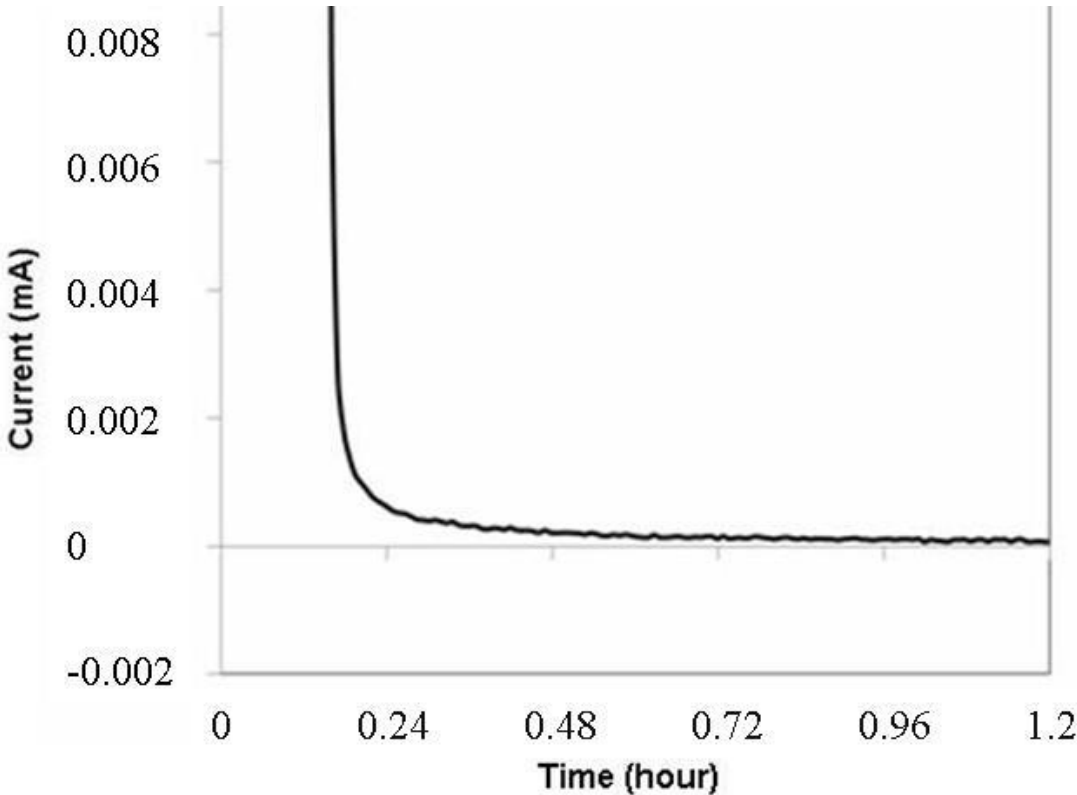


Figure S4.

Ionic conductivity for undoped HEx sample, as a function of frequency, at various temperatures.

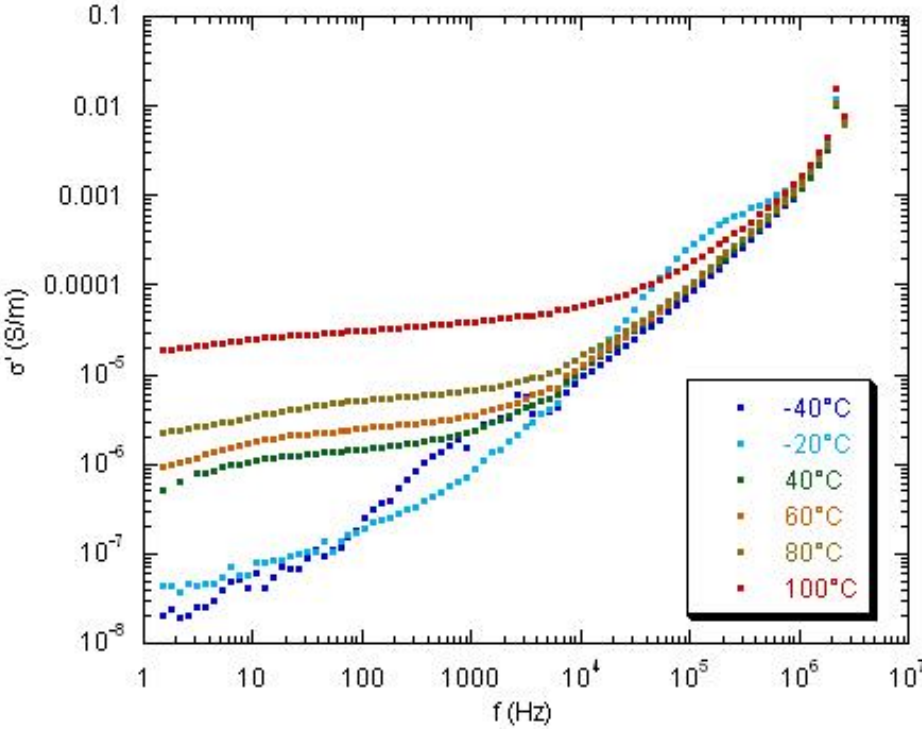


Figure S5

Real part of the permittivity for undoped HEOx as a function of frequency, at various temperatures.

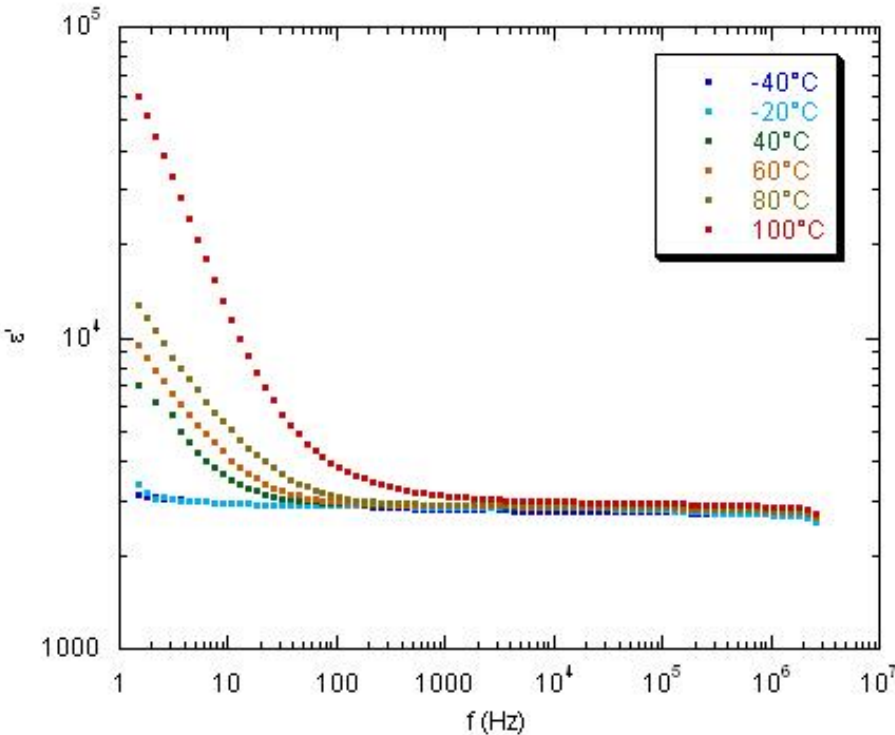


Figure S6. Real part of the permittivity for 2%Li HEOx as a function of frequency, for various temperatures.

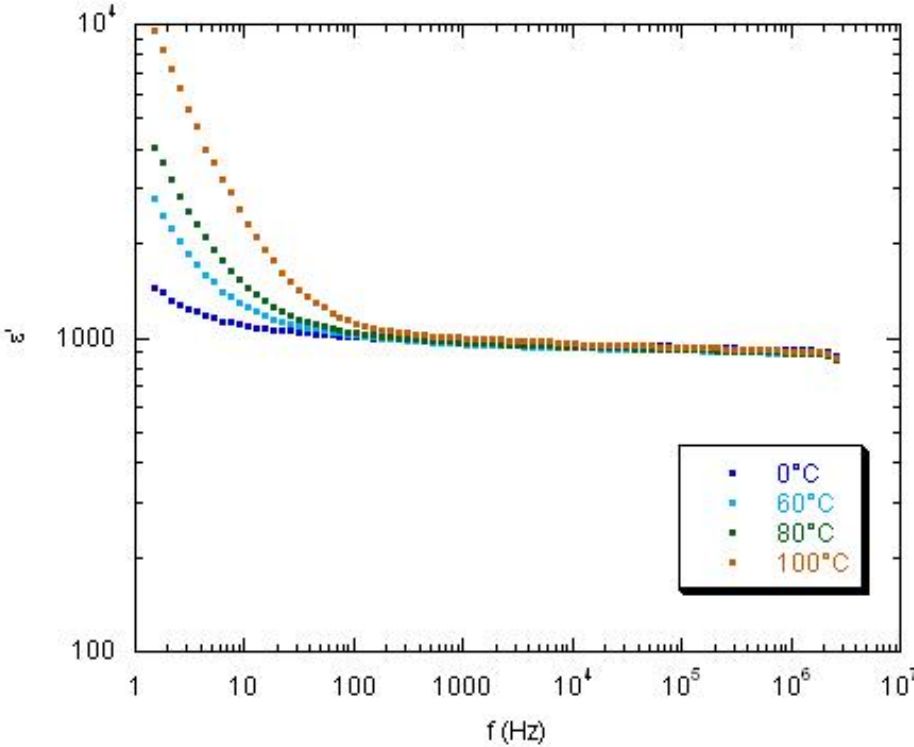


Figure S7. Real part of the permittivity for HEOx-2%Li with Li-electrodes

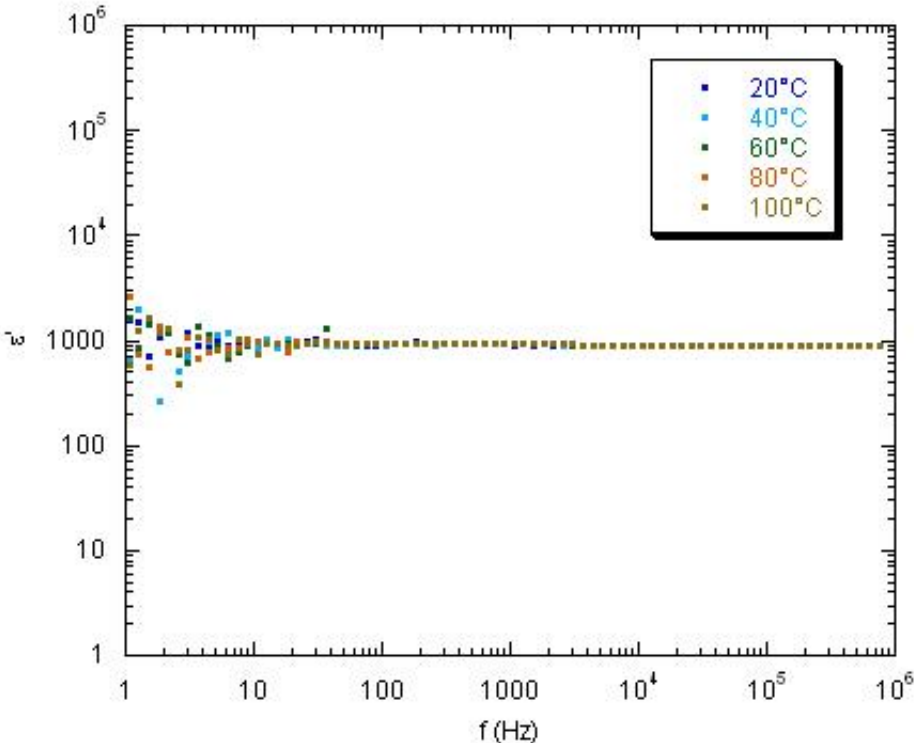
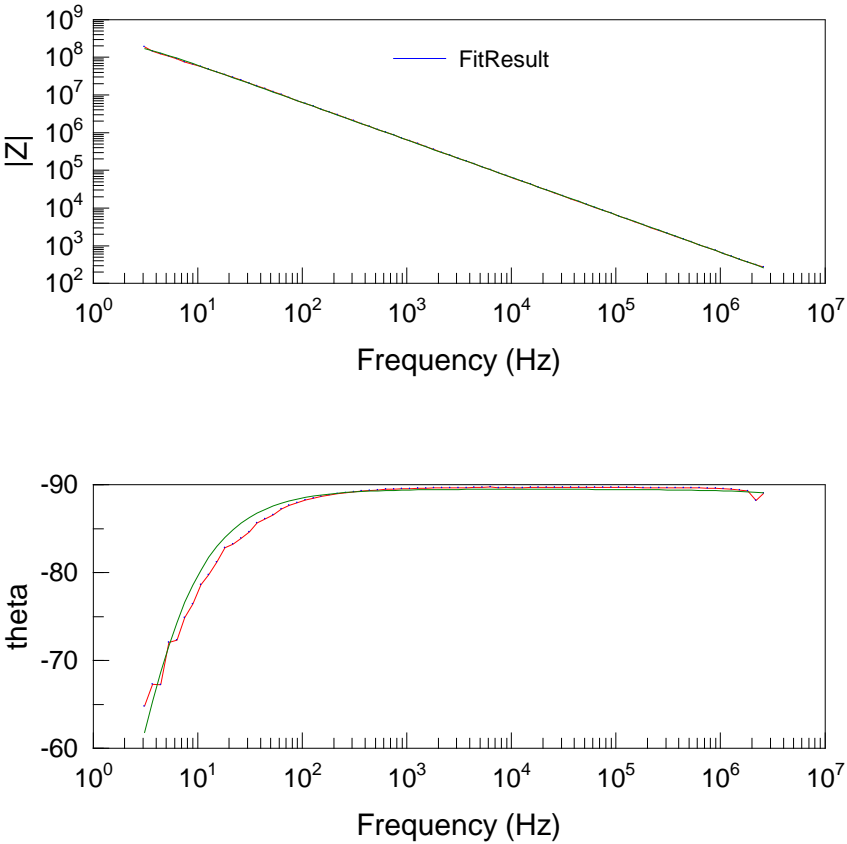
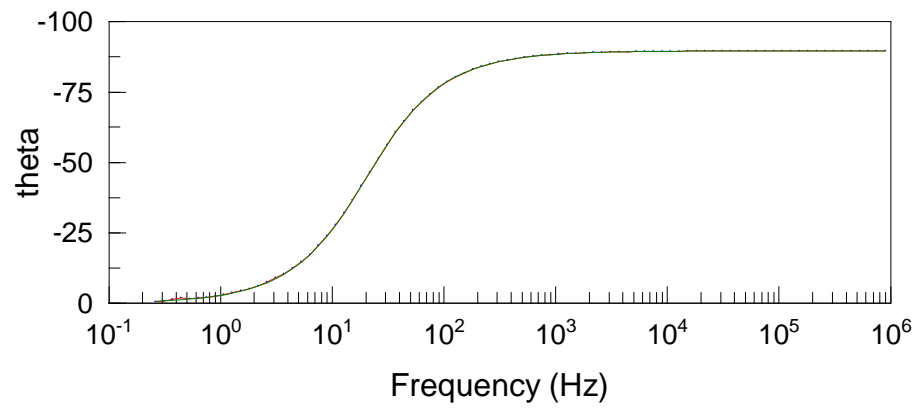
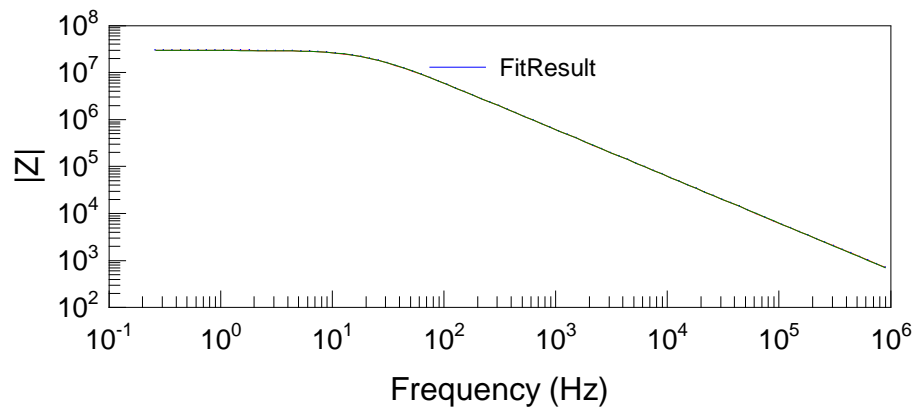


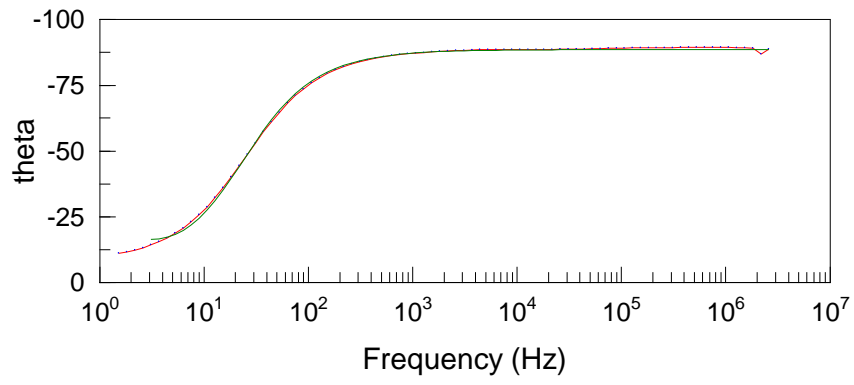
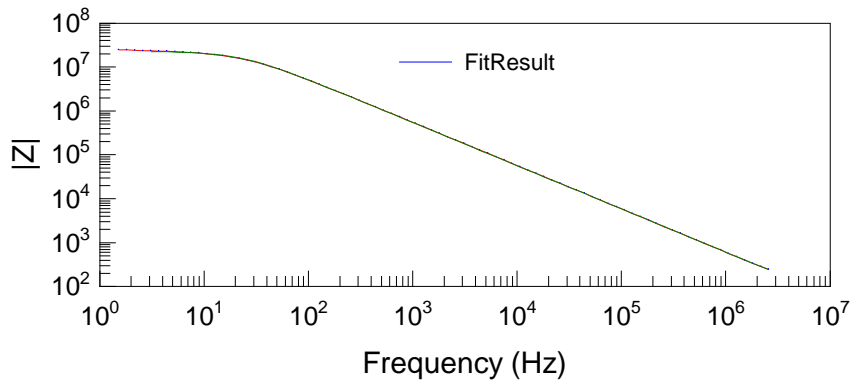
Figure S8. Experimental and fitted impedance spectra.



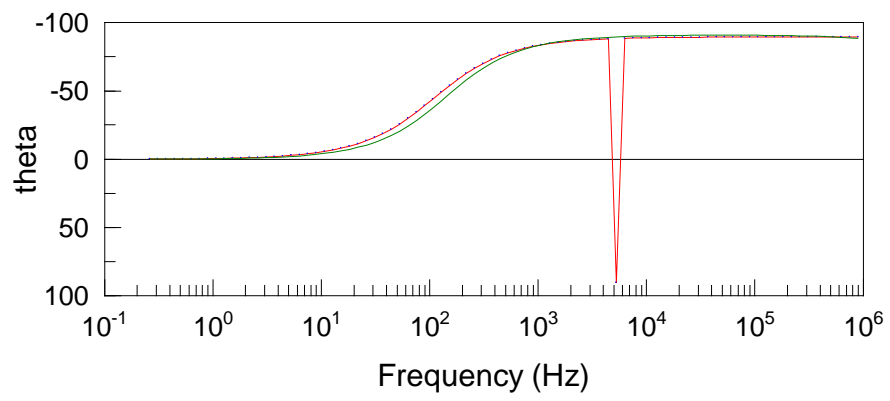
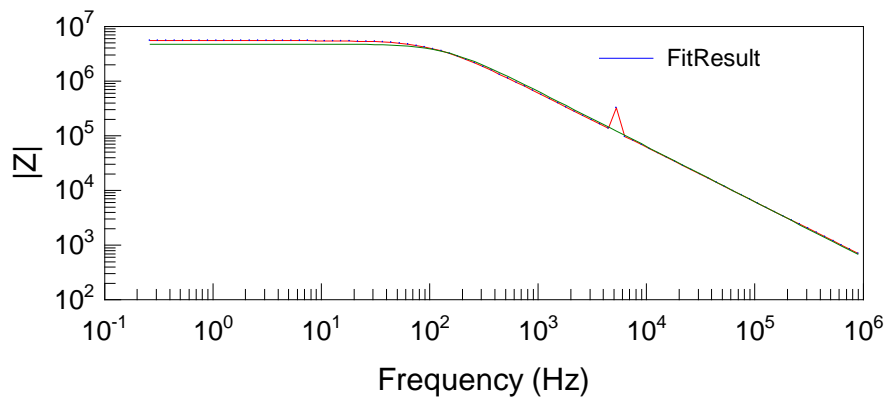
0% - Pt/Pt



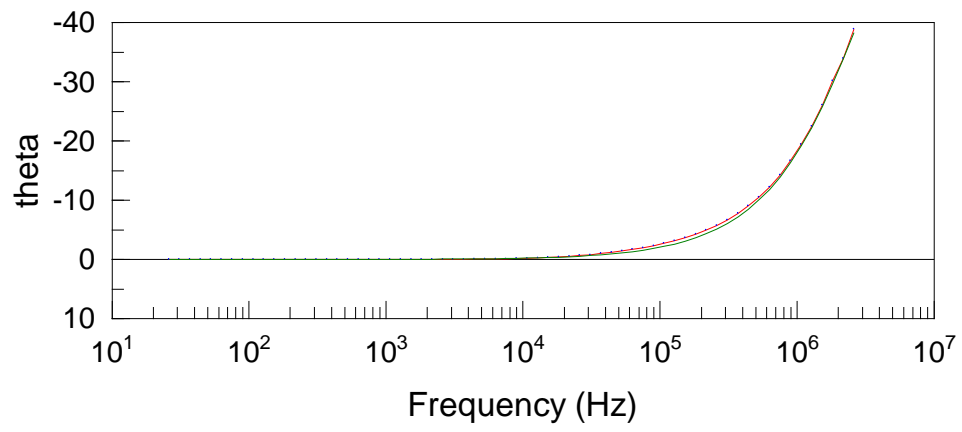
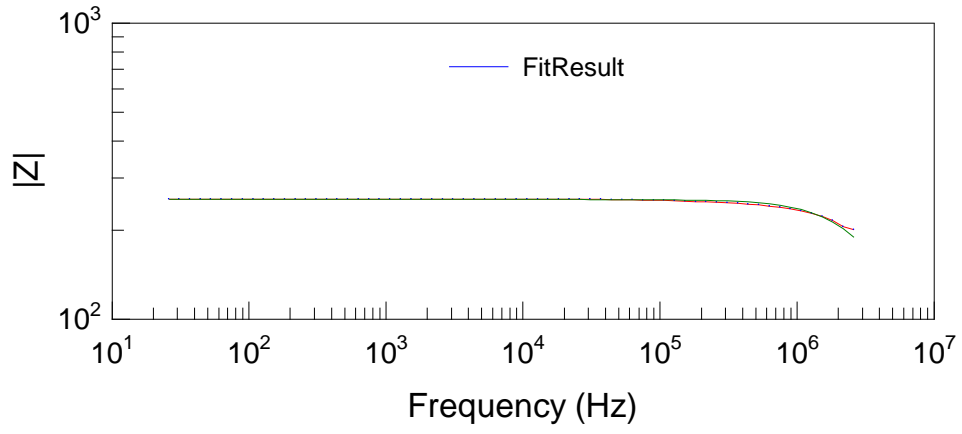
0% - Li/Li



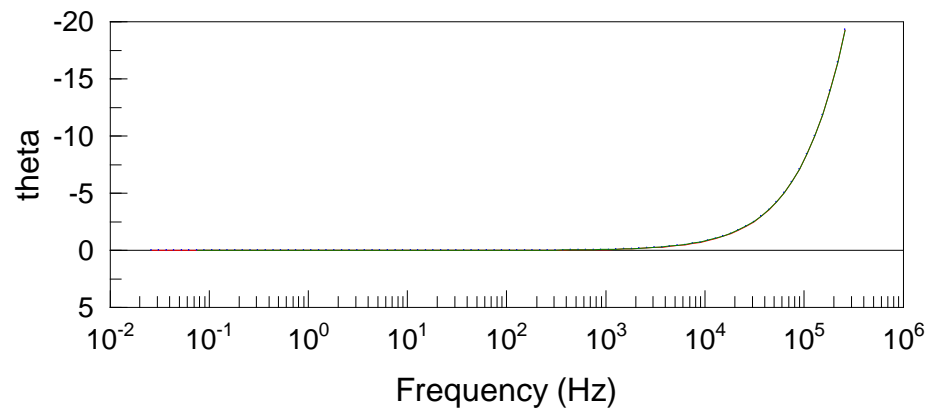
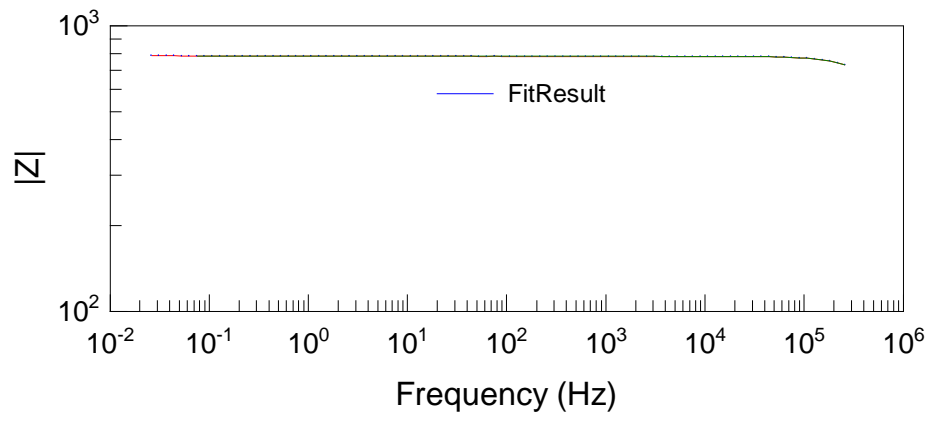
2% - Pt/Pt



10% - Li/Li

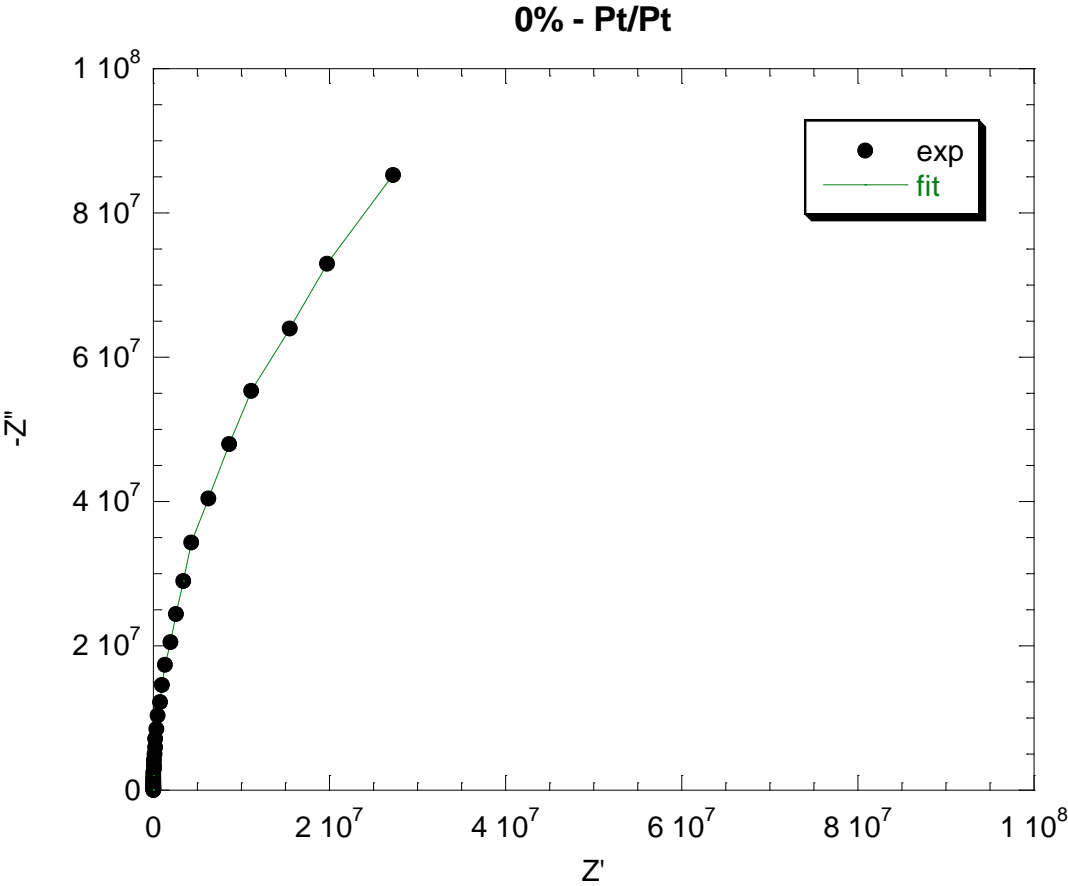


30% - Pt/Pt

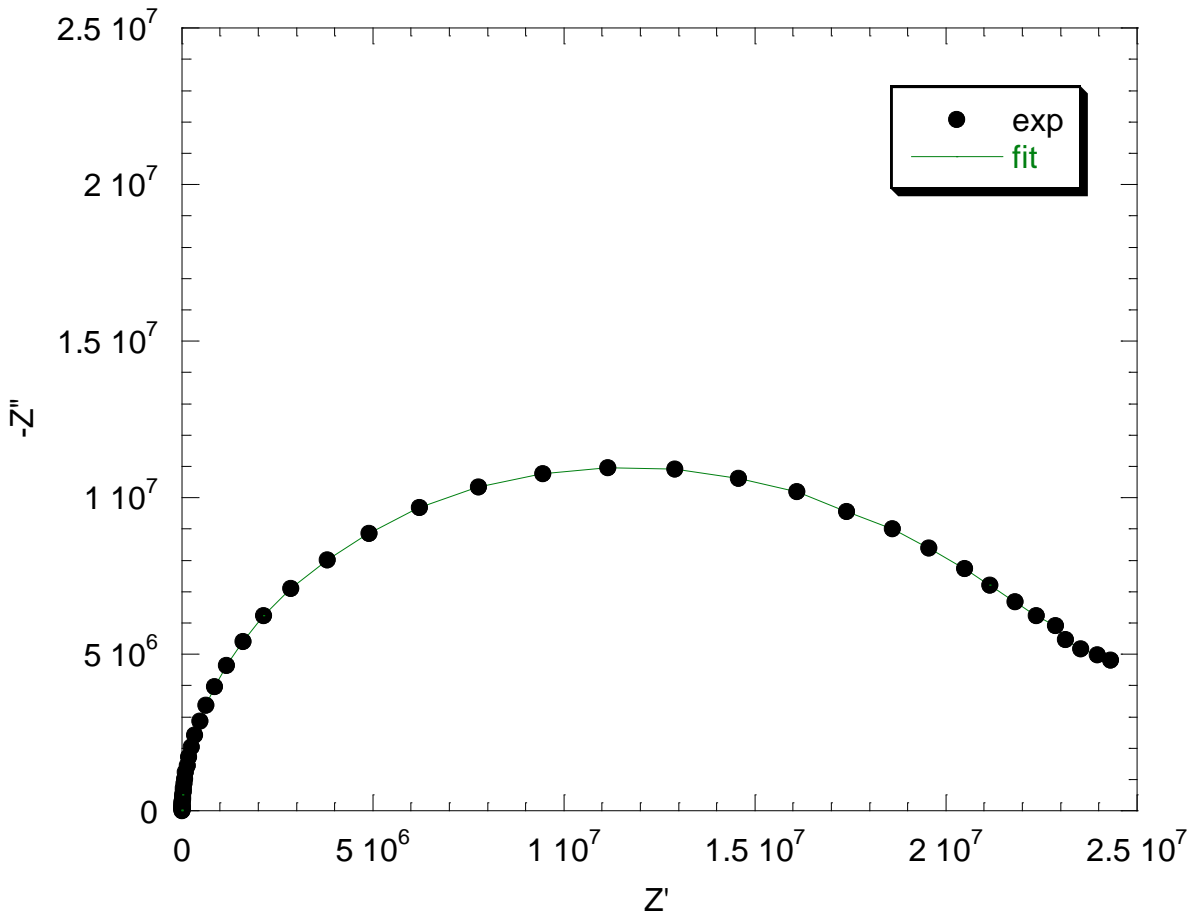


30% - Li/Li

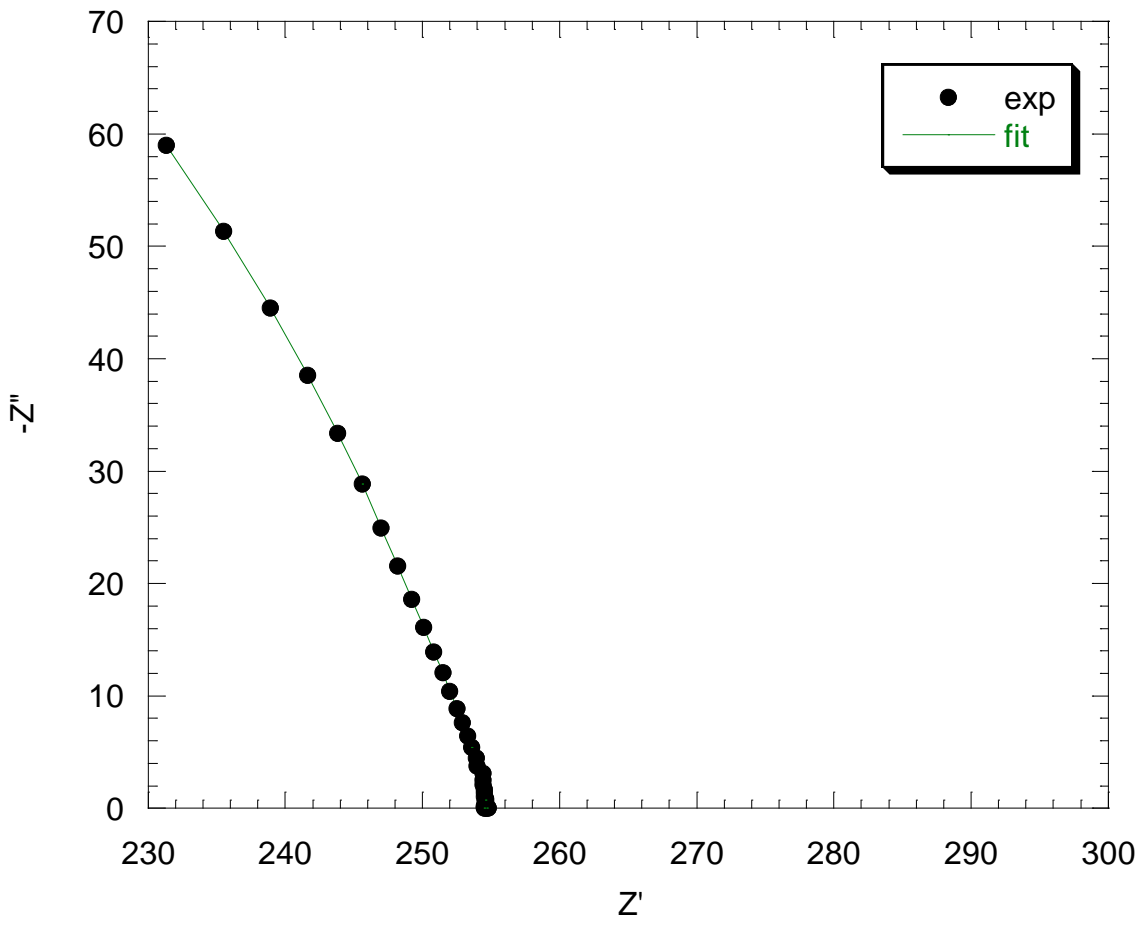
S9. Experimental and fitted impedance spectra (Nyquist)



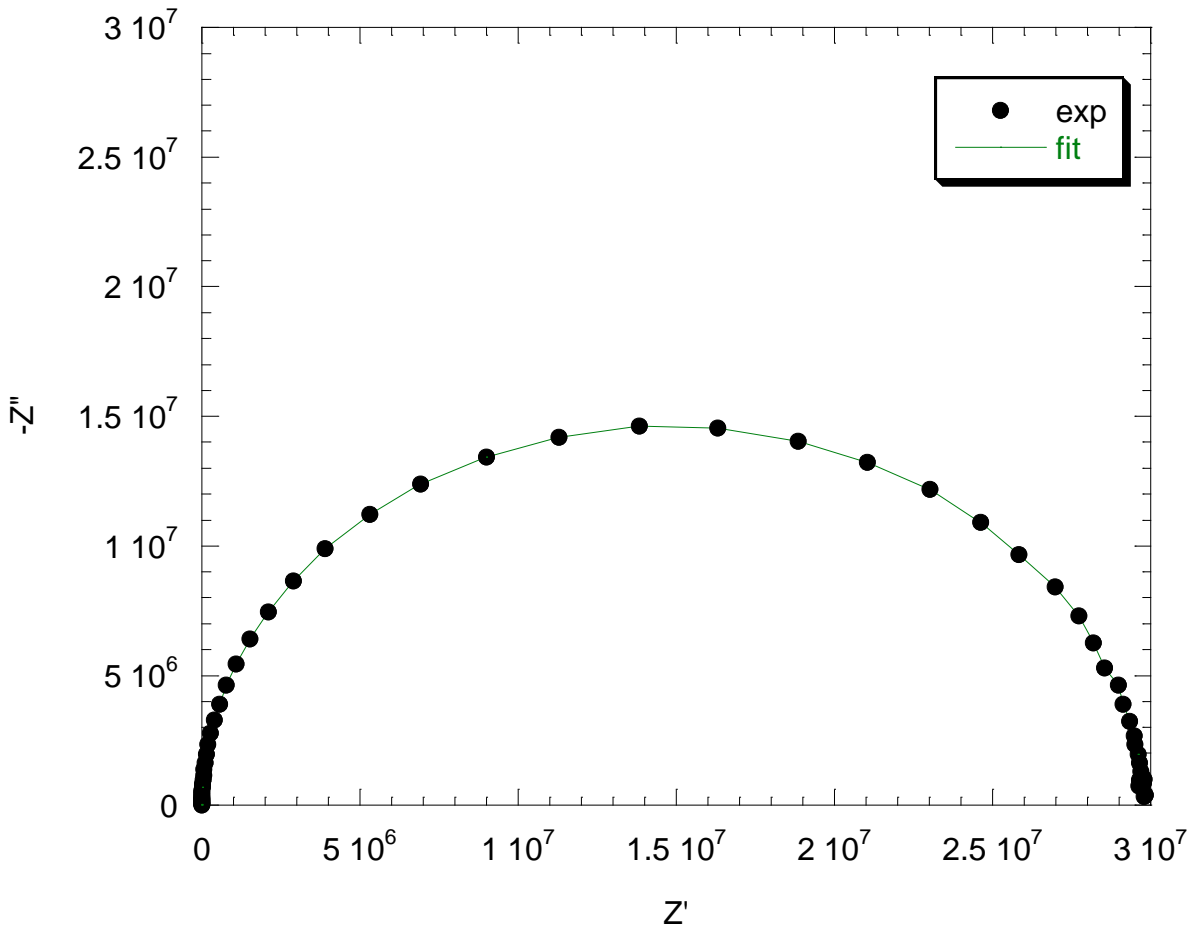
2% - Pt/Pt



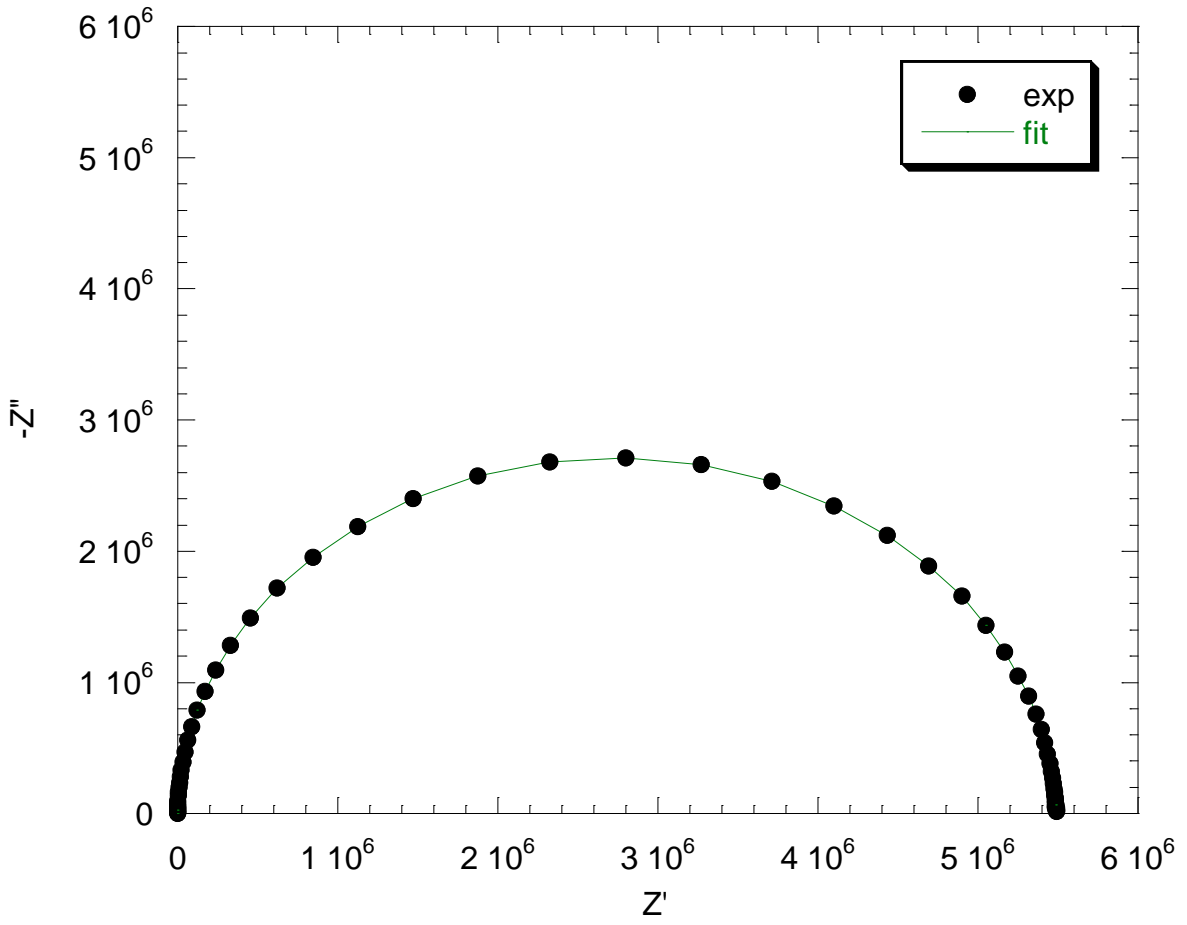
30% - Pt/Pt



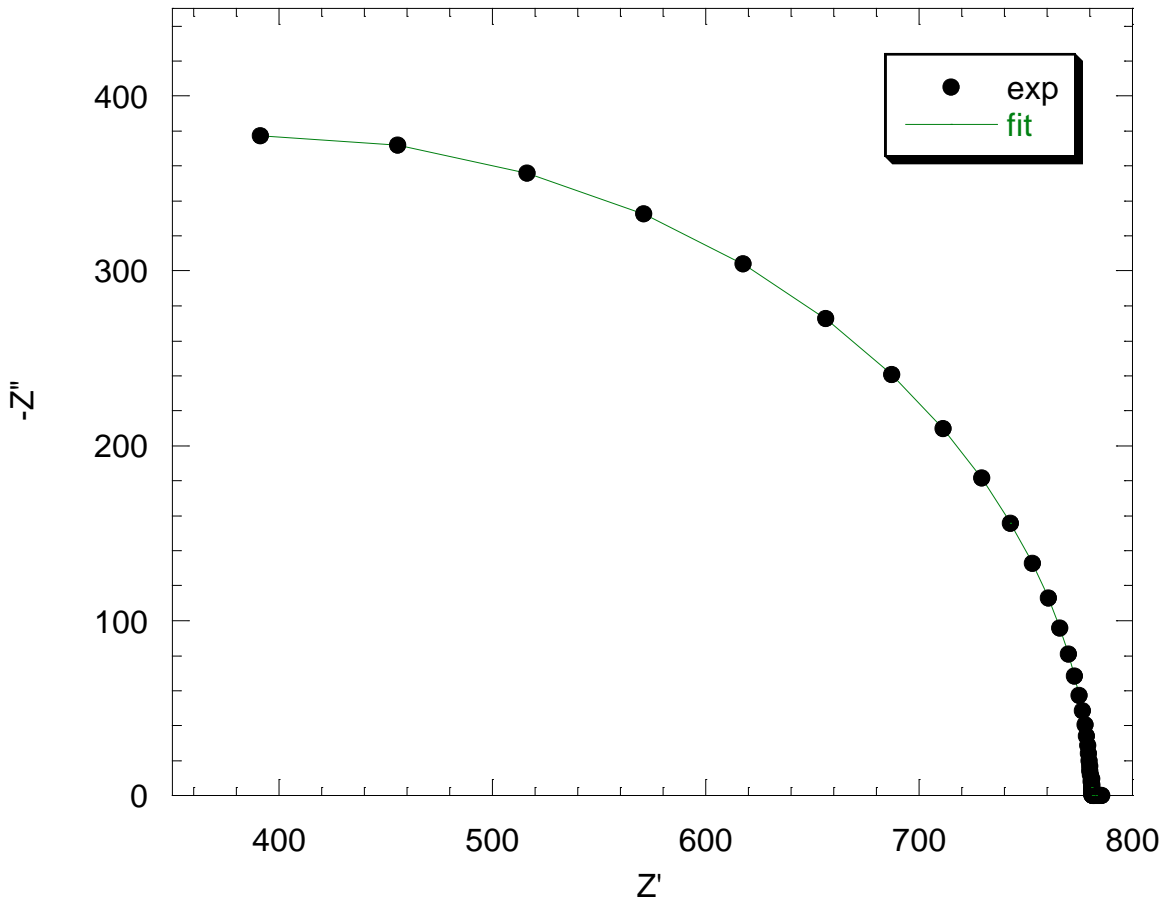
0% - Li/Li



10% - Li/Li

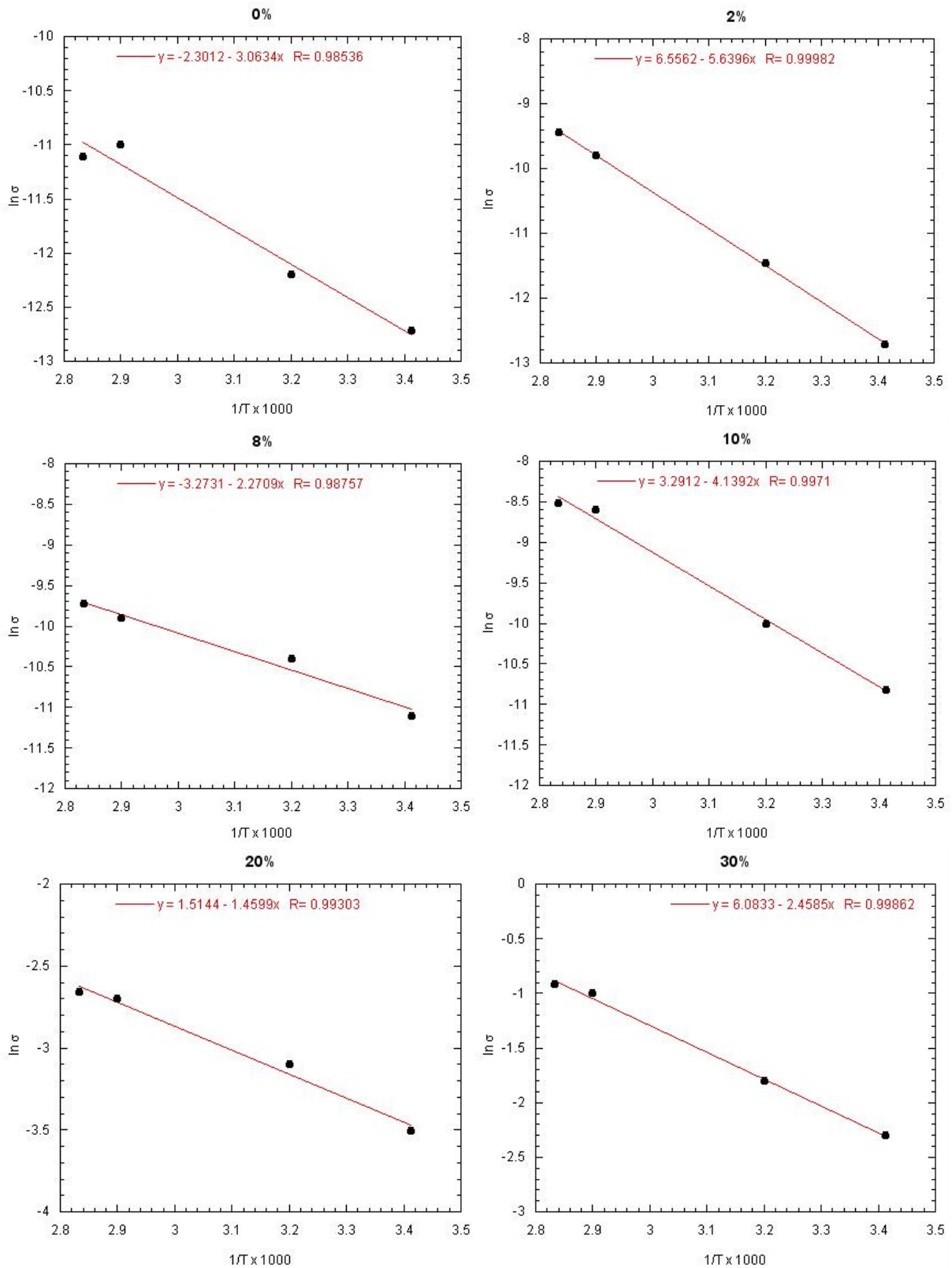


30% - Li/Li



S10. Arrhenius plots

Arrhenius Li



Arrhenius Na

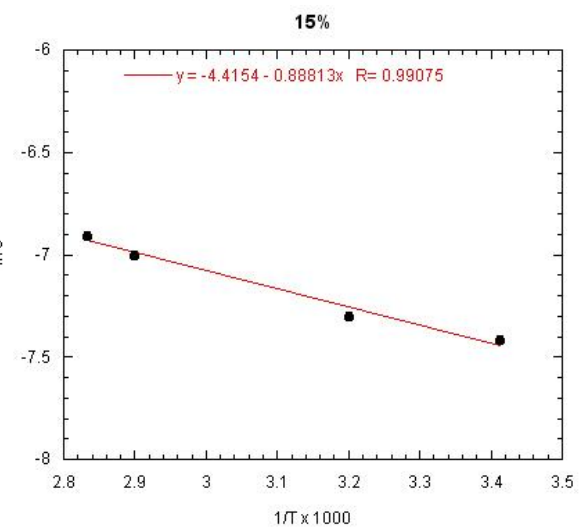
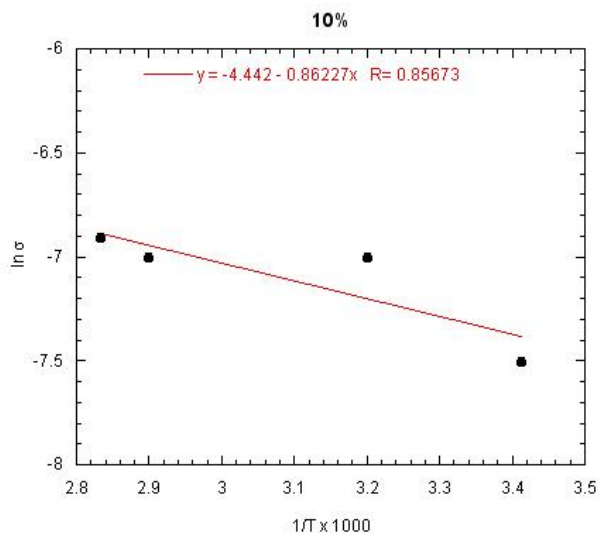
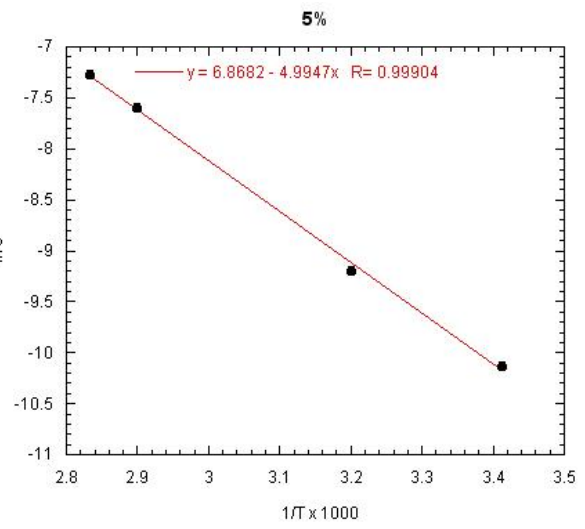
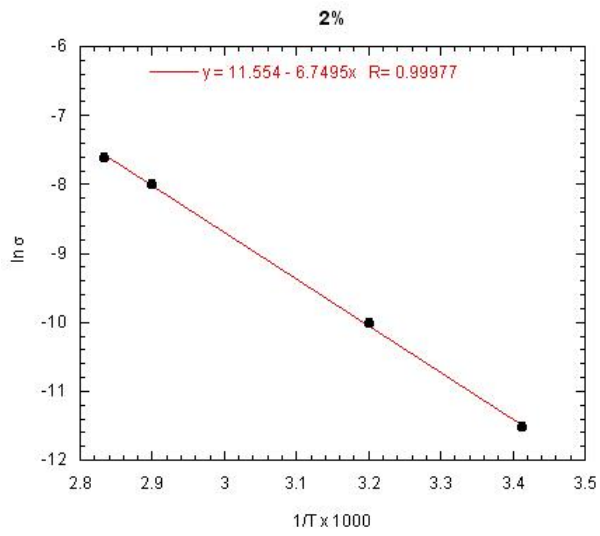
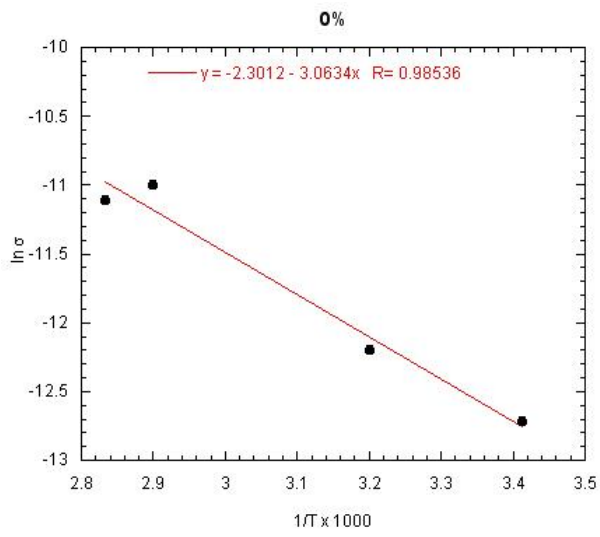


Table : Fitted equivalent circuit parameters (raw data).

Pt/heox/Pt

Electrical parameters	0%	2%	16.6%	30%
R1	1.4	1.2	1.4	1.3
R2	$3.6 \cdot 10^8$	$2.3 \cdot 10^7$	$4.6 \cdot 10^6$	254
Q2	$2.6 \cdot 10^{-10}$	$3.2 \cdot 10^{-10}$	$4.5 \cdot 10^{-10}$	$3.8 \cdot 10^{-10}$
α	0.99	0.98	0.98	0.98
C3	∞	∞	∞	∞
χ^2	10^{-4}	10^{-3}	10^{-2}	10^{-3}

Li/heox/Li

Electrical parameters	0%	10%	16.6%	30%
R1	1.3	1.2	1.4	1.2
R2	$2.9 \cdot 10^7$	$5.5 \cdot 10^6$	$9.4 \cdot 10^4$	781
Q2	$2.7 \cdot 10^{-10}$	$2.4 \cdot 10^{-10}$	$3.1 \cdot 10^{-10}$	$3.7 \cdot 10^{-10}$
α	0.99	0.99	0.99	0.98
Rct	2.0	2.5	2.5	2.1
Cp	$1.1 \cdot 10^{-3}$	$1.2 \cdot 10^{-3}$	$1.0 \cdot 10^{-3}$	$1.1 \cdot 10^{-3}$
α	0.99	0.99	0.99	0.99
χ^2	10^{-4}	10^{-3}	10^{-3}	10^{-3}

Chemical analysis

Chemical analysis was performed on pellets with a Panalytical X-ray spectrometer with a Rh tube for Co, Cu, Ni, Zn, Ga.

For Li, Na, Mg, Co, Ni, Cu, Zn the analysis was done on a Agilent VISTA spectrometer . 50 to 100 mg samples were dissolved in a hot mixture of pure concentrated HCl and HNO₃ (5:1 molar ratio). Standard samples were prepared in the similar mixture of HCl:HNO₃ . The following wavelength were used for analysis :

Li: 670.783 nm

Na 589.592; 558.995

Co 238.892; 237.863

Cu 324.754, 213.598

Zn 206.200; 334.502

Mg 279.563; 260.270

Ni 231.204; 216.555