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Supporting Information

Selection criteria for current collectors for highly efficient anode-free Zn batteries

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Gravimetric analsys be EQCM-D

As broadly described in our papers[1,2] once suitable gravimetric conditions are established i.e constant energy dissipation values overtones independent frequency changes, the following formula can be applied:

$$\Delta F_{theo} = \frac{C_m * Mw * Q}{nF}$$

where Cm is the mass sensitivity constant of 5MHz quartz sensor (56.6 Hz cm^2 /µg), Q is the obtained charge, Mw is the atomic mass of the inserted cation (i.e 65.38 g/mol for Zn^{2+}) in its desolvated form, n is the number of the electrons (2 in our case), and F is Faraday's constant.

In non-gravimetric situations, the theoretical frequency changes provide a useful indication of the real contribution of the electroactive mass to the entire frequency changes. Yet, as indicated throughout the manuscript, the actually measured frequency changes are strongly linked with the morphological and the viscoelastic state of the deposited mass, therefore they may strongly deviate from the values predicted by the above equation.

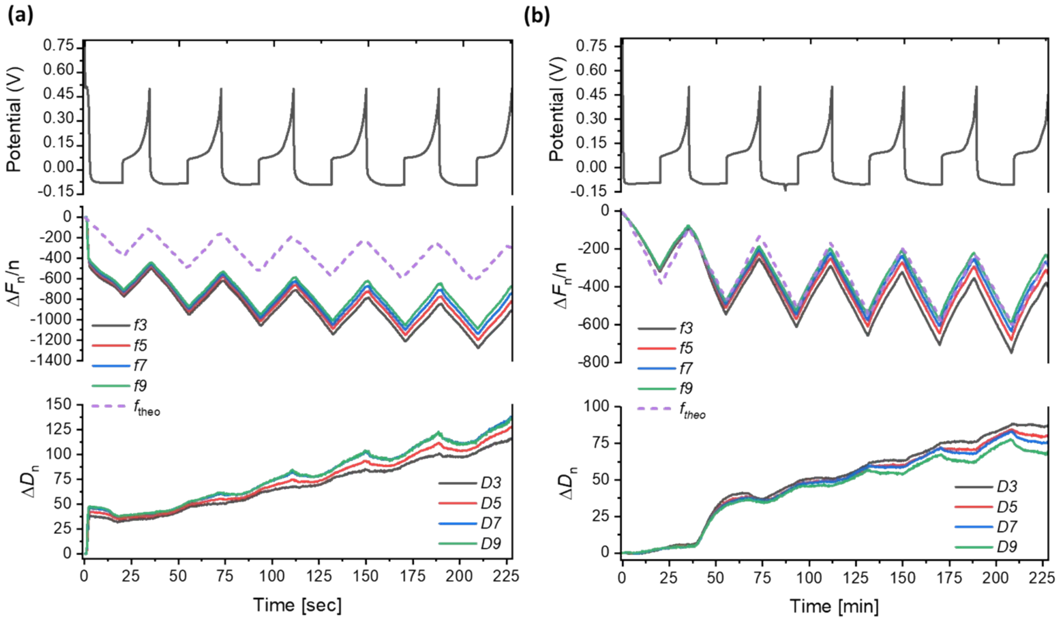

Figure S1. Multi harmonic variations in frequency and dissipation factor were measured during consecutive Zn deposition/stripping cycles on **(a)** Cu-coated quartz crystal and **(b)** Au-coated quartz crystal. The theoretical frequency is represented by dashed purple lines

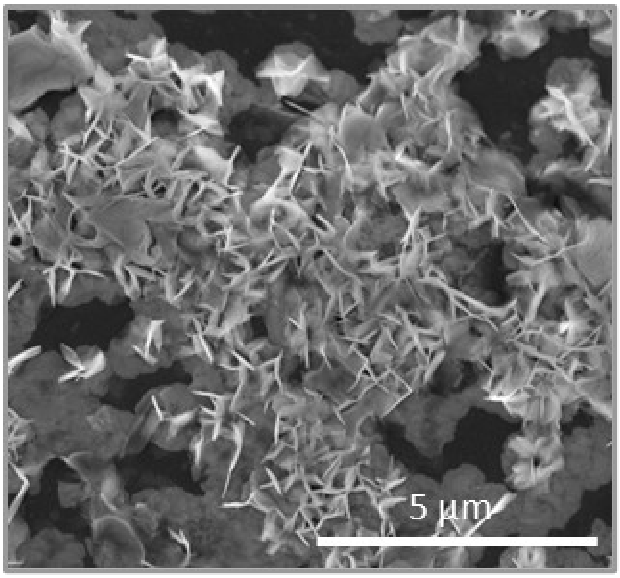

Figure S2. SEM images of the GF substrate following the first electrodeposition processes in a 1M $ZnSO_4$ electrolyte solution. The flatter, denser deposits are found below the perpendicularly oriented Zn crystals.

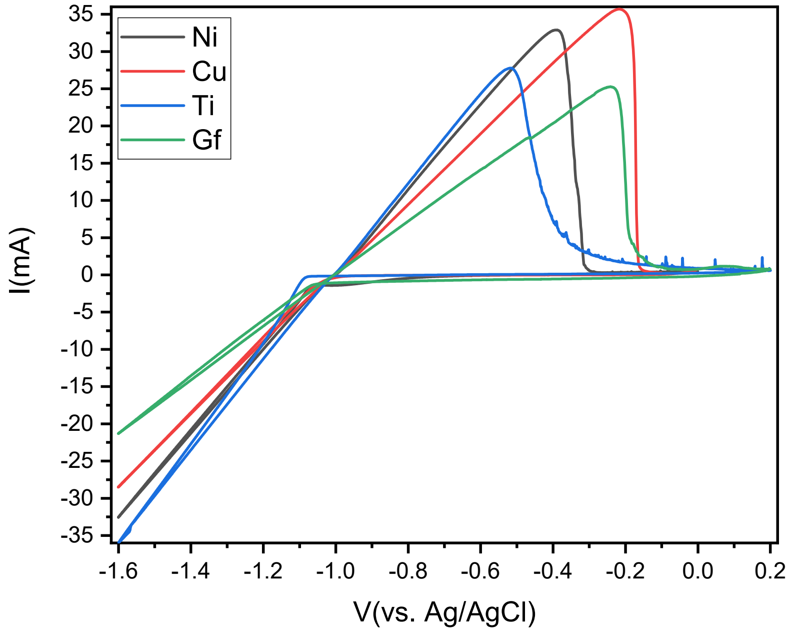

Figure S3. Cyclic voltammetry of Zn deposition and stripping on different substrates in 1 M $ZnSO_4$ at 10 mV/s. Potential is plotted versus Ag/AgCl reference electrode, Zn metal as counter.

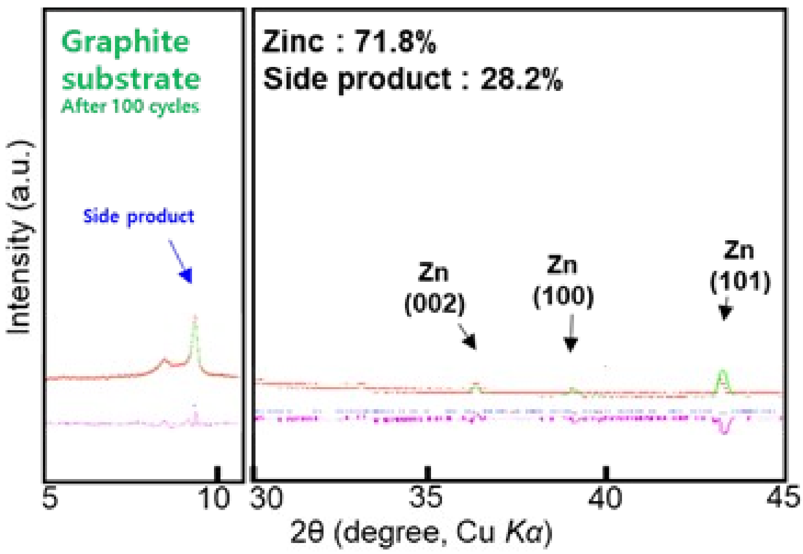

Figure S4. XRD diffraction obtained after the 100^{th} Zn deposition processes on grafoil substrate in 1M $ZnSO_4$ electrolyte solution.

Table S1. Properties of the different substrates and calaculatued energy density for Zn deposition of 5 mA/h on 1 cm^2 substrate

Substrate	**Thickness[μm]**	**Density[g/cm³]**	**Energy density [Wh/Kg]**	**Price per Kg[$]**
Ti	25	4.5	666.6666667	6.08
Cu	10	8.96	837.0535714	8.42
Ni	10	8.91	841.7508418	20.2
Gf	25	1.12	2678.571429	5