Support information

The EDL capacitance value (C_{el}) equals to the real surface area (S_r) times the specific double layer capacitance (C_{sdl}) of the electrode, namely,

$$C_{el} = S_r * C_{sdl} \qquad (1)$$

In general, the typical specific double layer capacitance values on some bare metals can range from 10 to 50 μF/cm^2 [1]. To estimate the real C_{sdl} of the used Ti discs as accurate as possible, we selected a dense Ti disc (Φ9×2 mm^3), having a total geometrical surface area of 1.84 cm^2 (including its two faces and a side-perimeter), for estimating the C_{sdl} values by EIS data by which the C_{el} value of the planer Ti disc can be extracted from its EDL capacitance–frequency plot at low frequencies, where the EDL capacitance was calculated based the following formula [2].

$$C'(\omega) = \frac{-Zim(\omega)}{\omega |Z(\omega)|^2} \qquad (2)$$

Where Zim(ω) is the imaginary part of the impedance Z(ω), ω is the angle frequency and C'(ω) stands for the real part of the EDL capacitance.

For the dense Ti disc, its EDL capacitance value of 82 μF (at 1 Hz) led to the C_{sdl} values of 42.3 μF/cm^2, being in the range of 10-50 μF/cm^2 for bare metals [1]. Thus, according to equation 1 and the capacitance values (at 1Hz) of pTi discs shown in Fig. 6, the real surface areas of the tested three pTi discs were calculated to be 29.8, 30.6 and 32.0 cm^2, respectively, yielding a mean value of 30.8 cm^2.

References:

1. M. E. Orazem, T. Bernard, *Electrochemical impedance spectroscopy*, John Wiley & Sons, 2011.

2. P. L. Taberna, P. Simon and J. F. Fauvarque, *Journal of the Electrochemical Society*, 2003, **150**, A292-A300.