**Supplementary Information**

**Novel Franklinite-like Synthetic Zinc Ferrite Redox Nanomaterial, with Controlled Composition, for Reductive and Oxidative Degradation of Diclofenac**

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Eighteen Figures and one table

**Figures**

**Fig. S1:** Collecting the nanomaterial from solution using a magnet

**Fig. S2:** HR-TEM images of various mixtures of the ZnxFe3-xO4 samples show crystallized nanoparticles with an average diameter measuring (A) 41 nm for Zn0.1Fe2.7O4 (B) 34 nm for Zn0.3Fe2.7O4 (C) 26 nm for Zn0.7Fe2.3O4 (D) and 31 nm for Zn1.0Fe2.0O4.

**Fig. S3:** Schematic of two subcells of a unit cell of the spinel structure, showing octahedral (A) and tetrahedral (B) sites.

**Fig. S4:** (A) Survey scans from Zn1.0Fe2.0O4; (B) Deconvoluted C1s XP core level from Zn1.0Fe2.0O4; (C) O 1s XP core level from Zn1.0Fe2.0O4; (D) Fe2p XP core level from Zn1.0Fe2.0O4; (E) Zn 2p XP core level from Zn1.0Fe2.0O4.

**Fig. S5:** (A) Survey scans from Zn0.7Fe2.3O4; (B) Deconvoluted C1s XP core level from Zn0.7Fe2.3O4; (C) O 1s XP core level from Zn0.7Fe2.3O4; (D) Fe2p XP core level from Zn0.7Fe2.3O4; (E) Zn 2p XP core level from Zn0.7Fe2.3O4.

**Fig. S6:** (A) Survey scans from Zn0.3Fe2.7O4; (B) Deconvoluted C1s XP core level from Zn0.3Fe2.7O4; (C) O 1s XP core level from Zn0.3Fe2.7O4; (D) Fe2p XP core level from Zn0.3Fe2.7O4; (E) Zn 2p XP core level from Zn0.3Fe2.7O4.

**Fig. S7:** (A) Survey scans from Zn0.1Fe2.9O4; (B) Deconvoluted C1s XP core level from Zn0.1Fe2.9O4; (C) O 1s XP core level from Zn0.1Fe2.9O4; (D) Fe2p XP core level from Zn0.1Fe2.9O4; (E) Zn 2p XP core level from Zn0.1Fe2.9O4.

**Fig. S8:** (A) Survey scans from Zn1.0Fe2.0O4 after use; (B) Deconvoluted C1s XP core level from Zn1.0Fe2.0O4 after use; (C) O 1s XP core level from Zn1.0Fe2.0O4 after use; (D) Fe2p XP core level from Zn1.0Fe2.0O4 after use; (E) Zn 2p XP core level from Zn1.0Fe2.0O4 after use.

**Fig. S9:** (A) Survey scans from Zn1.0Fe2.0O4 after use; (B) Deconvoluted C1s XP core level from Zn1.0Fe2.0O4 after second reuse; (C) O 1s XP core level from Zn1.0Fe2.0O4 after use; (D) Fe2p XP core level from Zn1.0Fe2.0O4 after use; (E) Zn 2p XP core level from Zn1.0Fe2.0O4 after use.

**Fig. S10:** X-ray absorption near-edge structure (XANES) K-edge spectroscopy of Zn1.0Fe2.0O4 for Zn (A) and Fe (B). Black curves are the normalized XANES spectra and red curves are derivatives of the normalized XANES spectra.

**Fig. S11:** K-edge Zn and Fe k3-weighted χ functions for Zn1.0Fe2.0O4.

**Fig.** **S12:** Radial structure functions obtained by Fourier transformation of the K-edge Zn (A) and Fe (B) spectra (black curve) and fitting parameter results (red curve). The fit results are summarized in Table 3.

**Fig. S13:** The UV/Vis spectrum for reduction of behavior of KMnO4 using Zn1.0Fe2.0O4. Experimental conditions are: Zn1.0Fe2.0O4 = 0.17 g/L, [KMnO4]0= 1.0 N.

**Fig. S14:** (A); KMnO4 and Zn1.0Fe2.0O4 at 0 min reaction time,(B); KMnO4 and Zn1.0Fe2.0O4 at 80 min reaction time,(C); KMnO4 and Zn1.0Fe2.0O4 at 215 min reaction time,(D); KMnO4 and Zn1.0Fe2.0O4 at 370 min reaction time,(E) KMnO4 ONLY at 370 min reaction time. Experimental conditions are: Zn1.0Fe2.0O4 = 0.17 g/L, [KMnO4]0= 1.0 N.

**Fig. S15:** The effect of different pH on the degradation of DCF using Zn1.0Fe2.0O4 = 0.17 g/L, [DCF]0= 10 µM.

**Fig. S16** Effect florescence light and dark conditions on overall degradation on DCF at 240 min. Experimental conditions are: Zn1.0Fe2.0O4 = 0.17 g/L, [DCF]0= 50 µM.

**Fig. S17** Zn1.0Fe2.0O4 reusability performance on the degradation on DCF at 60 min. Experimental conditions are: = 0.17 g/L, [DCF]0= 10 µM.

**Fig. S18** Effect of different initial concentration of DCF (1, 5, 10 and 15 µM) on the overall degradation of DCF at 240 min using Zn1.0Fe2.0O4 = 0.17 g/L.

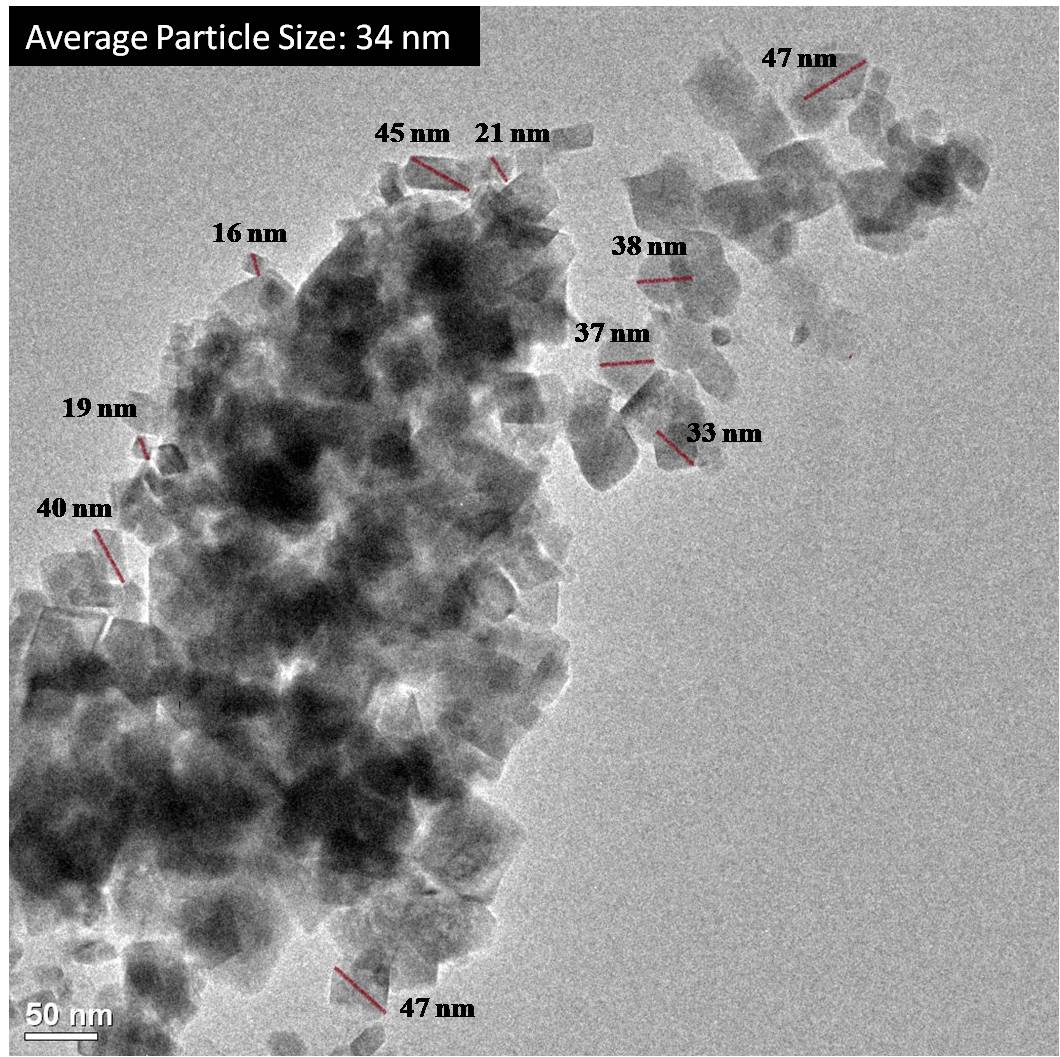
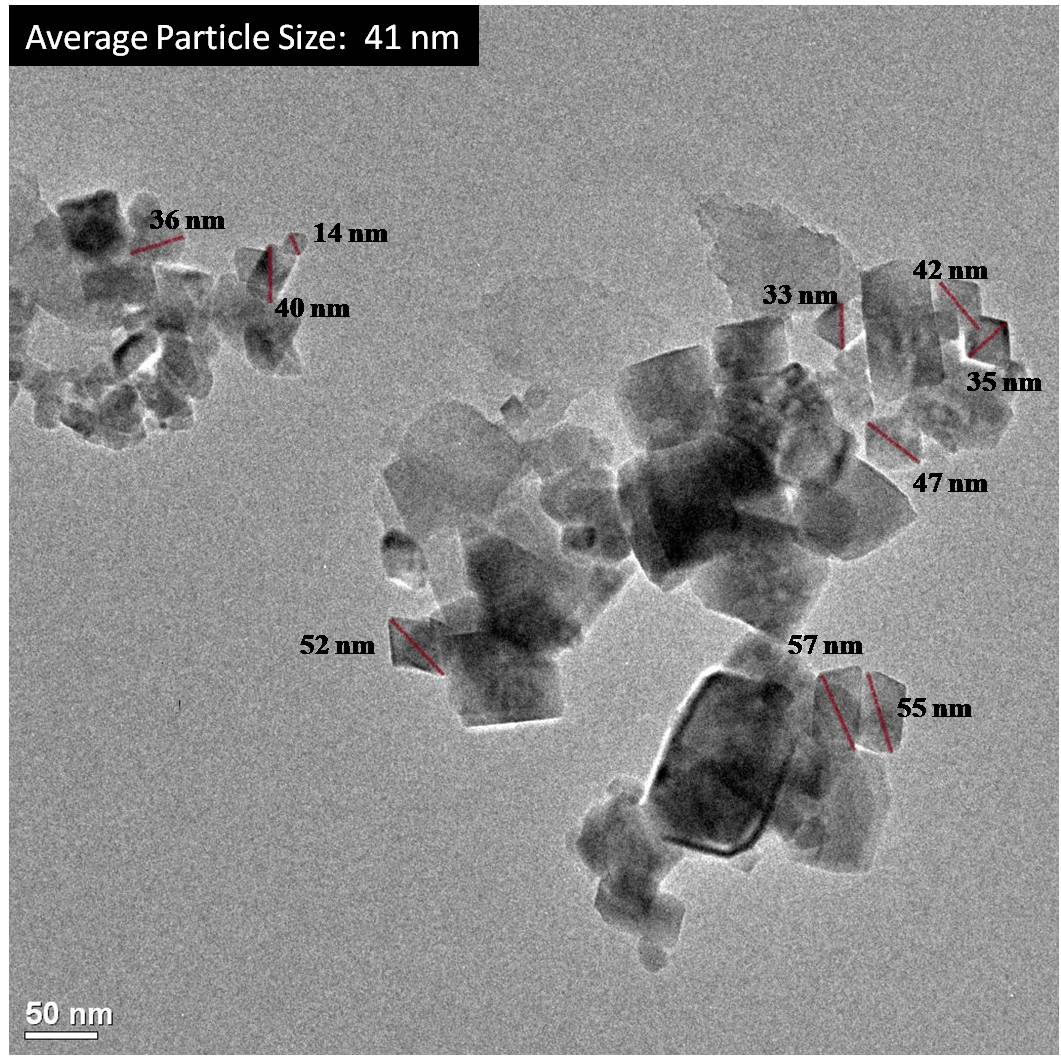
**Tables;**

**Table S1:** LC/Q-TOF-ESI-MS results collected during the degradation of DCF measurement of chromatogram peak area corresponding to each transformation products at each time interval according to their suggested molecular weight (MW), formula, and *m/z*. Experimental conditions are weight of Zn1.0Fe2.0O4 = 0.17 g/L, [DCF]0= 30 µM.

**Fig. S1**

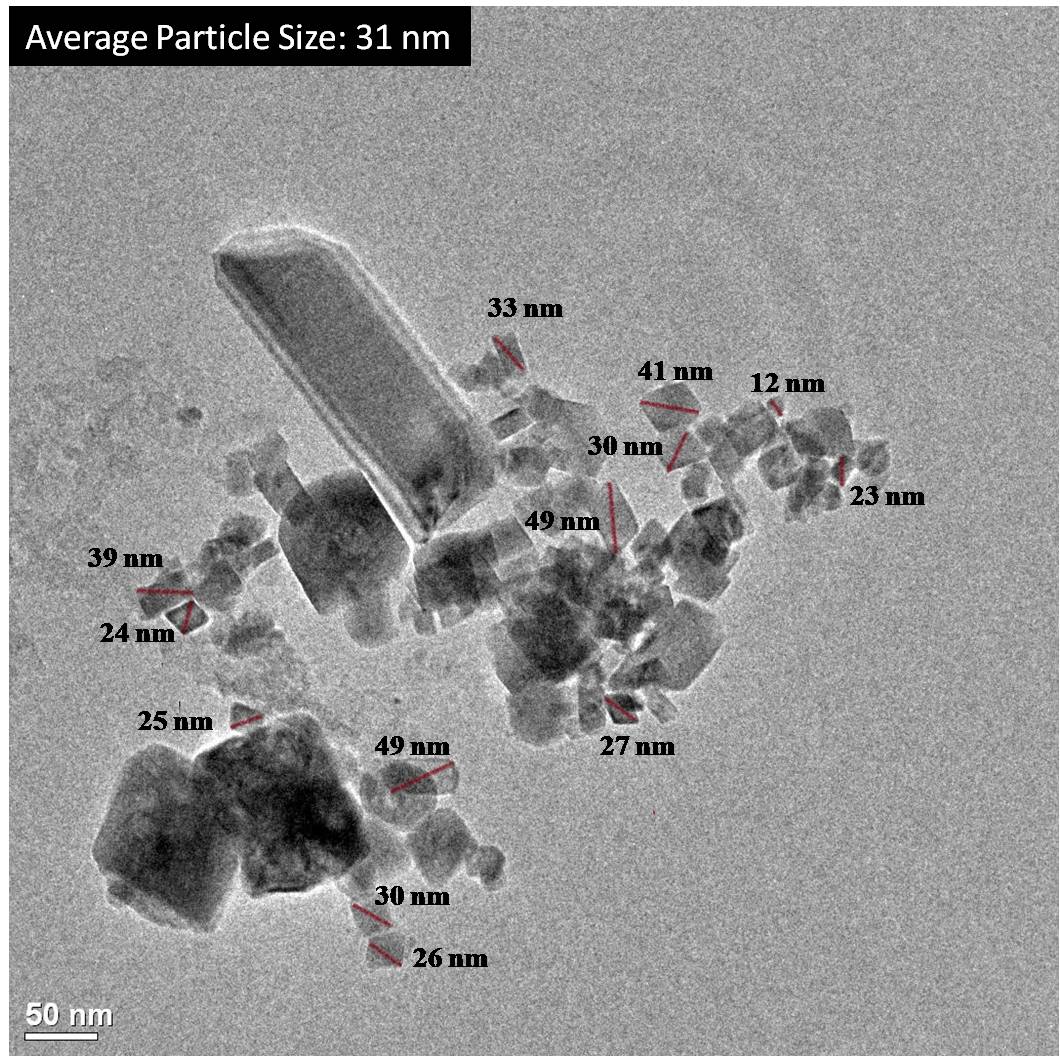
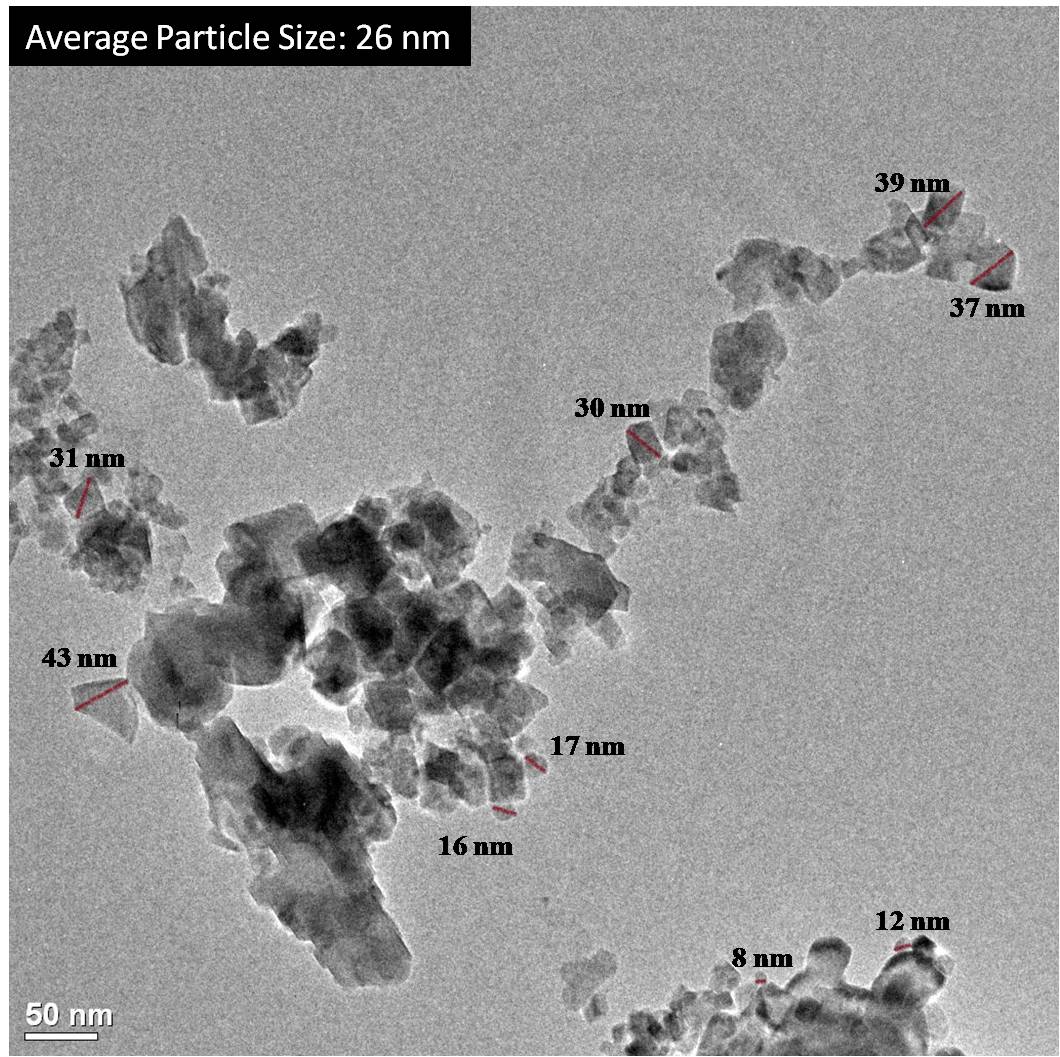


**Fig. S2** **(A, B, C and D)**



**(A)**

**(B)**



**(C)**

**(D)**

**Fig. S3**



**Fig. S4**

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**Fig. S5**

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**Fig. S6**

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**Fig. S7**

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**Fig. S8**

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**Fig. S9**

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**Fig. S10 (A and B)**





**Fig. S11**



**Fig. S12 (A and B)**





**Fig. S13**



**Fig.S14**



**A**



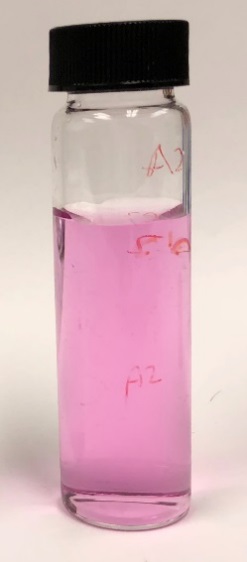
**B**



**C**



**D**



**E**

**Fig. S15.**



**Fig. S16.**



**Fig. S17**



**Fig. S18**



**Table S1**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Formula** | **MW** | **ID** | ***m/z*** |  | **Reaction Time (min)** | | | | | | | |
|  | ***0*** | ***1*** | ***2*** | ***4*** | ***8*** | ***16*** | ***30*** | ***60*** |
| **C14 H11 Cl2 N O2** | 295 | DCF | 296.024 |  | 417531 | 141639 | 97038 | 80575 | 95064 | 79231 | 60696 | 57465 |
| **C14 H11 N O2** | 265 | P9 | 266.01 |  | 0 | 53605 | 70341 | 69720 | 74237 | 65906 | 63858 | 62327 |
| **C6 H4 Cl2 O2** | 177.96 | P4 | 178.96 |  | 0 | 30176 | 48327 | 42476 | 45370 | 44370 | 44309 | 43767 |
| **C6 H4 Cl2 O3** | 193.95 | P5 | 194.954 |  | 0 | 58272 | 16472 | 15695 | 15964 | 17804 | 18059 | 13144 |
| **C8 H8 O4** | 168 | P3 | 169.042 |  | 0 | 20805 | 34340 | 32991 | 31079 | 29023 | 27789 | 31859 |
| **C14 H13 N O2** | 227.09 | R3 | 228.1019 |  | 0 | 576051 | 2180907 | 180391 | 286452 | 705148 | 961170 | 121560 |
| **C14 H11 N O2** | 225 | R2 | 226.086 |  | 0 | 21523 | 26649 | 26301 | 25808 | 25738 | 26930 | 25311 |
| **C14 H12 Cl N O2** | 261 | R1 | 262.0629 |  | 0 | 66832 | 64743 | 71385 | 81619 | 155016 | 80140 | 62536 |
| **C14 H11 Cl2 N O3** | 311 | P6 | 310.003 |  | 0 | 23300 | 35401 | 34778 | 34187 | 31919 | 29968 | 33632 |
| **C8 H9 N O2** | 151 | P1 | 152.0706 |  | 0 | 69599 | 93789 | 95368 | 82679 | 76214 | 78993 | 81223 |
| **C13 H9 Cl2 N O2** | 281 | P8 | 282.008 |  | 0 | 5673 | 8458 | 9600 | 9023 | 9826 | 7202 | 6821 |
| **C13 H11 Cl2 N O** | 267 | P7 | 268.029 |  | 0 | 33430 | 43296 | 39342 | 41289 | 43761 | 42030 | 6821 |

**Table S1.** LC/Q-TOF-ESI-MS results collected during the degradation of DCF measurement of chromatogram peak area corresponding to each transformation products at each time interval according to their suggested molecular weight (MW), formula, and *m/z*,. Experimental conditions are weight of Zn1.0Fe2.0O4 = 0.17 g/L, [DCF]0= 30 µM