Electronic Supplementary Information

I. Scanning Electron Microscopy (SEM)

The abbreviation Ag_xFeO_2, where x = Ag content, is used here for simplicity. Representative Ag_xFeO_2 samples of varying silver content (x = 0.4, x = 1.0) were prepared for SEM on double-sided carbon tape (Ted Pella). SEM images were collected on a JEOL JSM-6010PLUS in secondary electron imaging mode at 5kX and 10 kX magnification, **Figure S1**. SEM shows that the nanocrystalline silver ferrite materials consist of small primary particles which aggregate into larger granular particles 1 to 5 microns in diameter. No significant difference in particle size or morphology was seen as a function of silver content.

II. Extended X-ray Absorption Fine Structure (EXAFS)

EXAFS modeling was carried out using the ARTEMIS which uses FEFF6 calculation to determine the scattering paths out to a distance of 6 Å from the photoabsorbing atom. The crystallographic information files (CIFs) used to calculate the scattering paths were obtained using the International Crystal Structure Database (ICSD# 31919). The R-space data was obtained by taking the Fourier transform of k-space data between 2 and 10 $Å^{-1}$ with Hanning windows (dk = 0.5). The EXAFS data was fit to the paths with the most significant contributions within the fitting range (1.2 < R < 3.5 Å, Hanning, dR = 0) as determined by the FEFF6 calculation. The edge energy (ΔE_0) and the Debye-Waller factor (σ^2) were the same for all paths, however the amplitude reduction factor (S_0^2) and the change to the half-path length (ΔR) were fit for different groups of paths for each reference material. In total there were three groups of paths that were each fit independently with S_0^2 and ΔR terms: 1) the first shell (Fe-O paths at R_{eff} = 2.0 Å), 2) the second shell (Fe-Fe path at R_{eff} = 3.0 Å), and 3) the third shell (Fe-Ag and Fe-O paths between R_{eff} = 3.5 and 4.1 Å). A table of the fitting results is presented below (**Table ST1**).

The results of the fit are shown in **Figure S2** for x = 0.4, 0.6, 0.8, and 1.0 samples, with diamonds representing the measured data and solid lines as the EXAFS fit to the data. The solid black line shows the fitting window. The positions of the first two peaks in the spectrum are similar across all samples consistent with our XRD results. The third peak (between 3.0 and 3.5 Å) is dominated by the Fe-Ag scattering path and changes as a function of silver concentration. The intensity of the third shell compared to the first two shells decreases with decreasing nominal silver content is consistent with fewer silver atoms present.

III. Slow Scan Cyclic Voltammetry

Slow scan rate cyclic voltammetry was collected in a three-electrode configuration using Ag_xFeO_2 (x = 0.8) on the working electrode, lithium metal on the reference and counter electrodes. Electrolyte of 0.1 M $LiBF_4$ in 1:1 EC:DMC was used, with three cycles collected under voltage limits of 1.2 – 3.5 V and a scan rate of 0.05 mV s^{-1}. The resulting data is shown in **Figure S3**. The first cathodic scan showed a large irreversible peak near 2.0 V, with subsequent scans showing lower current reversible peaks.

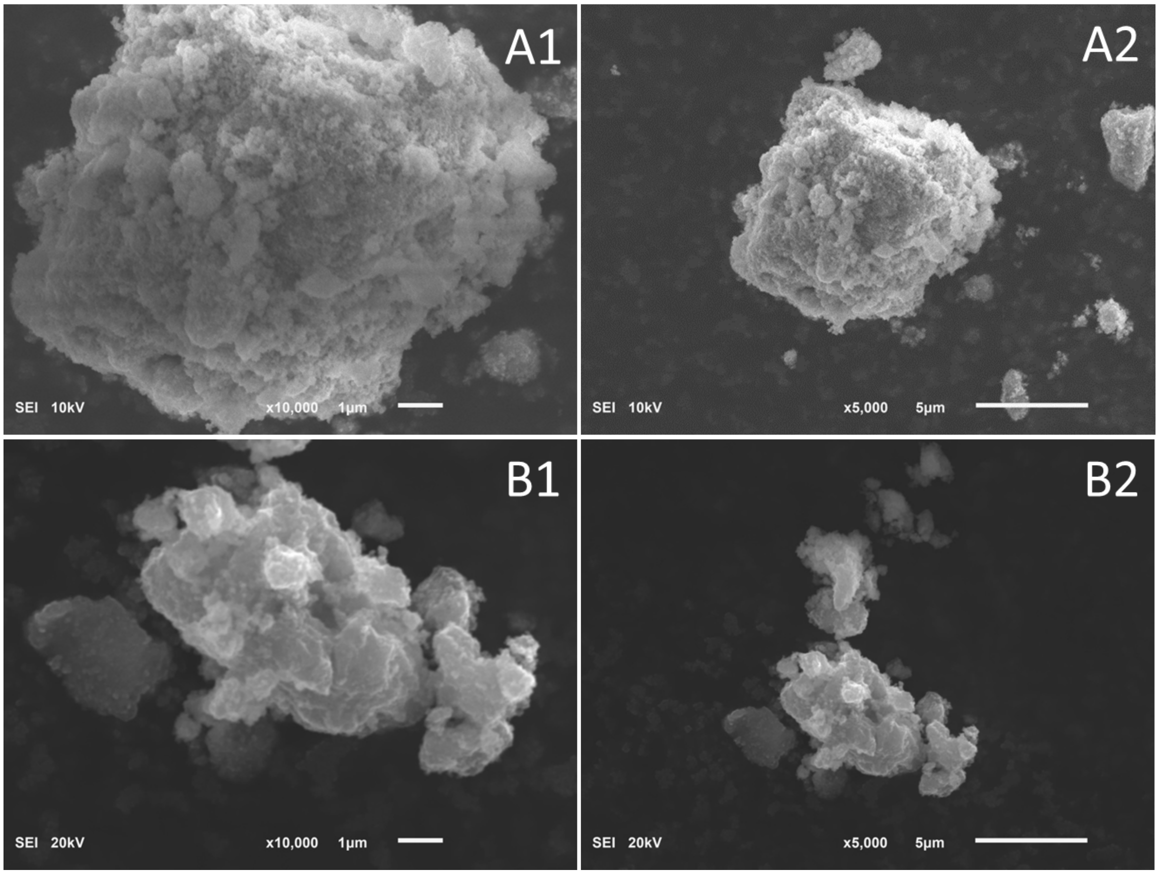

Figure S1: Scanning electron micrograph (SEM) images of Ag_xFeO_2. A) x = 1.0 and B) x = 0.4.

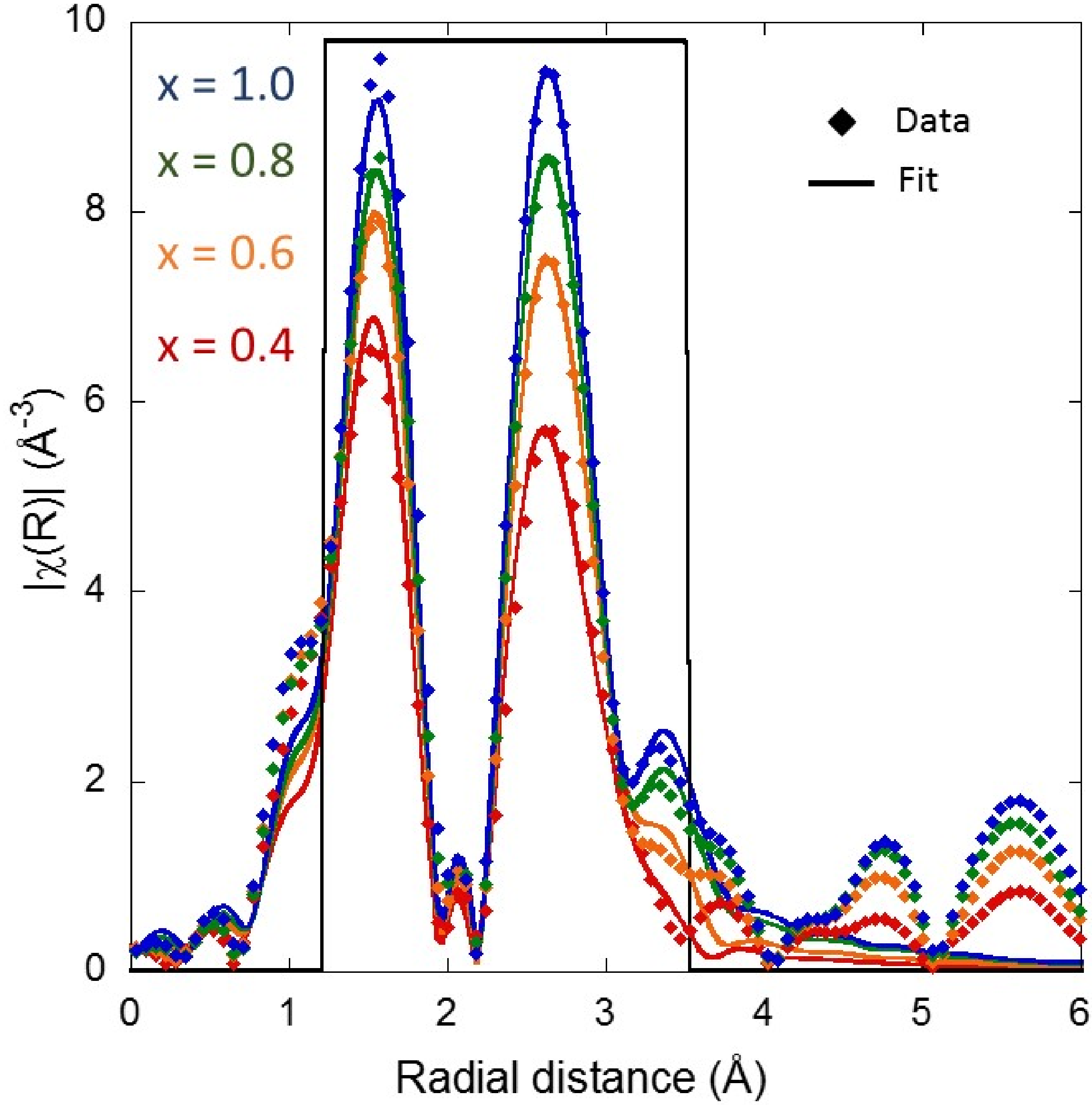

Figure S2: Fit to EXAFS region using ARTEMIS for samples of Ag_xFeO_2, x = 0.4, 0.6, 0.8, and 1.0. Diamonds represent the data and the solid lines are the fit as described in the text.

Table ST1: Table of EXAFS fit results

Shell	Parameter Name	X in Ag_xFeO_2	Value
All	ΔE_0	0.4 – 1.0	0.666(306)
	σ^2	0.4 – 1.0	0.0064(4)
First shell	S_0^2	1.0	0.766(34)
		0.8	0.702(52)
		0.6	0.666(25)
		0.4	0.565(26)
	ΔR	1.0	-0.021(4)
		0.8	-0.025(8)
		0.6	-0.029(4)
		0.4	-0.040(4)
Second shell	S_0^2	1.0	0.775(55)
		0.8	0.705(80)
		0.6	0.629(41)
		0.4	0.489(40)
	ΔR	1.0	0.009(4)
		0.8	0.010(8)
		0.6	0.006(4)
		0.4	-0.005(5)
Third shell	S_0^2	1.0	0.244(62)
		0.8	0.199(106)
		0.6	0.128(43)
		0.4	0.093(56)
	ΔR	1.0	-0.014(19)
		0.8	-0.010(40)
		0.6	0.036(35)
		0.4	0.093(47)

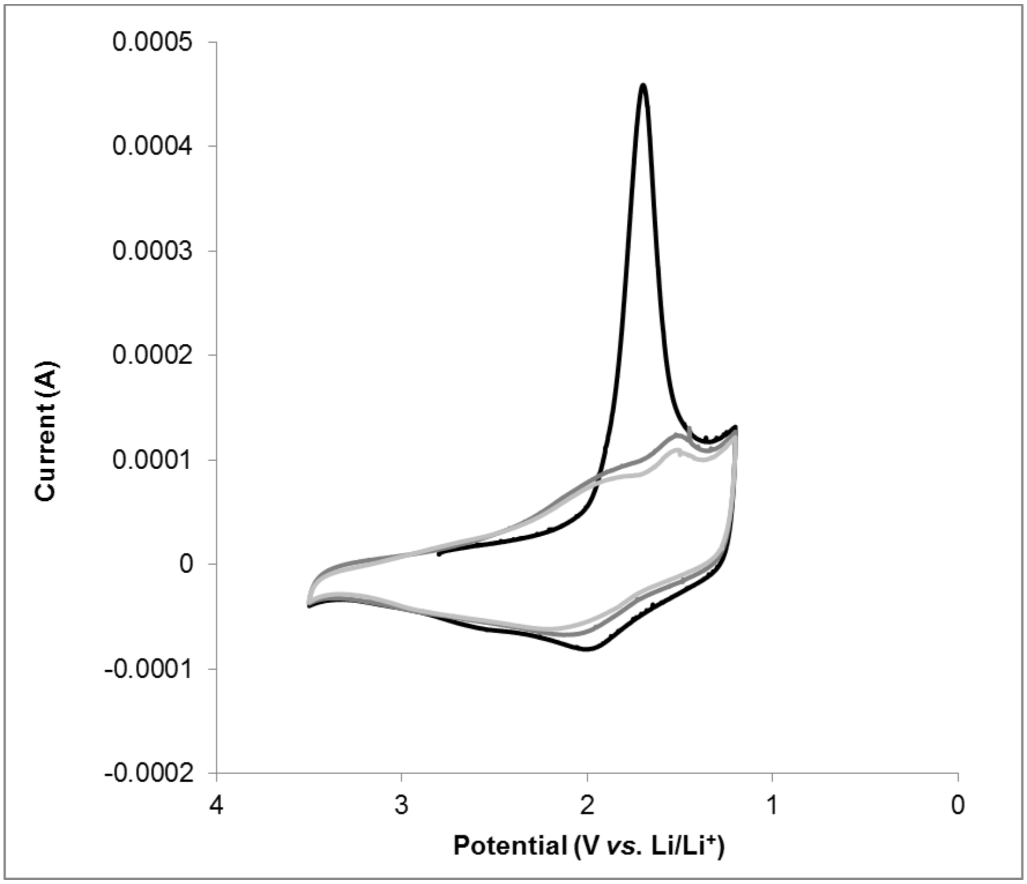

Figure S3: Slow scan rate voltammetry of Ag_xFeO_2 (x = 0.8) at 0.05 mV s^{-1} versus lithium metal reference.