Supporting Information

Zr-doped Ir as effective anode for refractory SMX degradation

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Scheme S1. Electrocatalytic Study

Estimation of the service life of electrodes

The service life of the electrode is closely related to the using conditions. At the same time, the service life of the dimensionally stable anode is too long to be calculated specifically. At present, the accelerated life test is an effective method to reduce lifetime, and the relationship between the actual service life and the using conditions is as follows[1, 2]:

$$\tau_2 = \tau_2\left({}^{i_1}/_{i_2}\right)^2 \quad \text{(S1)}$$

where τ2 is the actual service life (h), τ1 is the accelerated life (h), i1 is the current density of accelerated life test (A/m2), i2 is the current density in actual conditions (generally 1000 A/m2). Substituting the data in Figure 1(e-f) into the formula, it can be obtained that the actual life of the catalysts with different Ir: Zr mole ratios is all several decades.

Calculation of electrochemical specific surface area (ECSA).

The ECSA can be obtained by processing the charging current of the double-layer capacitor at different scan rates. For CVs in the range of 0.1 to 1.4 V_{RHE}, some potential regions of curves present reduction/oxidation peaks, which are mainly Faraday currents (i_F) with changes in oxidation states, while the flat portion without significant peaks is contributed by the charging currents (i_c). The CVs were performed in a potential range where no Faraday process occurs between scan rates of 20 and 100 mv·s^{-1} when measuring ECSA. So there is a linear relationship between the charging currents and the scanning rates where C_d is the capacitance of the double layer:

$$i_c = C_d v \quad \text{(S2)}$$

The values of ECSA can be estimated from Eq.(S2) where C_s is the specific capacitance of the electrode (general specific capacitances of Cs is 0.035 mF·cm^{-2}):

$$\text{ECSA} = {}^{C_d}/_{C_s} \quad \text{(S3)}$$

Figure 2a shows the CV curves with different scan rates for catalysts with different

Ir: Zr mole ratios in 0.1 M $HClO_4$. For a given potential (here is 0.9V vs. RHE) where the curves are flat, slopes of the current to scan rate are shown in Figure S1. The average of the slopes is C_d, and the calculation results are shown in the Figure 2b.

Calculation of Tafel slopes

The Tafel slope is obtained by fitting the low-current straight part of the Tafel curve, which is related to the surface state of the electrode material, solution concentration and temperature. At the same time, a smaller Tafel slope indicates that the electrochemical reaction is more likely to occur. In this experiment, staircase voltammetry measurements is used to measure the Tafel curve. With 10mV voltage as a step, each step is maintained for 100s to achieve the state of charge balance. Reading the current value after each step can effectively eliminate the influence of the capacitor current.

Scheme S2. Calculation of current efficiency (CE)

The values of CE can be calculated from Eq.(S3)[3] where COD_0 is the initial chemical oxygen demand (in g O_2/L), $COD_{\Delta t}$ is the chemical oxygen demands at time Δt (in g O_2/L), I is the electrolysis current (A), V is the volume of wastewater (L), and F is Faraday constant (96500 C/mol).

$$CE = \frac{COD_0 - COD_{\Delta t}}{8I\Delta t}FV \quad (S4)$$

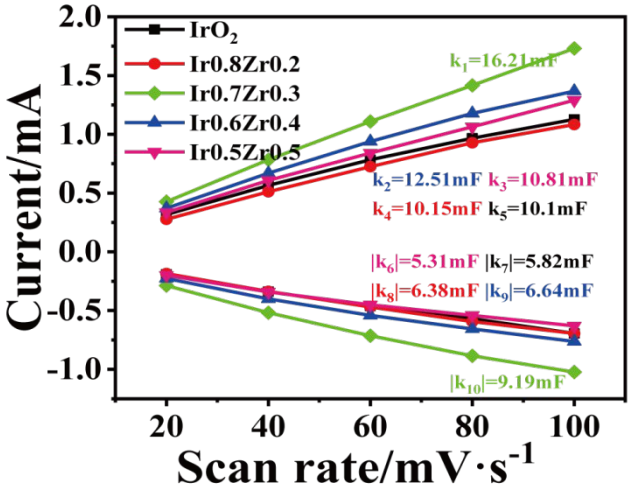

Figure S1. Slopes of the current to different scan rates

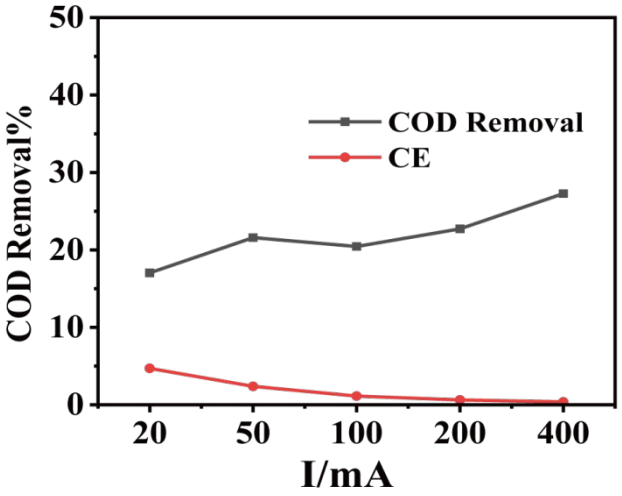

Figure S2. COD removal and CE after 4 h under different currents

References Section

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