Supplementary Information for

Incorporation of technetium into spinel ferrites

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Experimental

Table S1. Analytical data for Tc-doped spinel ferrites[a]

Sample[b]	% TcO_4^- removed[c]	%Tc recovered[d]	Size (nm)[e]	a (Å)	a (Å) (w/o Tc)	Fe(II)/Fe^{tot}	Fe(II)/Fe^{tot} (w/o Tc)
$Tc_{0.1}Mn_{1.1}Fe_{1.8}O_4$-o	99.975(2)	99(2)	19	8.4873(8)	8.4702(3)	0.11(2)	0.08(1)
$Tc_{0.1}Co_{1.1}Fe_{1.8}O_4$-o	99.921(3)	101(4)	42	8.4239(1)	8.4186(4)	0.18(5)	0.20(1)
$Tc_{0.1}Ni_{1.1}Fe_{1.8}O_4$-o	99.975(2)	97(1)	28	8.3881(4)	8.382(2)	0.05(1)	0.12(1)
$Tc_{0.1}Mg_{0.2}Fe_{2.7}O_4$-o	99.984(2)	111(4)	38	8.4017(1)	8.4009(5)	0.22(2)	0.25(1)
$Tc_{0.1}Mn_{0.2}Fe_{2.7}O_4$-o	99.909(4)	94(1)	41	8.4205(1)	8.4160(5)	0.22(1)	0.20(1)
$Tc_{0.1}Fe_{2.9}O_4$-o	99.937(3)	89(1)	42	8.3916(1)	8.3987(6)	0.22(1)	0.26(1)
$Tc_{0.1}Co_{0.2}Fe_{2.7}O_4$-o	99.884(4)	92(1)	46	8.4010(1)	8.3993(7)	0.27(1)	0.26(1)
$Tc_{0.1}Ni_{0.2}Fe_{2.7}O_4$-o	99.901(4)	94(1)	36	8.3936(1)	8.3927(5)	0.24(1)	0.22(1)
$Tc_{0.1}Mn_{1.1}Fe_{1.8}O_4$-c	99.763(7)	81(1)	24	8.4906(4)	8.481(1)	0.02(1)	0.09(1)
$Tc_{0.1}Co_{1.1}Fe_{1.8}O_4$-c	99.49(1)	83(2)	9.2	8.4081(7)	8.415(1)	0.26(1)	0.37(1)
$Tc_{0.1}Ni_{1.1}Fe_{1.8}O_4$-c	99.52(1)	93(2)	7.7	8.374(3)	8.372(1)	0.10(1)	0.13(1)
$Tc_{0.1}Mg_{0.2}Fe_{2.7}O_4$-c	99.884(5)	96(2)	9.2	8.375(1)	8.3966(6)	0.22(2)	0.34(1)
$Tc_{0.1}Mn_{0.2}Fe_{2.7}O_4$-c	99.833(6)	100(2)	13	8.3932(7)	8.4143(3)	0.18(2)	0.32(1)
$Tc_{0.1}Fe_{2.9}O_4$-c	99.820(6)	88(2)	12	8.3672(3)	8.3946(4)	0.23(1)	0.37(1)
$Tc_{0.1}Co_{0.2}Fe_{2.7}O_4$-c	99.750(7)	101(1)	10	8.3767(8)	8.3962(4)	0.25(1)	0.36(1)
$Tc_{0.1}Ni_{0.2}Fe_{2.7}O_4$-c	99.848(6)	95(2)	12	8.3916(8)	8.3869(4)	0.22(1)	0.31(1)

a) Standard deviations are given in parentheses in the same units as the last digit

b) Samples with an "o" suffix were prepared by oxidation; "c" by coprecipitation

c) TcO_4^- removed from solution during formation of Tc-doped spinel ferrite

d) Tc recovered by dissolving Tc-doped spinel ferrite

e) Crystallite (particle) diameter determined by Rietveld analysis

Table S2. K_d values for the synthesis of Tc-doped spinel ferrites[a]

Sample[b]	K_d (L/kg)
$Tc_{0.1}Mn_{1.1}Fe_{1.8}O_4$-o	1.07E+05
$Tc_{0.1}Co_{1.1}Fe_{1.8}O_4$-o	3.32E+04
$Tc_{0.1}Ni_{1.1}Fe_{1.8}O_4$-o	1.05E+05
$Tc_{0.1}Mg_{0.2}Fe_{2.7}O_4$-o	1.97E+05
$Tc_{0.1}Mn_{0.2}Fe_{2.7}O_4$-o	3.37E+04
$Tc_{0.1}Fe_{2.9}O_4$-o	5.00E+04
$Tc_{0.1}Co_{0.2}Fe_{2.7}O_4$-o	2.63E+04
$Tc_{0.1}Ni_{0.2}Fe_{2.7}O_4$-o	3.09E+04
$Tc_{0.1}Mn_{1.1}Fe_{1.8}O_4$-c	1.41E+04
$Tc_{0.1}Co_{1.1}Fe_{1.8}O_4$-c	6.41E+03
$Tc_{0.1}Ni_{1.1}Fe_{1.8}O_4$-c	6.82E+03
$Tc_{0.1}Mg_{0.2}Fe_{2.7}O_4$-c	3.32E+04
$Tc_{0.1}Mn_{0.2}Fe_{2.7}O_4$-c	2.24E+04
$Tc_{0.1}Fe_{2.9}O_4$-c	2.11E+04
$Tc_{0.1}Co_{0.2}Fe_{2.7}O_4$-c	1.49E+04
$Tc_{0.1}Ni_{0.2}Fe_{2.7}O_4$-c	2.49E+04

a) Note that K_d may not be particularly meaningful in this context since ^{99}Tc is incorporated into the lattice of the solid rather than being adsorbed on the surface.

b) Samples with an "o" suffix were prepared by oxidation; "c" by coprecipitation

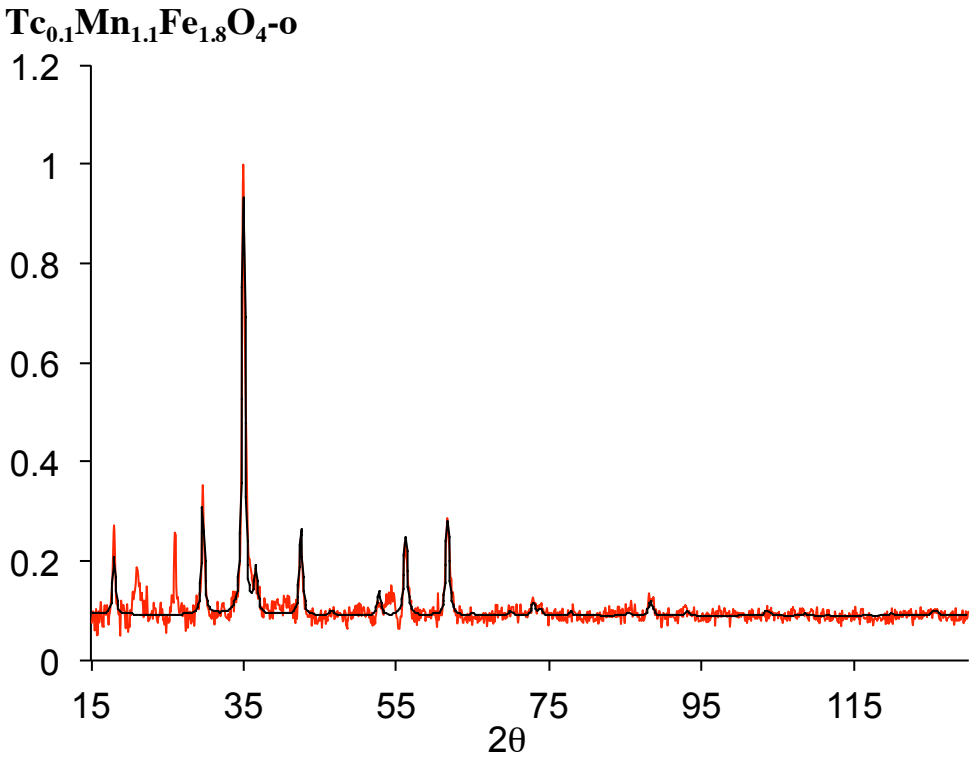

Figure S1: XRD pattern for $Tc_{0.1}Mn_{1.1}Fe_{1.8}O_4$-o (Data in color; Rietveld fit in black)

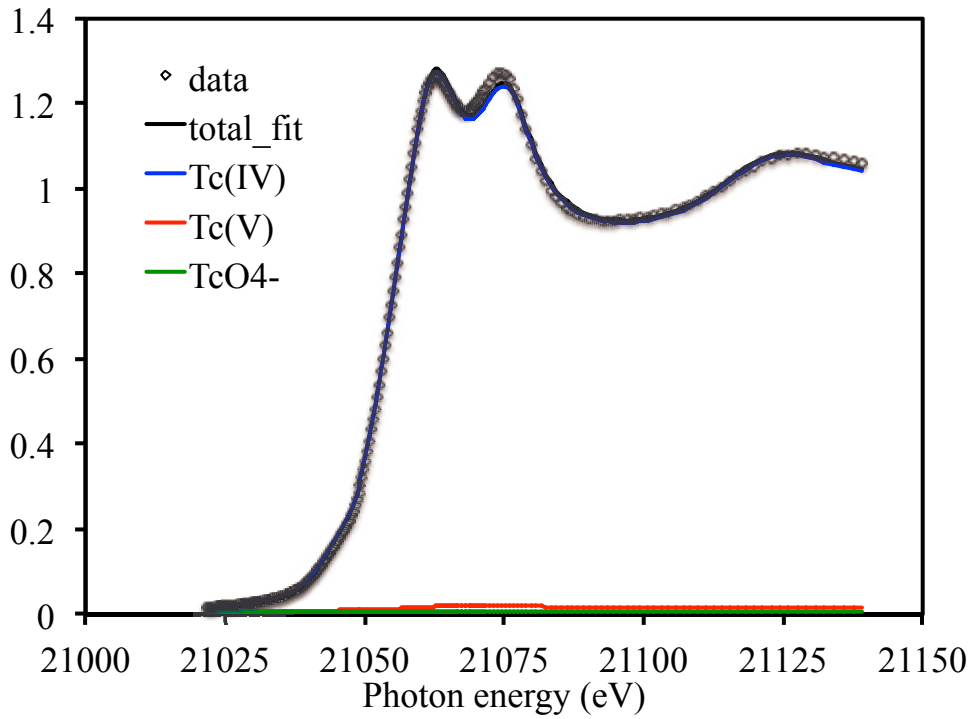

Figure S2: XANES fit for $Tc_{0.1}Mn_{1.1}Fe_{1.8}O_4$-o

Table S1: Best EXAFS fit parameters $Tc_{0.1}Mn_{1.1}Fe_{1.8}O_4$-o

Neighbor	# of Neighbors	σ^2 (Å^2)	Distance (Å)	O_h Fe_3O_4 (Å)	p
O	0.28(8)	0.001	1.59(1)	--	<0.001
O	5.72(8)[b]	0.0038(2)	2.025(3)	2.06	<0.001
Fe	4.0(1)	0.0035(8)	3.087(7)	2.97	<0.001
Tc	2.0(1)[b]	0.0035(8)[c]	3.087(7)[c]	2.97	0.018
Fe	6	0.0125(9)	3.565(8)	3.48	<0.001
O	8	0.021(6)	3.26(3)	3.57	0.009
O-Tc-O (MS)	6	0.016(2)	4.21(3)	4.12	0.002
Fe	12	0.016(2)[c]	5.27(2)	5.14	0.001

a) Fit range: 2<k<13.5, 1<R<5.2; 32.4 independent data. 15 parameters, $S_0^2 = 0.8$, $\Delta E_0 = 4.0(5)$ eV, $\chi^2 = 828$ $\chi_\nu^2 = 53.7$ R = 0.005. Parameters without errors are fixed.

b) Parameter is constrained to equal 6 minus the preceding parameter

c) Parameter constrained to equal the preceding parameter

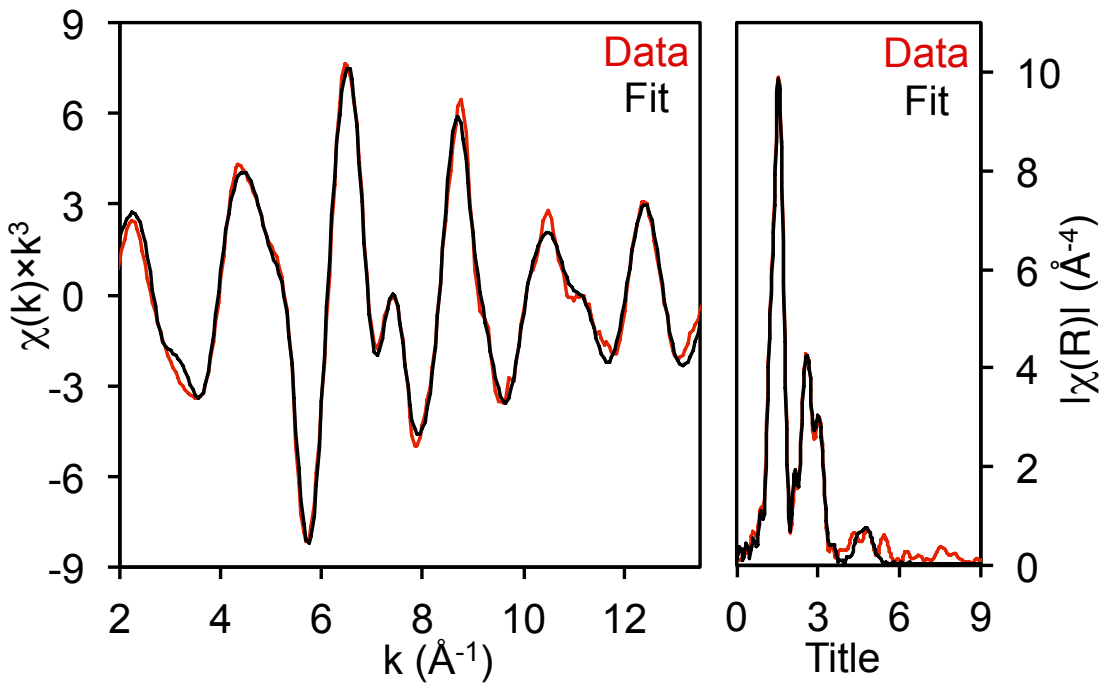

Figure S3: Tc K-edge EXAFS spectrum of Tc in $Tc_{0.1}Mn_{1.1}Fe_{1.8}O_4$-o

$Tc_{0.1}Co_{1.1}Fe_{1.8}O_4$-o

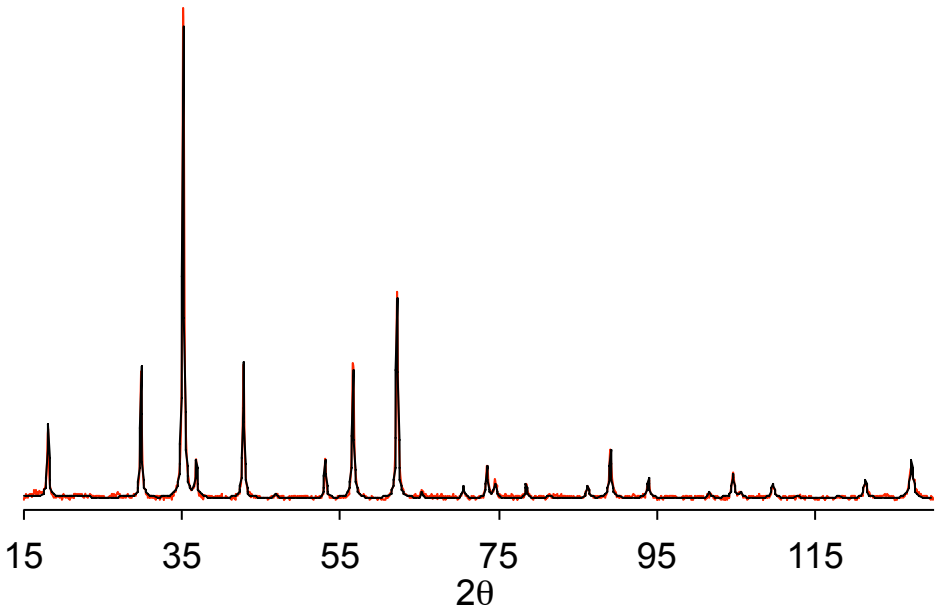

Figure S4: XRD pattern for $Tc_{0.1}Co_{1.1}Fe_{1.8}O_4$-o (Data in color; Rietveld fit in black)

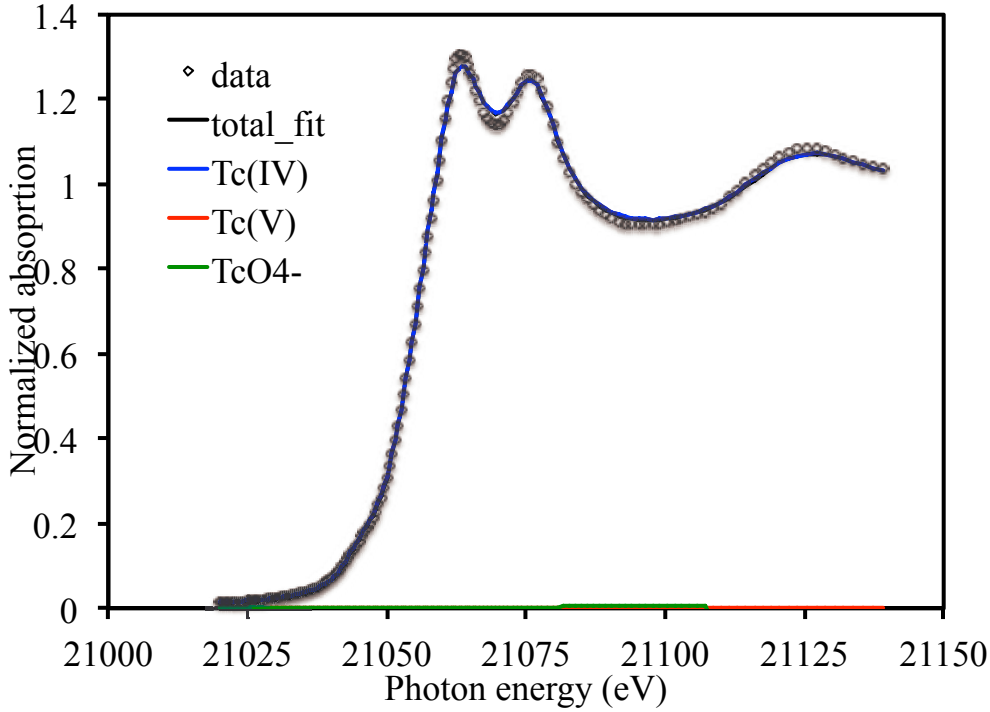

Figure S5: XANES fit for $Tc_{0.1}Co_{1.1}Fe_{1.8}O_4$-o

Table S2: Best EXAFS fit parameters $Tc_{0.1}Co_{1.1}Fe_{1.8}O_4$-o

Neighbor	# of Neighbors	σ^2 (Å^2)	Distance (Å)	O_h Fe_3O_4 (Å)	p
O	0.3(1)	0.001	1.54(3)	--	0.088
O[c]	5.7(1)[b]	0.0027(3)	2.009(4)	2.06	<0.001
Fe	6	0.0059(4)	3.035(5)	2.97	<0.001
Fe	6	0.0058(5)	3.516(7)	3.48	<0.001
O-Tc-O (MS)	6	0.008(1)	4.16(6)	4.12	0.141
O	12	0.008(1)[c]	4.73(3)	4.76	0.031
Fe	12	0.008(1)[c]	5.19(1)	5.14	<0.001

a) Fit range: 2<k<13.5, 1<R<5.2; 32.4 independent data. 15 parameters, S_0^2 = 0.8, ΔE_0 = -2.1(8) eV, χ^2 = 1875 χ_ν^2 = 107.7, R = 0.018.

b) Parameter is constrained to equal 6 minus the preceding parameter

c) Parameter constrained to equal the preceding parameter

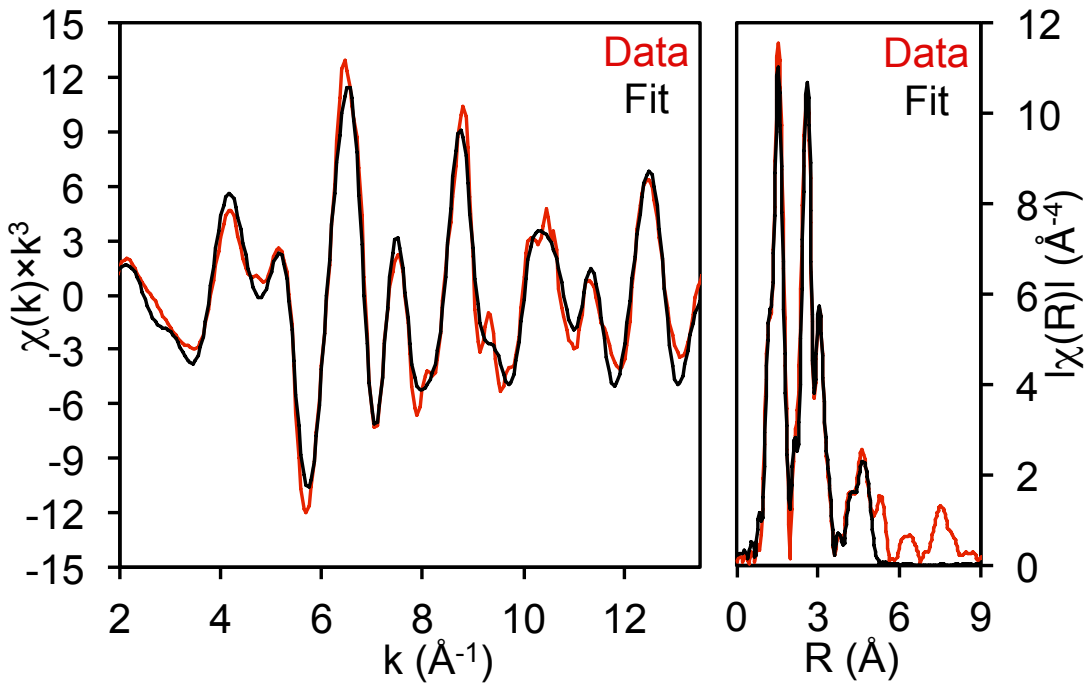

Figure S6: Tc K-edge EXAFS spectrum of Tc in $Tc_{0.1}Co_{1.1}Fe_{1.8}O_4$-o

$Tc_{0.1}Ni_{1.1}Fe_{1.8}O_4$-o

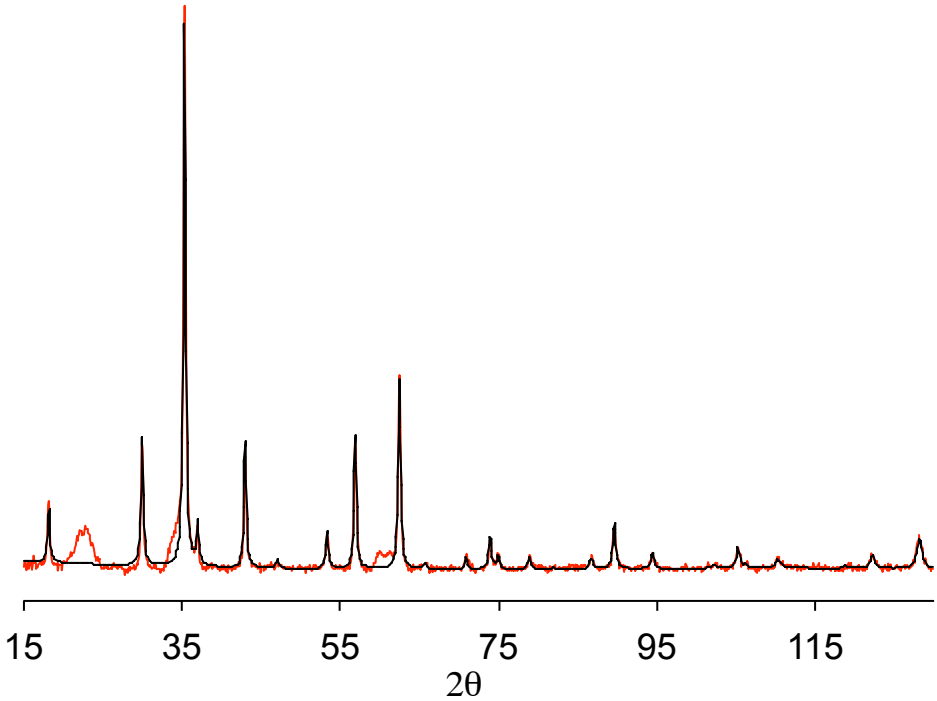

Figure S7: XRD pattern for $Tc_{0.1}Ni_{1.1}Fe_{1.8}O_4$-o (Data in color; Rietveld fit in black)

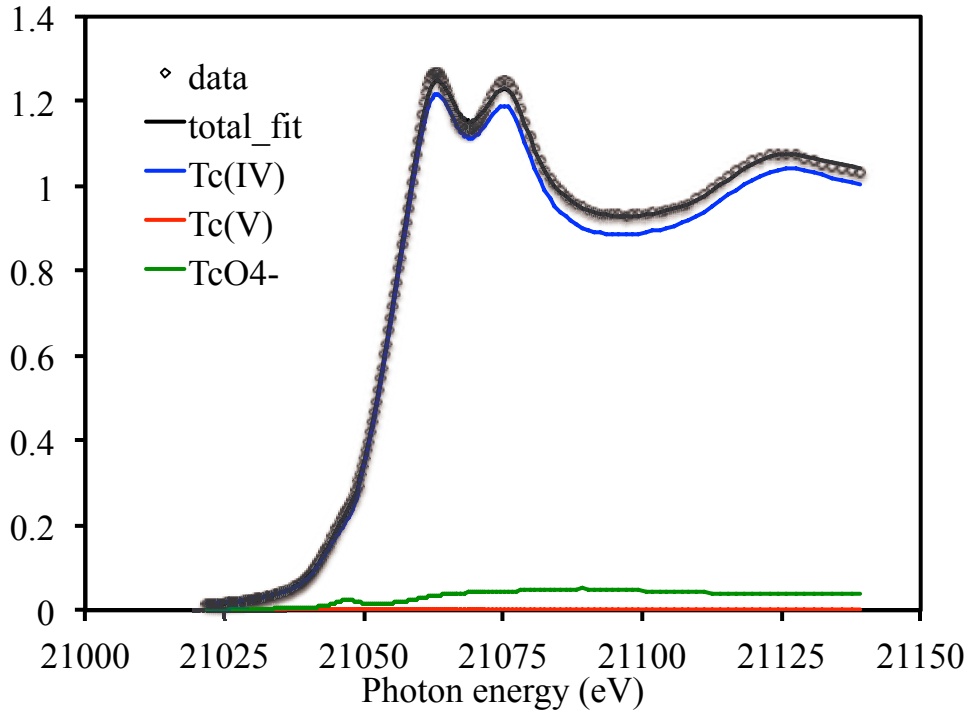

Figure S8: XANES fit for $Tc_{0.1}Ni_{1.1}Fe_{1.8}O_4$-o

Table S3: Best EXAFS fit parameters for $Tc_{0.1}Ni_{1.1}Fe_{1.8}O_4$-o

Neighbor	# of Neighbors	σ^2 (Å^2)	Distance (Å)	O_h Fe_3O_4 (Å)	p
O	0.4(1)	0.001	1.79(3)	--	0.070
O	5.6(1)[b]	0.0026(4)	2.009(4)	2.06	<0.001
Fe	4.8(5)	0.0029(2)	3.034(6)	2.97	<0.001
Tc	1.2(5)[b]	0.0029(2)[c]	3.034(6)[c]	2.97	0.101
Fe	6	0.0066(5)	3.514(7)	3.48	<0.001
O-Tc-O (MS)	5.6(1)	0.008(1)	4.12(5)	4.12	0.039
Fe	12	0.008(1)[c]	5.19(1)	5.14	<0.001

a) Fit range: 2<k<13.5, 1<R<5.2; 32.4 independent data. 13 parameters, $S_0^2 = 0.8$, $\Delta E_0 = -2(1)$ eV, $\chi^2 = 814$ $\chi_\nu^2 = 46.7$ R = 0.013. Parameters without errors are fixed.

b) Parameter is constrained to equal 6 minus the preceding parameter

c) Parameter constrained to equal the preceding parameter

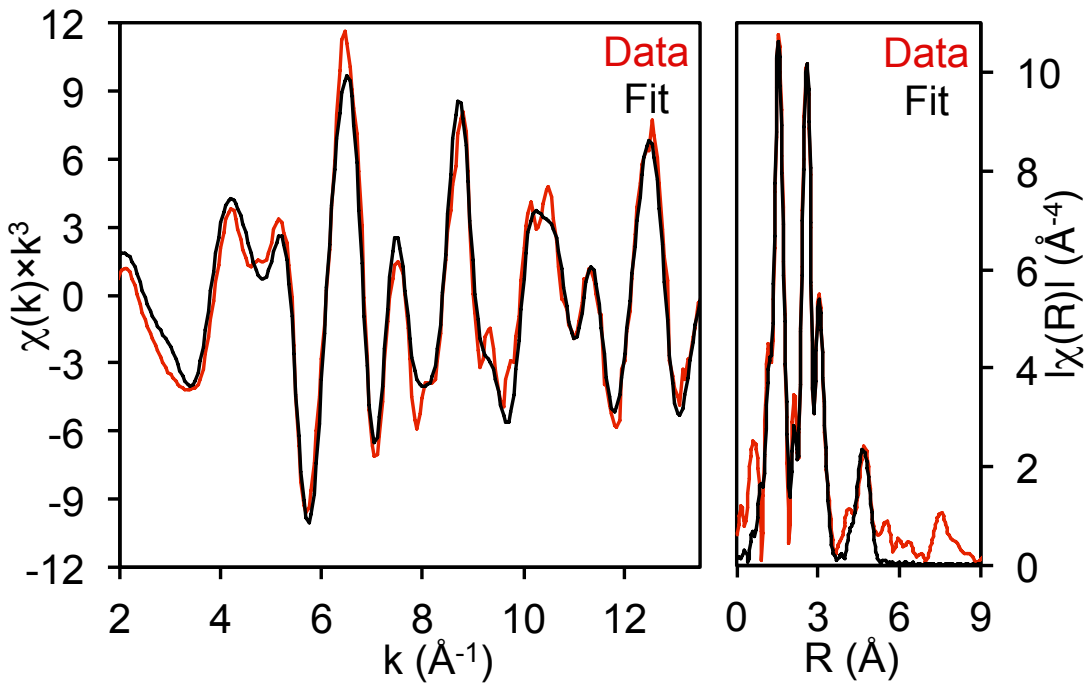

Figure S9: Tc K-edge EXAFS spectrum of Tc in $Tc_{0.1}Ni_{1.1}Fe_{1.8}O_4$-o

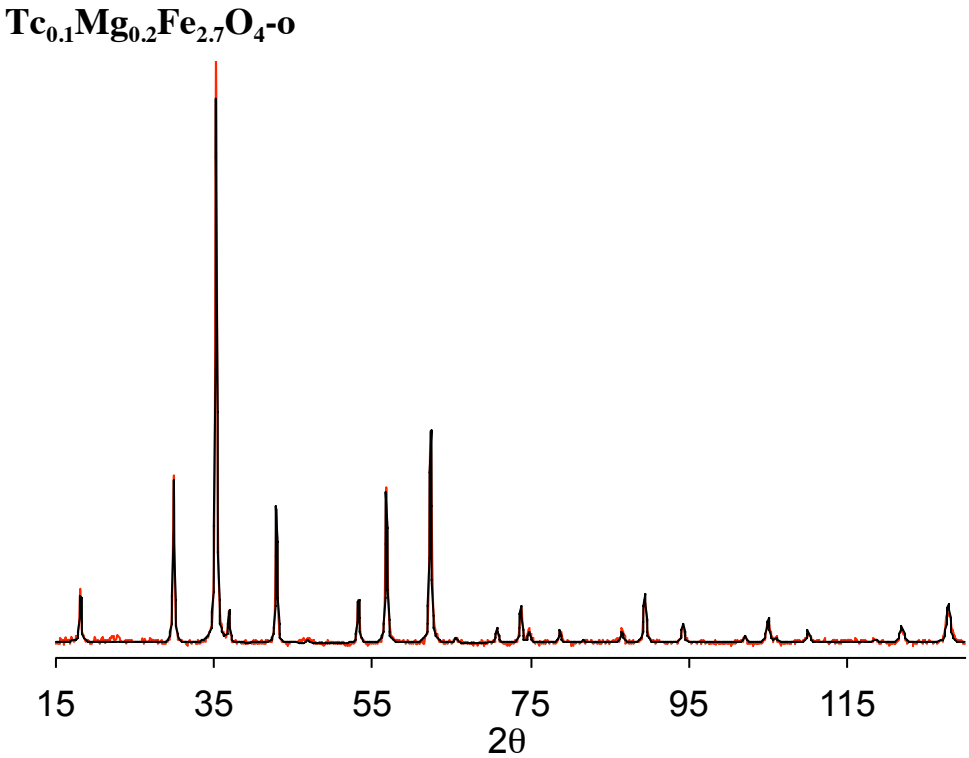

Figure S10: XRD pattern for $Tc_{0.1}Mg_{0.2}Fe_{2.7}O_4$-o (Data in color; Rietveld fit in black)

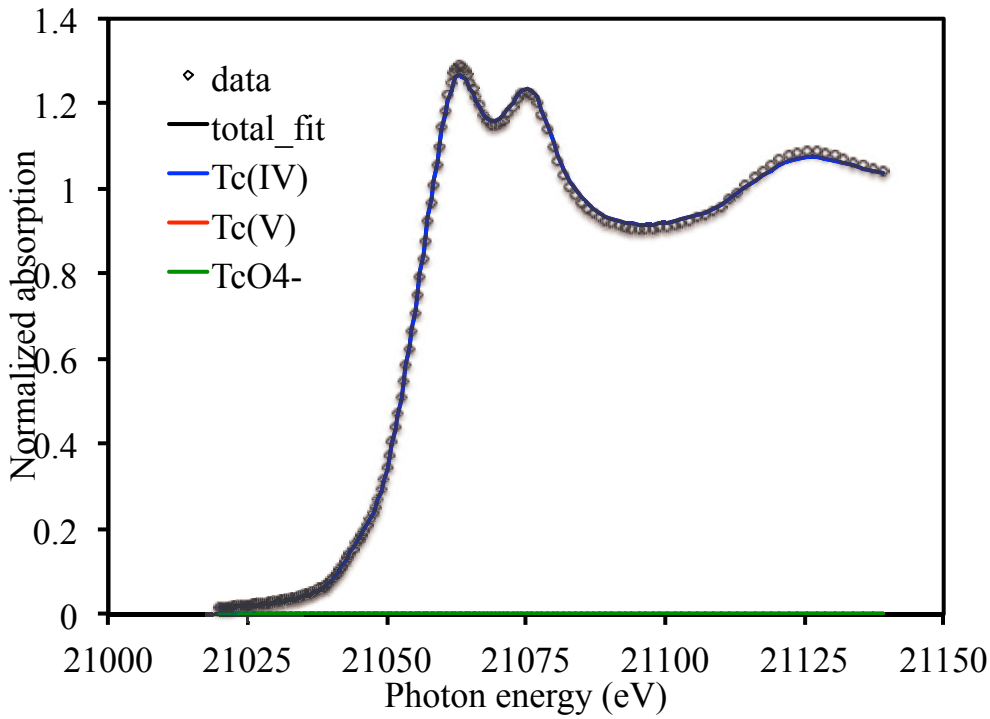

Figure S11: XANES fit for $Tc_{0.1}Mg_{0.2}Fe_{2.7}O_4$-o

Table S4: Best EXAFS fit parameters for $Tc_{0.1}Mg_{0.2}Fe_{2.7}O_4$-o

Neighbor	# of Neighbors	σ^2 (Å^2)	Distance (Å)	O_h Fe_3O_4 (Å)	P
O	0.29(9)	0.001	1.54(2)	--	0.012
O[c]	5.71(9)[b]	0.0031(3)	2.034(4)	2.06	<0.001
Fe	4.1(2)	0.004(2)	3.096(9)	2.97	<0.001
Tc	1.9(2)[b]	0.004(2)[c]	3.096(9)[b]	2.97	0.077
Fe	6	0.0070(5)	3.537(7)	3.48	<0.001
O-Tc-O (MS)	6	0.011(1)	4.21(4)	4.12	0.003
O	12	0.011(1)[c]	4.78(4)	4.76	0.039
Fe	12	0.011(1)[c]	5.22(2)	5.14	0.001

a) Fit range: 2<k<13.5, 1<R<5.2; 32.4 independent data. 15 parameters, S_0^2 = 0.8, ΔE_0 = 2.0(8) eV, χ^2 = 4049 χ_ν^2 = 247, R = 0.013.
b) Parameter is constrained to equal 6 minus the preceding parameter
c) Parameter constrained to equal the preceding parameter

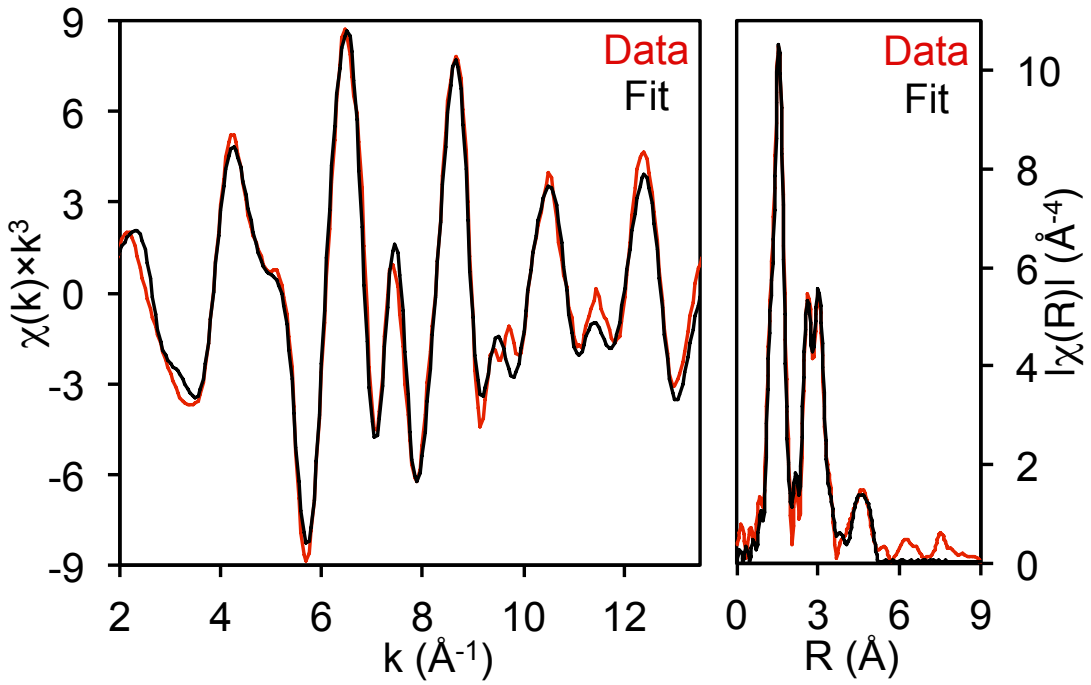

Figure S12: Tc K-edge EXAFS spectrum of Tc in $Tc_{0.1}Mg_{0.2}Fe_{2.7}O_4$-o

$Tc_{0.1}Mn_{0.2}Fe_{2.7}O_4$-o

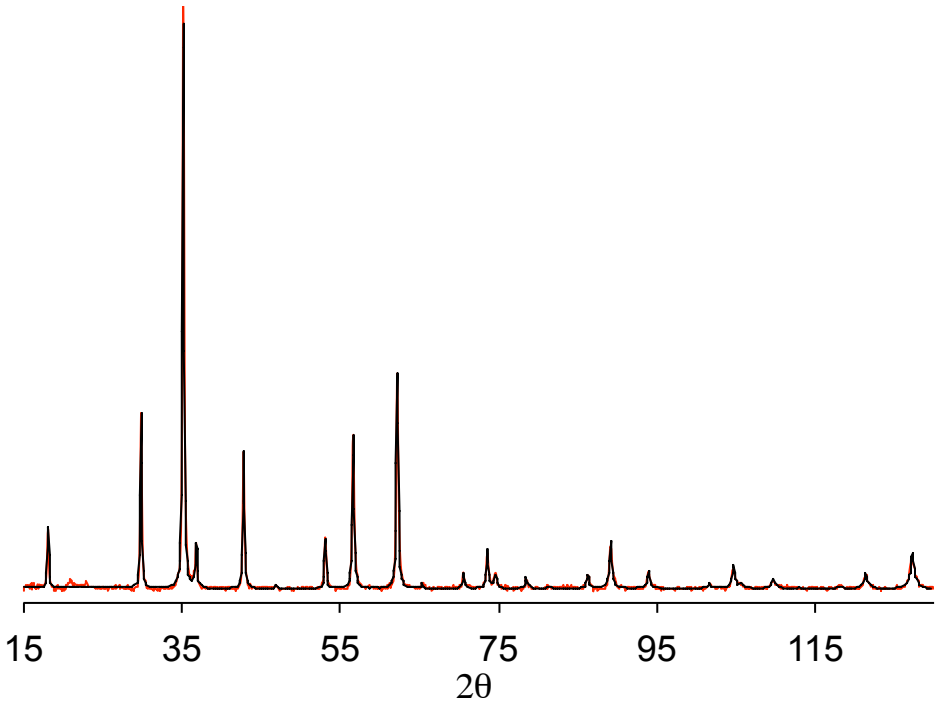

Figure S13: XRD pattern for $Tc_{0.1}Mn_{0.2}Fe_{2.7}O_4$-o (Data in color; Rietveld fit in black)

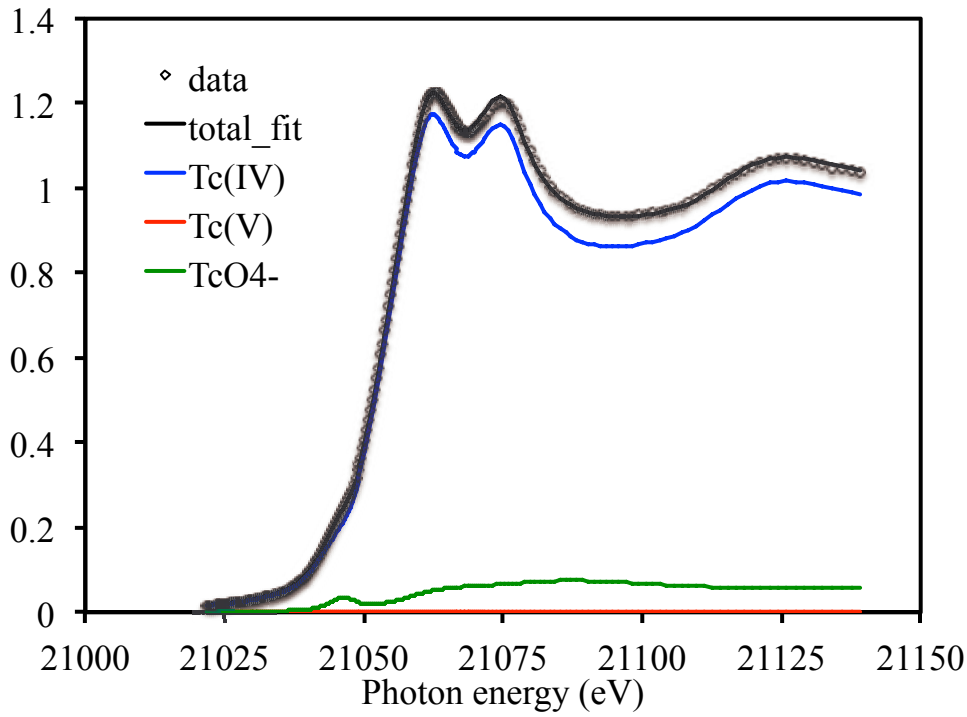

Figure S14: XANES fit for $Tc_{0.1}Mn_{0.2}Fe_{2.7}O_4$-o

Table S5: Best EXAFS fit parameters for $Tc_{0.1}Mn_{0.2}Fe_{2.7}O_4$-o

Neighbor	# of Neighbors	σ^2 (Å^2)	Distance (Å)	O_h Fe_3O_4 (Å)	p
O	0.38(9)	0.001	1.51(1)	--	0.026
O	5.62(9)[b]	0.0043(3)	2.036(4)	2.06	<0.001
Fe	3.80(8)	0.0017(6)	3.100(8)	2.97	<0.001
Tc	2.20(8)[b]	0.0017(6)[c]	3.100(8)[c]	2.97	<0.001
Fe	6	0.0100(9)	3.53(1)	3.48	<0.001
O-Tc-O (MS)	6	0.013(2)	4.22(5)	4.12	0.003
Fe	12	0.013(2)[c]	5.25(2)	5.14	0.004

a) Fit range: 2<k<13.5, 1<R<5.2; 32.4 independent data. 13 parameters, $S_0^2 = 0.8$, $\Delta E_0 = 6.0(9)$ eV, $\chi^2 = 572$ $\chi_\nu^2 = 32.9$ R = 0.020. Parameters without errors are fixed.

b) Parameter is constrained to equal 6 minus the preceding parameter

c) Parameter constrained to equal the preceding parameter

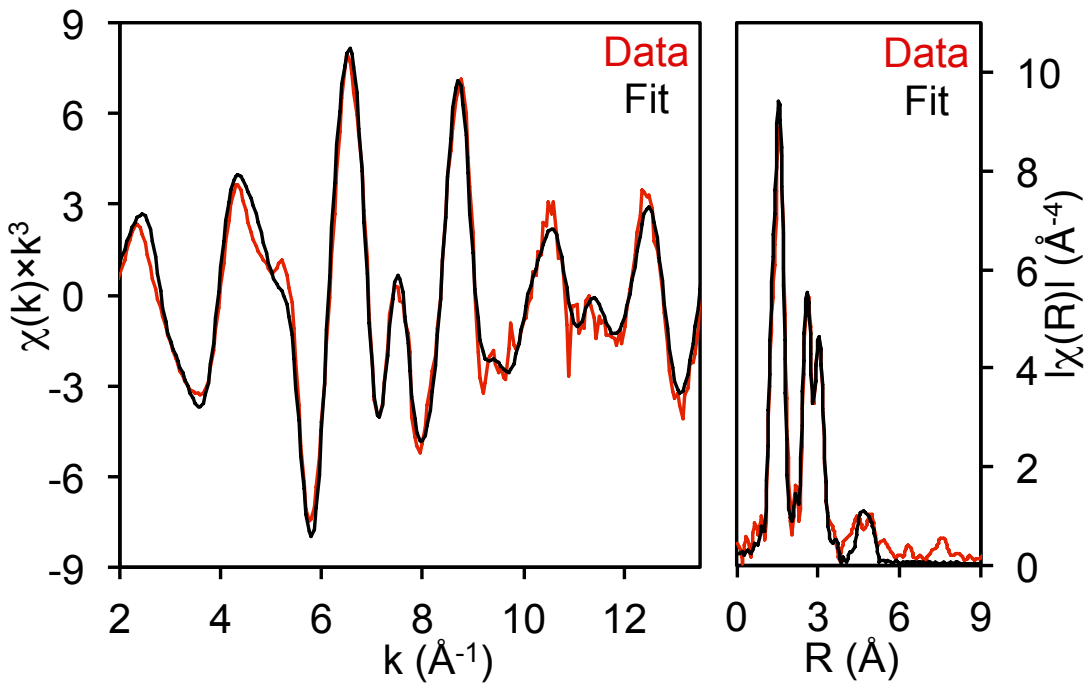

Figure S15: Tc K-edge EXAFS spectrum of Tc in for $Tc_{0.1}Mn_{0.2}Fe_{2.7}O_4$-o

$Tc_{0.1}Fe_{2.9}O_4$-o

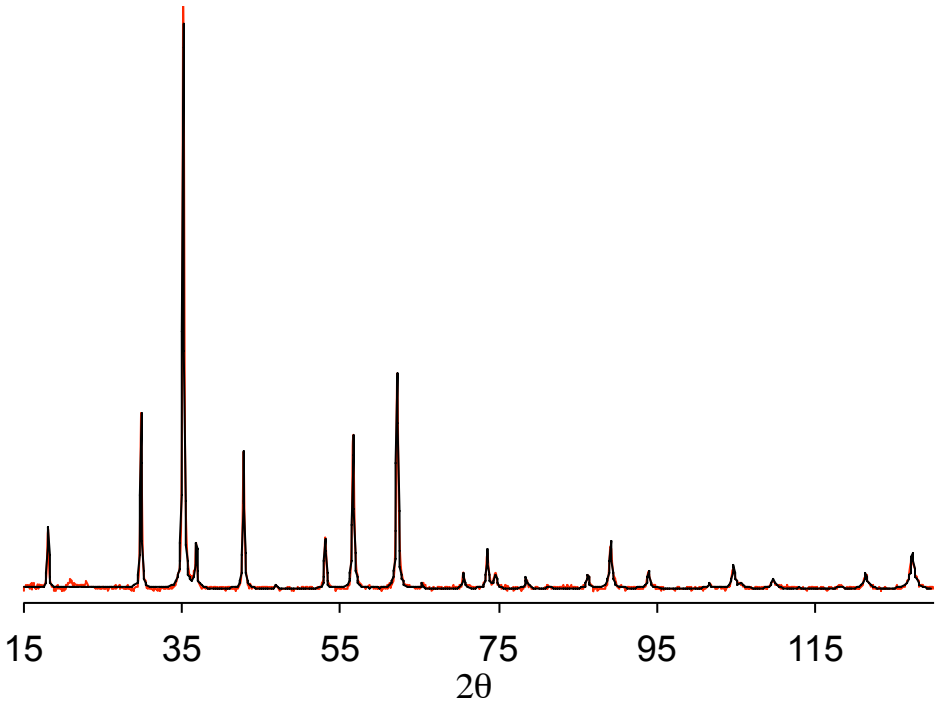

Figure S16: XRD pattern for $Tc_{0.1}Fe_{2.9}O_4$-o (Data in color; Rietveld fit in black)

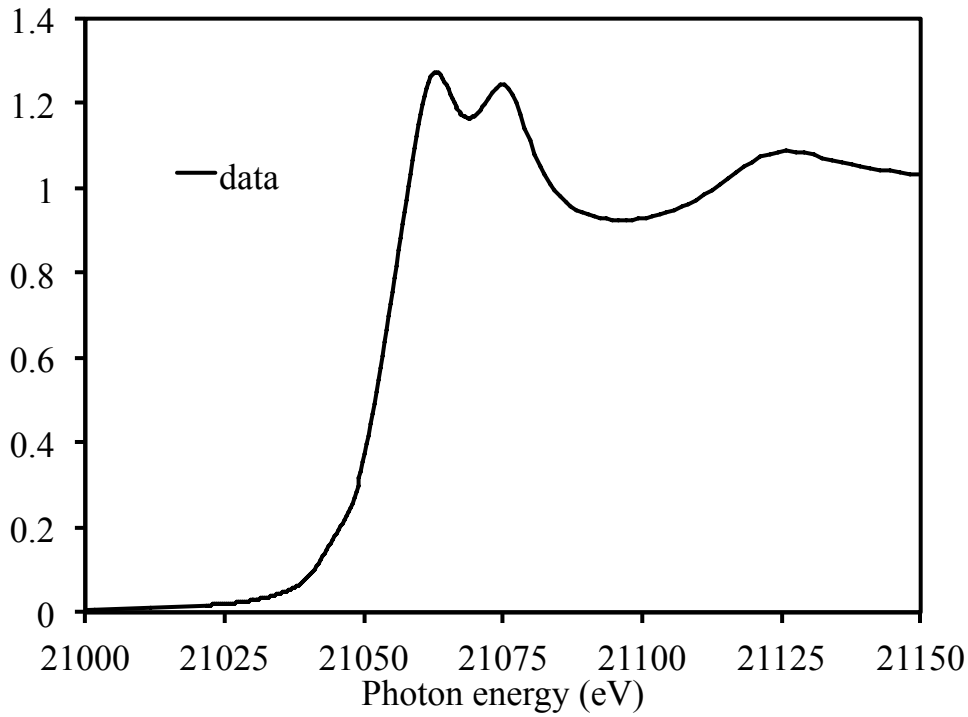

Figure S17: XANES fit for $Tc_{0.1}Fe_{2.9}O_4$-o (XANES data was not fit. The XANES spectrum of this sample is the Tc(IV) in spinel ferrite standard spectrum)

Table S6: Best EXAFS fit parameters for $Tc_{0.1}Fe_{2.9}O_4$-o

Neighbor	# of Neighbors	σ^2 (Å^2)	Distance (Å)	O_h Fe_3O_4 (Å)	p
O	0.20(8)	0.001	1.61(2)	--	0.002
O	5.80(8)[b]	0.0039(2)	2.027(3)	2.06	<0.001
Fe	3.9(1)	0.0036(9)	3.090(7)	2.97	<0.001
Tc	2.1(1)[b]	0.0036(9)[c]	3.090(7)[c]	2.97	0.001
Fe	6	0.0084(5)	3.524(6)	3.48	<0.001
O	8	0.009(3)	4.07(2)	3.57	0.262
O-Tc-O (MS)	6	0.013(2)	4.27(5)	4.12	0.051
Fe	12	0.013(2)[c]	5.22(2)	5.14	<0.001

a) Fit range: 2<k<13.5, 1<R<5.2; 32.4 independent data. 15 parameters, $S_0^2 = 0.8$, $\Delta E_0 = 2.1(7)$ eV, $\chi^2 = 434$ $\chi_\nu^2 = 28.4$ R = 0.009. Parameters without errors are fixed.

b) Parameter is constrained to equal 6 minus the preceding parameter

c) Parameter constrained to equal the preceding parameter

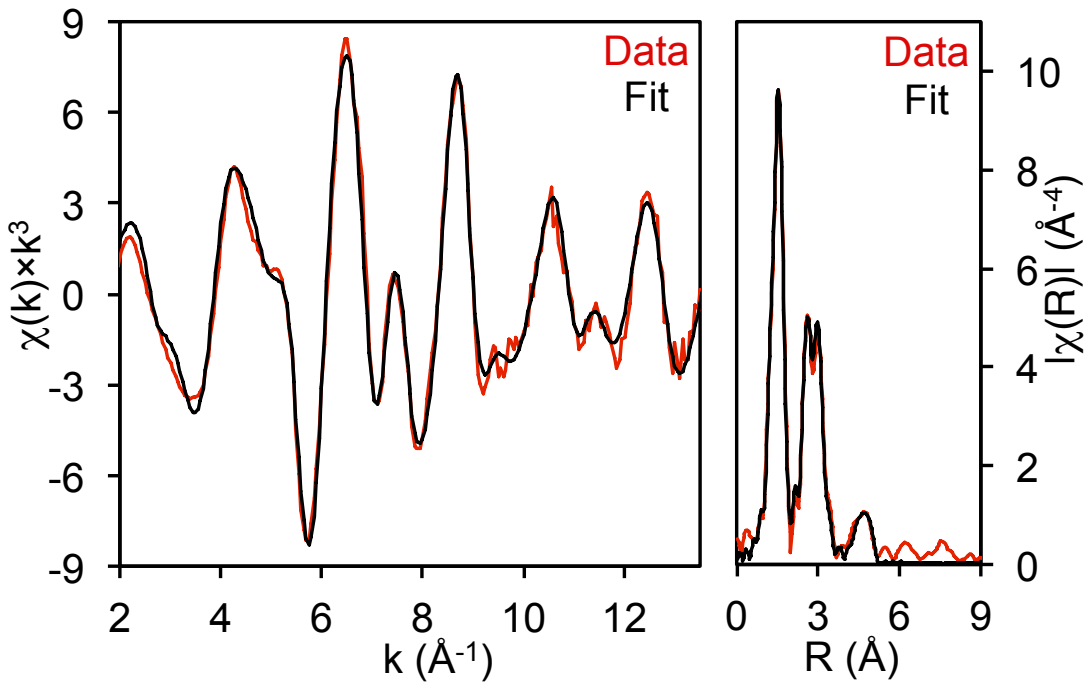

Figure S18: Tc K-edge EXAFS spectrum of Tc in $Tc_{0.1}Fe_{2.9}O_4$-o

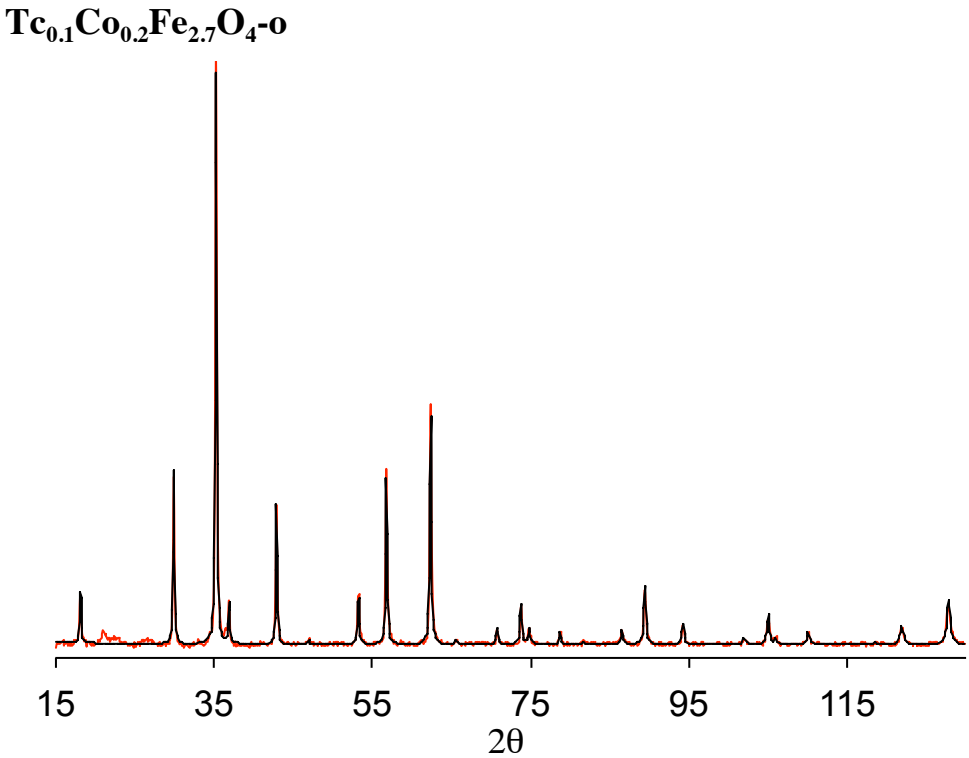

Figure S19: XRD pattern for $Tc_{0.1}Co_{0.2}Fe_{2.7}O_4$-o (Data in color; Rietveld fit in black)

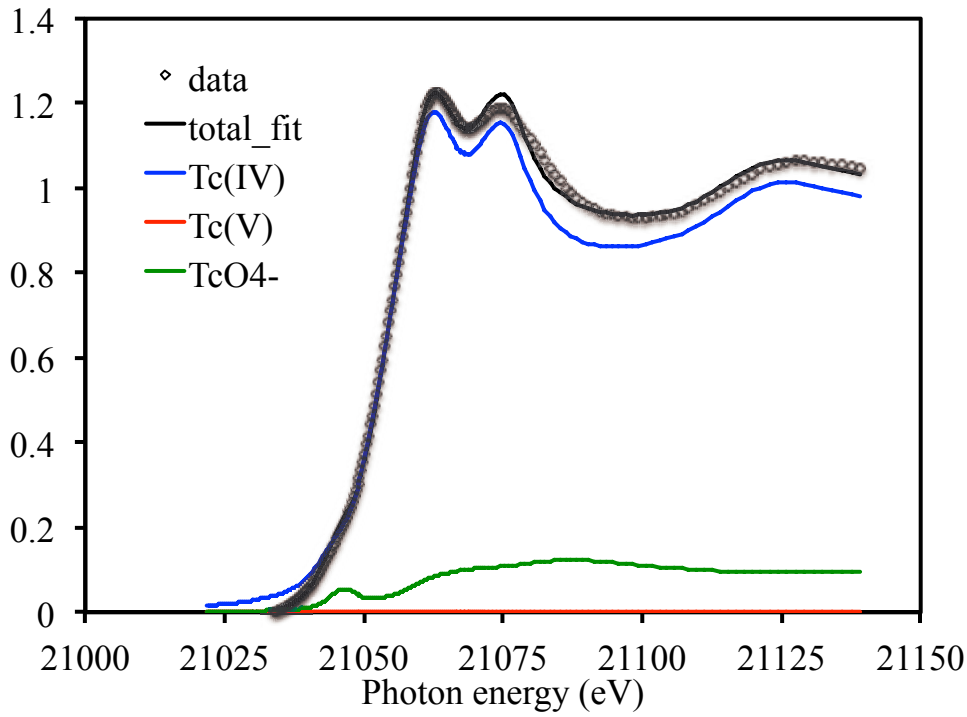

Figure S20: XANES fit for $Tc_{0.1}Co_{0.2}Fe_{2.7}O_4$-o

Table S7: Best fit parameters for $Tc_{0.1}Co_{0.2}Fe_{2.7}O_4$-o [a]

Neighbor	# of Neighbors	σ^2 (Å^2)	Distance (Å)	O_h Fe_3O_4 (Å)	p
O	0.4(1)	0.001	1.66(2)	--	<0.001
O	5.6(1)[b]	0.0046(5)	2.026(6)	2.06	<0.001
Fe	3.8(1)	0.003(1)	3.08(1)	2.97	<0.001
Tc	2.2(1)[b]	0.003(1)[c]	3.08(1)[c]	2.97	0.020
Fe	6	0.0084(9)	3.51(1)	3.48	<0.001
O-Tc-O (MS)	6	0.012(2)	4.19(6)	4.12	0.050
O	12	0.012(2)[c]	4.77(6)	4.76	0.256
Fe	12	0.012(2)[c]	5.20(2)	5.14	0.009

a) Fit range: 2<k<13.5, 1<R<5.2; 32.4 independent data. 14 parameters, $S_0^2 = 0.8$, $\Delta E_0 = 7(1)$ eV, $\chi^2 = 935$ $\chi_\nu^2 = 57$ R = 0.031. Parameters without errors are fixed.

b) Parameter is constrained to equal 6 minus the preceding parameter

c) Parameter constrained to equal the preceding parameter

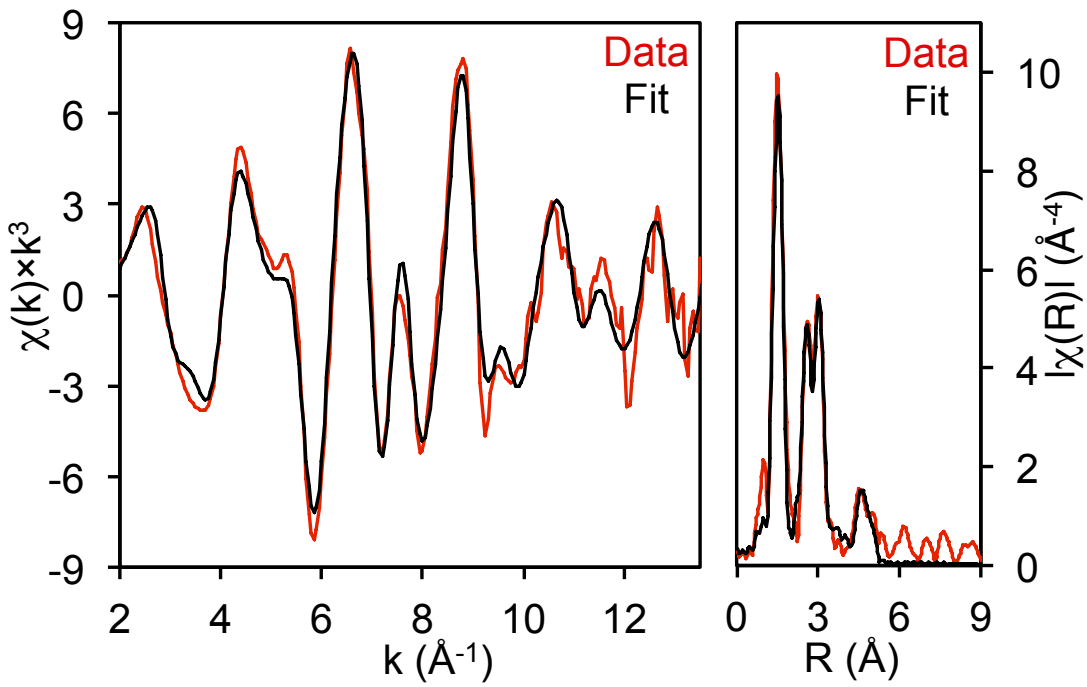

Figure S21: Tc K-edge EXAFS spectrum of Tc in $Tc_{0.1}Co_{0.2}Fe_{2.7}O_4$-o

$Tc_{0.1}Ni_{0.2}Fe_{2.7}O_4$-o

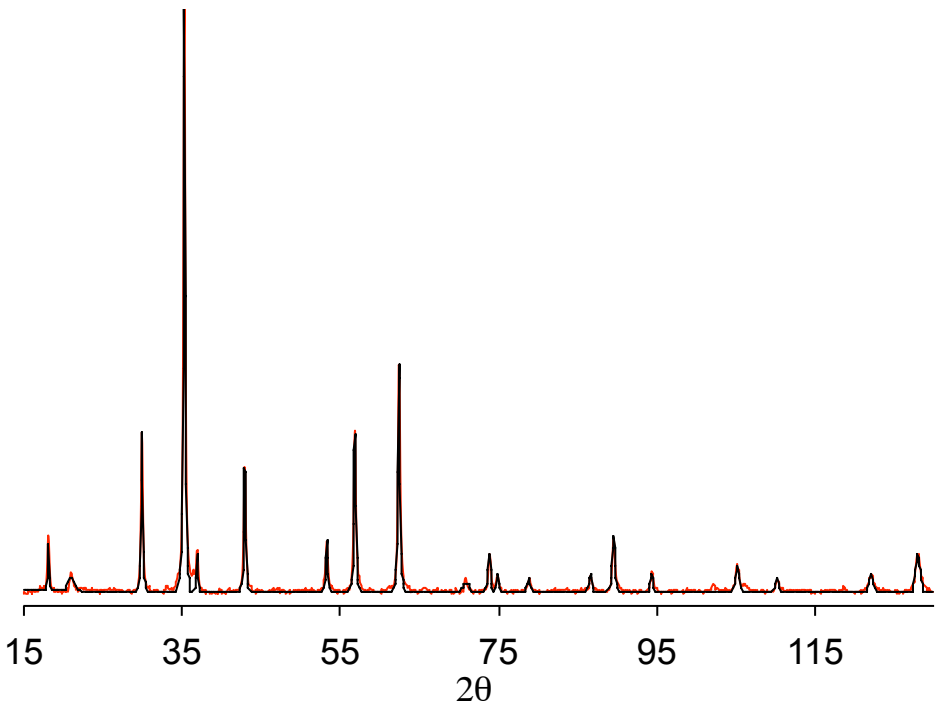

Figure S22: XRD pattern for $Tc_{0.1}Ni_{0.2}Fe_{2.7}O_4$-o (Data in color; Rietveld fit in black)

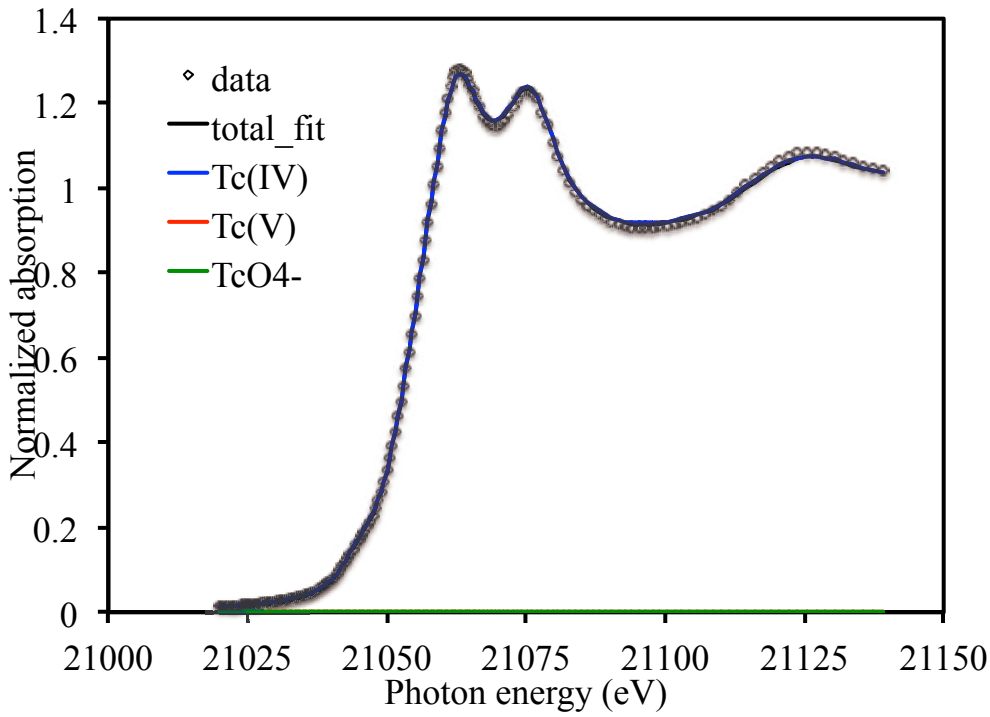

Figure S23: XANES fit for $Tc_{0.1}Ni_{0.2}Fe_{2.7}O_4$-o

Table S8: Best fit parameters for $Tc_{0.1}Ni_{0.2}Fe_{2.7}O_4$-o [a]

Neighbor	# of Neighbors	σ^2 (Å^2)	Distance (Å)	O_h Fe_3O_4 (Å)	p
O	0.31(8)	0.001	1.57(1)	--	<0.001
O[c]	5.69(8)	0.0032(2)	2.030(3)	2.06	<0.001
Fe	4.1(1)	0.003(1)	3.075(7)	2.97	<0.001
Tc	1.9(1)	0.003(1)[b]	3.075(7)[b]	2.97	0.002
Fe	6	0.0074(5)	3.530(6)	3.48	<0.001
O-Tc-O (MS)	6	0.011(1)	4.21(3)	4.12	<0.001
O	12	0.011(1)[b]	4.77(3)	4.76	0.023
Fe	12	0.011(1)[b]	5.21(1)	5.14	<0.001

a) Fit range: 2<k<13.5, 1<R<5.2; 32.4 independent data. 14 parameters, S_0^2 = 0.8, ΔE_0 = 4.2(7) eV, χ^2 = 1689 χ_ν^2 = 103, R = 0.009.
b) Parameter is constrained to equal 6 minus the preceding parameter
c) Parameter constrained to equal the preceding parameter

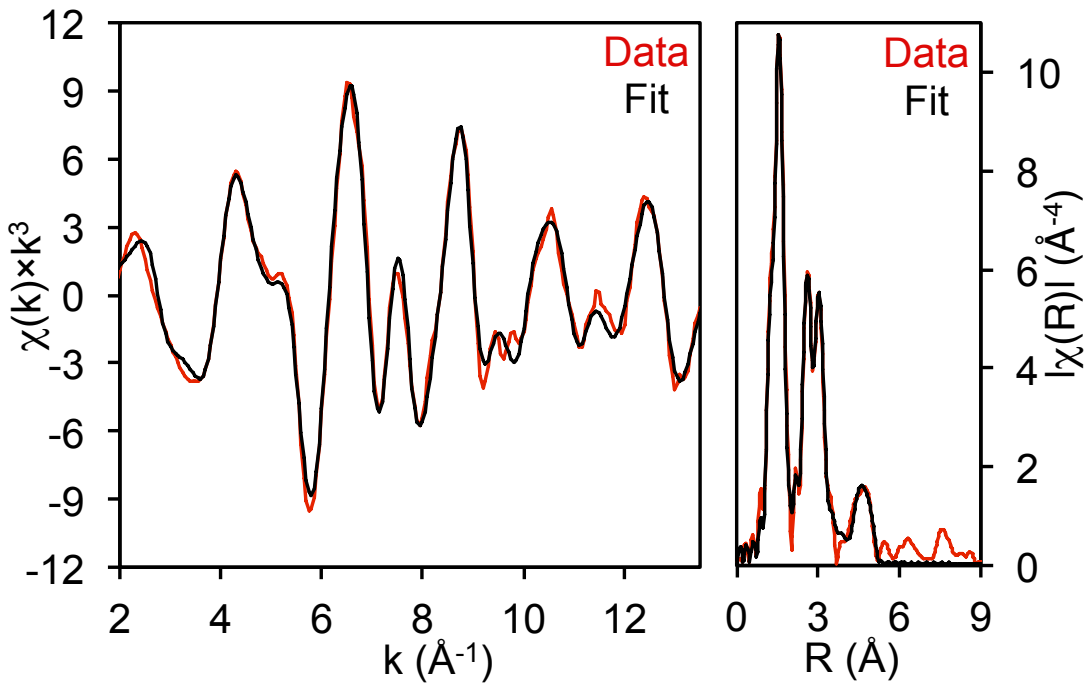

Figure S24: Tc K-edge EXAFS spectrum of Tc in $Tc_{0.1}Ni_{0.2}Fe_{2.7}O_4$-o

$Tc_{0.1}Mn_{1.1}Fe_{1.8}O_4$-c

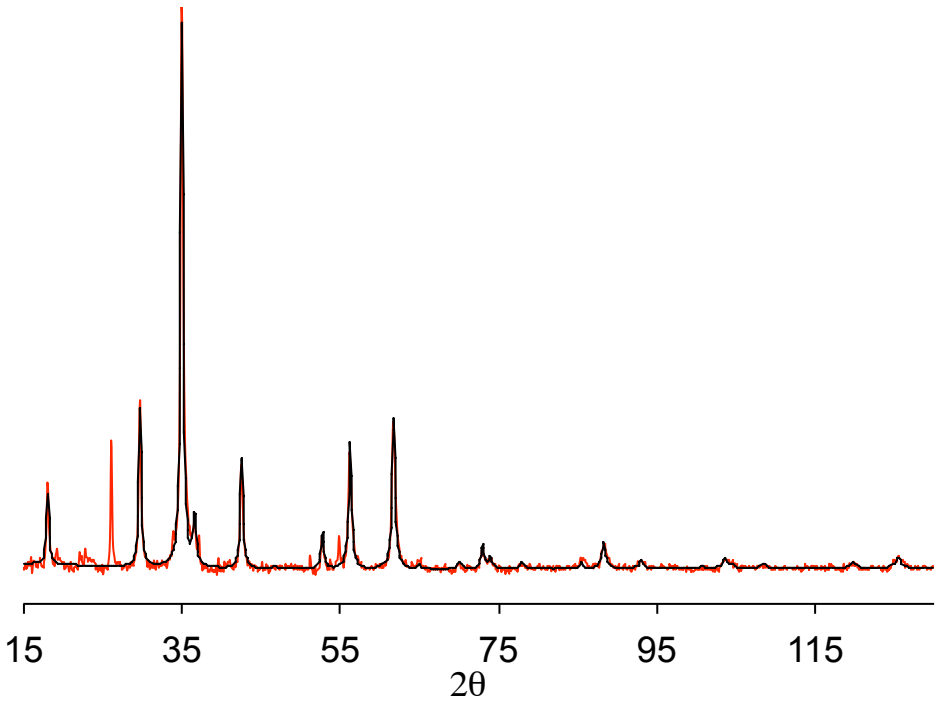

Figure S25: XRD pattern for $Tc_{0.1}Mn_{1.1}Fe_{1.8}O_4$-c (Data in color; Rietveld fit in black)

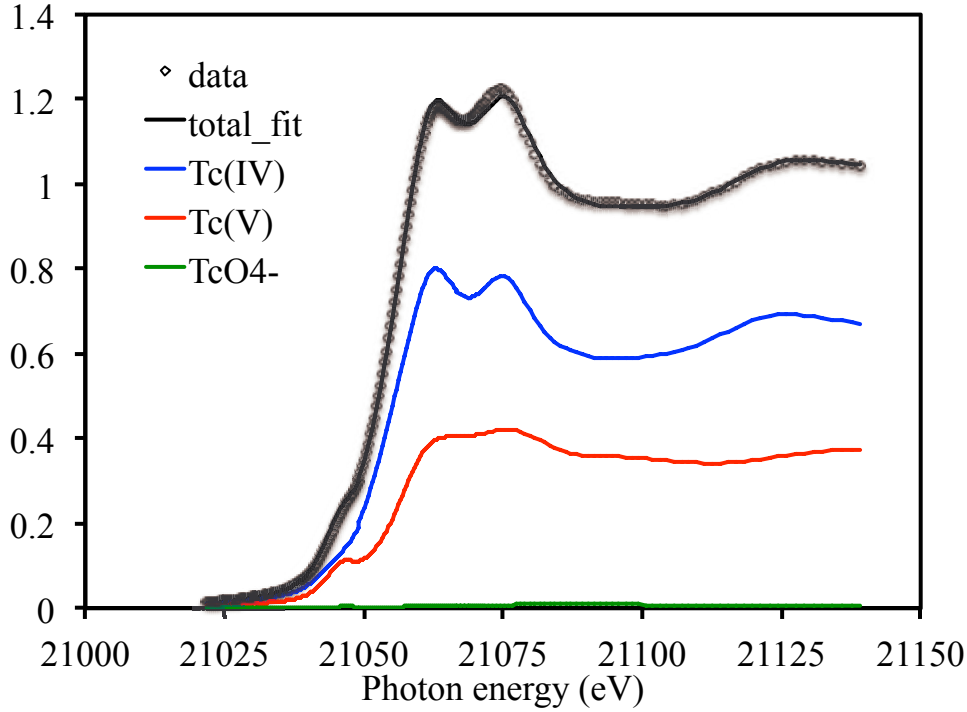

Figure S26: XANES fit for $Tc_{0.1}Mn_{1.1}Fe_{1.8}O_4$-c

Table S9: Best fit parameters for $Tc_{0.1}Mn_{1.1}Fe_{1.8}O_4$-c

Neighbor	# of Neighbors	σ^2 (Å^2)	Distance (Å)	O_h Fe_3O_4 (Å)	p
O	0.4(1)	0.001	1.72(1)	--	0.007
O	5.6(1)[b]	0.0043(3)	2.016(5)	2.06	<0.001
Fe	4.0(2)	0.003(1)	3.083(1)	2.97	0.057
Tc	2.0(2)[b]	0.003(1)[c]	3.083(1)[c]	2.97	0.108
Fe	6	0.015(3)	3.550(3)	3.48	0.039
O	8	0.017(7)	3.28(5)	3.48	0.091
O-Tc-O (MS)	6	0.018(4)	4.14(7)	4.12	0.096
Fe	12	0.018(4)[c]	5.26(4)	5.14	0.044

a) Fit range: 2<k<13.5, 1<R<5.2; 32.4 independent data. 15 parameters, $S_0^2 = 0.8$, $\Delta E_0 = 3(1)$ eV, $\chi^2 = 4425$ $\chi_\nu^2 = 287$ R = 0.020. Parameters without errors are fixed.

b) Parameter is constrained to equal 6 minus the preceding parameter

c) Parameter constrained to equal the preceding parameter

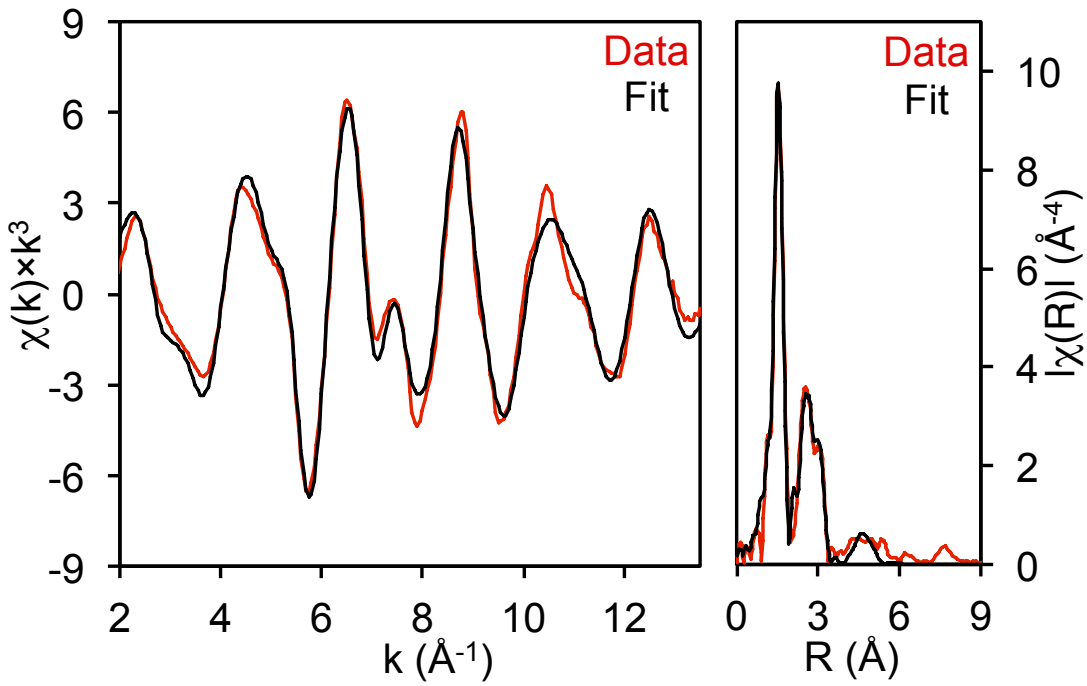

Figure S27: Tc K-edge EXAFS spectrum of Tc in $Tc_{0.1}Mn_{1.1}Fe_{1.8}O_4$-c

$Tc_{0.1}Co_{1.1}Fe_{1.8}O_4$-c

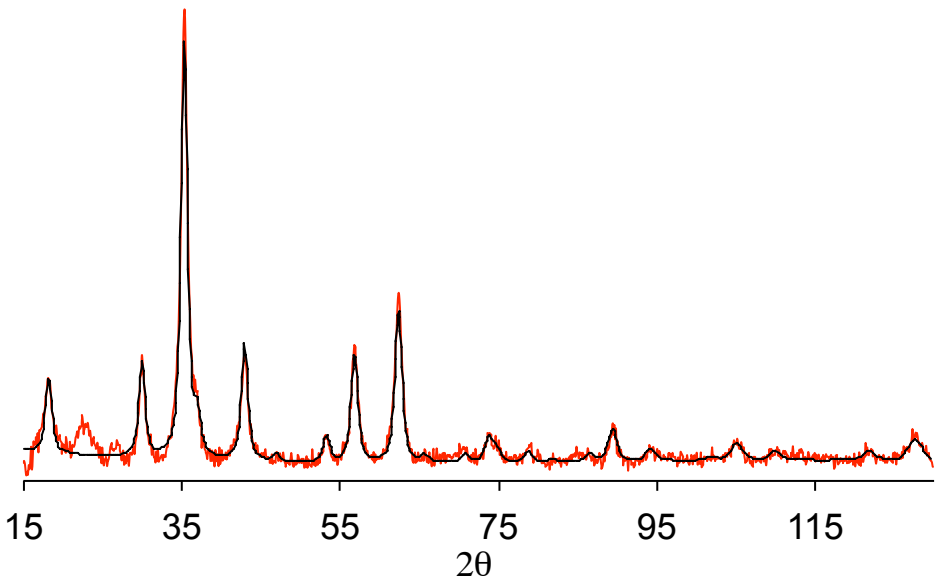

Figure S28: XRD pattern for $Tc_{0.1}Co_{1.1}Fe_{1.8}O_4$-c (Data in color; Rietveld fit in black)

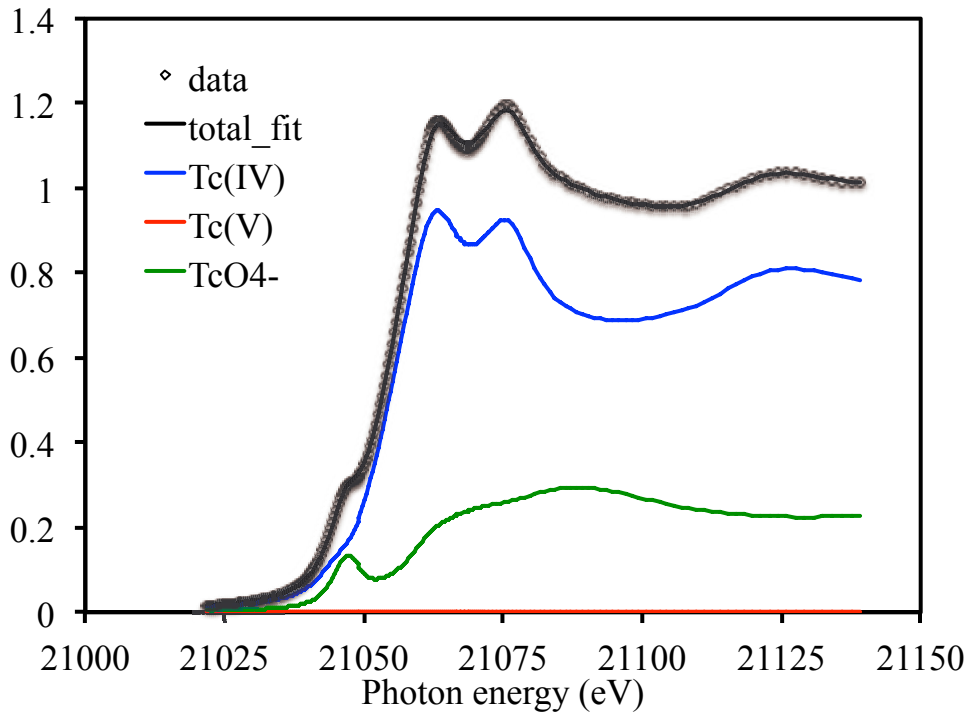

Figure S29: XANES fit for $Tc_{0.1}Co_{1.1}Fe_{1.8}O_4$-c

Table S10: Best fit parameters for $Tc_{0.1}Co_{1.1}Fe_{1.8}O_4$-c[a]

Neighbor	# of Neighbors	σ^2 (Å^2)	Distance (Å)	O_h Fe_3O_4 (Å)	p
O	0.84(7)	0.001	1.718(5)	--	<0.001
O	5.16(7)[b]	0.0044(4)	2.027(5)	2.06	<0.001
Fe	3.93(8)	0.0008(5)	3.069(8)	2.97	<0.001
Tc	2.07(8)[b]	0.0008(5)[c]	3.069(8)[c]	2.97	<0.001
Fe	6	0.011(1)	3.54(1)	3.48	<0.001
O-Tc-O (MS)	6	0.012(2)	4.21(5)	4.12	<0.001
Fe	12	0.012(2)[c]	5.23(2)	5.14	<0.001

a) Fit range: 2<k<13.5, 1<R<5.2; 32.4 independent data. 13 parameters, $S_0^2 = 0.8$, $\Delta E_0 = 2(1)$ eV, $\chi^2 = 1777$ $\chi_\nu^2 = 102$ R = 0.020. Parameters without errors are fixed.

b) Parameter is constrained to equal 6 minus the preceding parameter

c) Parameter constrained to equal the preceding parameter

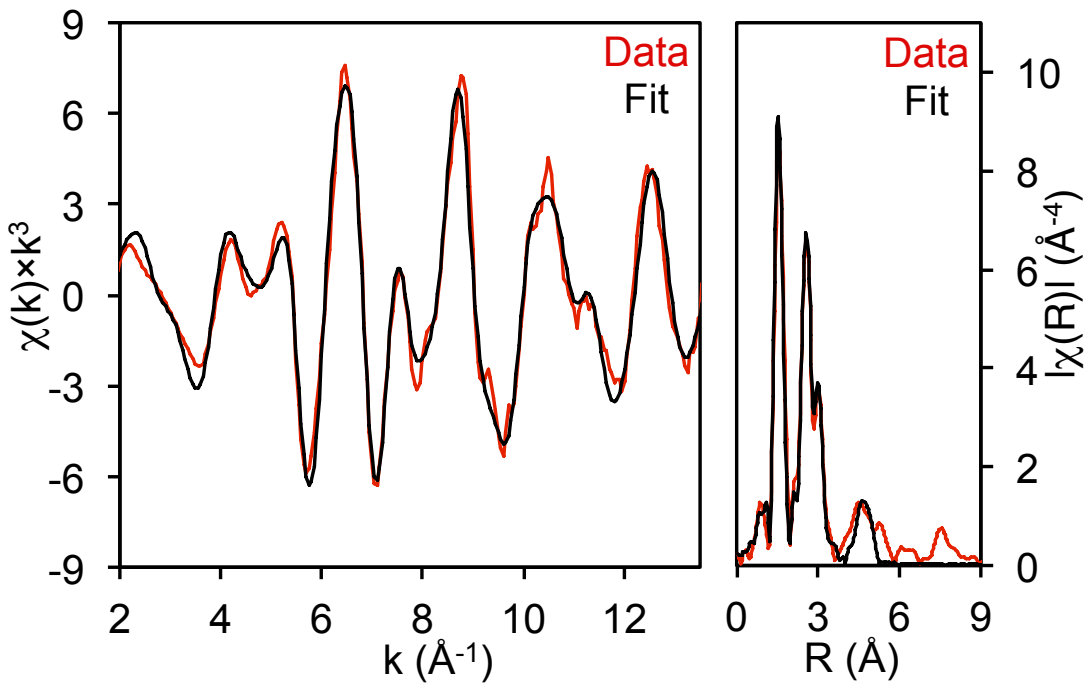

Figure S30: Tc K-edge EXAFS spectrum of Tc in $Tc_{0.1}Co_{1.1}Fe_{1.8}O_4$-c

$Tc_{0.1}Ni_{1.1}Fe_{1.8}O_4$-c

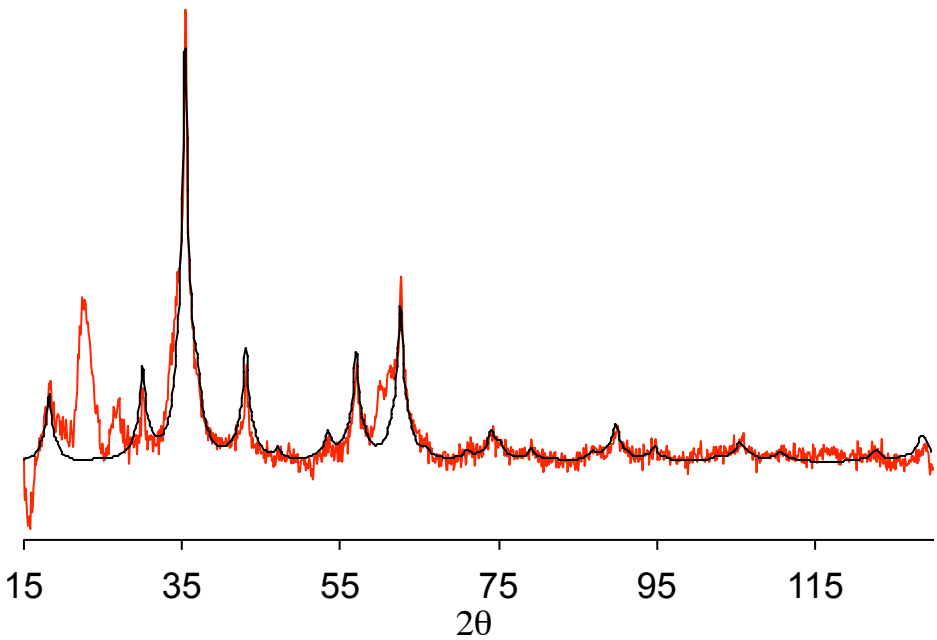

Figure S31: XRD pattern for $Tc_{0.1}Ni_{1.1}Fe_{1.8}O_4$-c (Data in color; Rietveld fit in black)

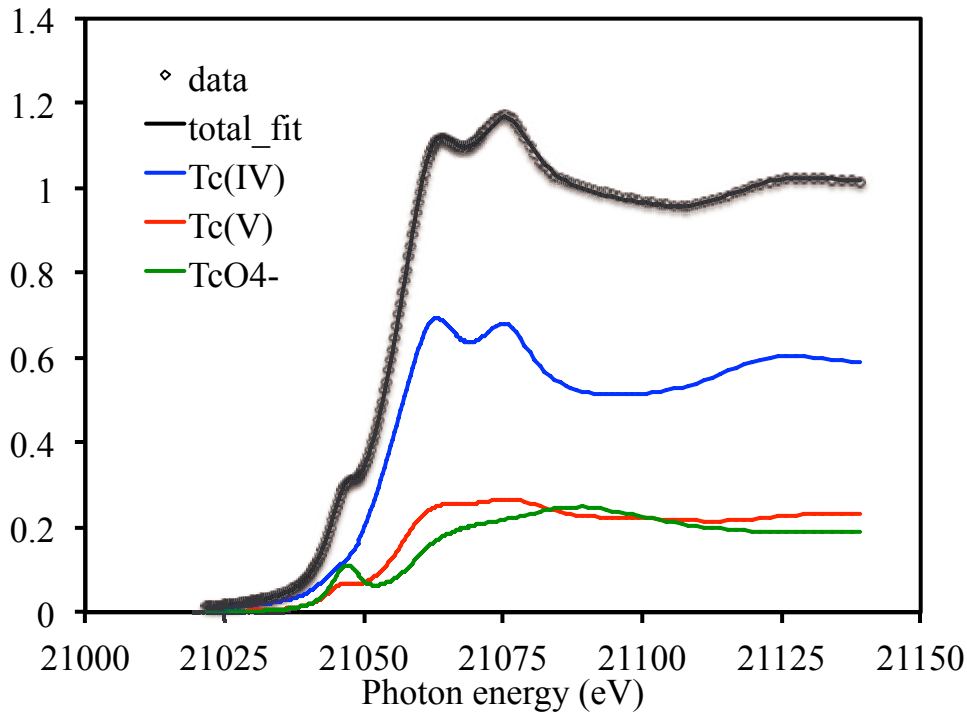

Figure S32: XANES fit for $Tc_{0.1}Ni_{1.1}Fe_{1.8}O_4$-c

Table S11: Best fit parameters for $Tc_{0.1}Ni_{1.1}Fe_{1.8}O_4$-c[a]

Neighbor	# of Neighbors	σ^2 (Å^2)	Distance (Å)	O_h Fe_3O_4 (Å)	p
O	1.2(1)	0.001	1.726(6)	--	<0.001
O	4.8(1)[b]	0.0056(6)	2.027(8)	2.06	<0.001
Fe	3.7(2)	0.005(1)	3.10(2)	2.97	<0.001
Tc	2.3(2)[b]	0.005(1)[c]	3.10(2)[c]	2.97	0.038
Fe	6	0.018(4)	3.50(3)	3.48	0.037
O-Tc-O (MS)	6	0.01(1)	4.18(1)	4.12	0.085

a) Fit range: 2<k<13.5, 1<R<5.2; 32.4 independent data. 12 parameters, $S_0^2 = 0.8$, $\Delta E_0 = 4(2)$ eV, $\chi^2 = 3866$ $\chi_\nu^2 = 210$ R = 0.058. Parameters without errors are fixed.

b) Parameter is constrained to equal 6 minus the preceding parameter

c) Parameter constrained to equal the preceding parameter

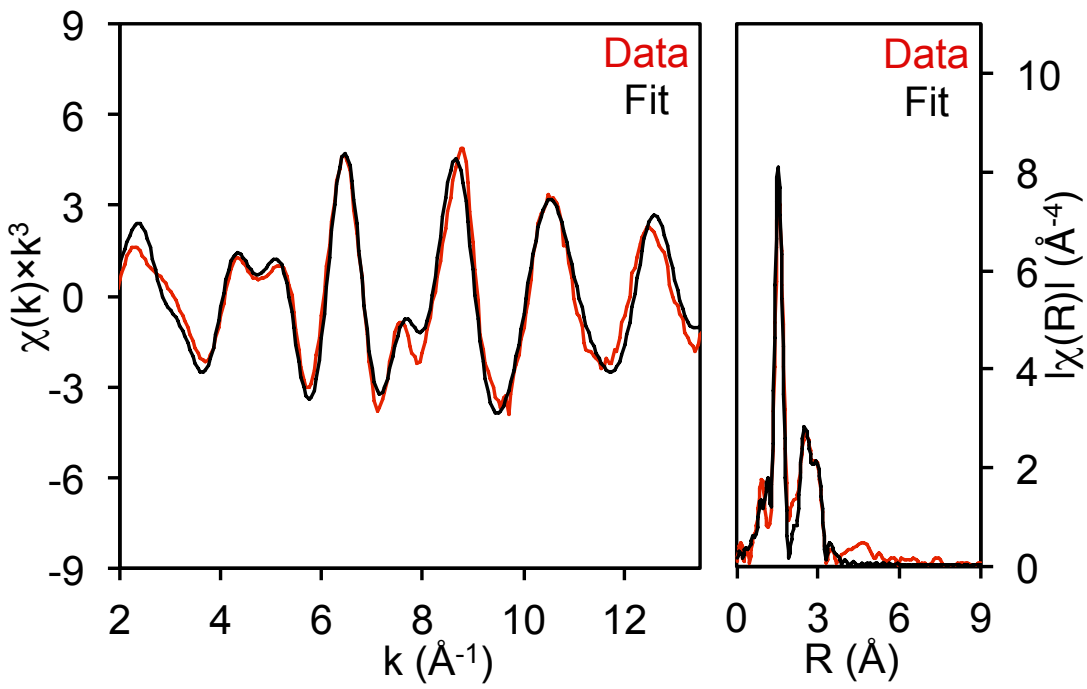

Figure S33: Tc K-edge EXAFS spectrum of Tc in $Tc_{0.1}Ni_{1.1}Fe_{1.8}O_4$-c

$Tc_{0.1}Mg_{0.2}Fe_{2.7}O_4$-c

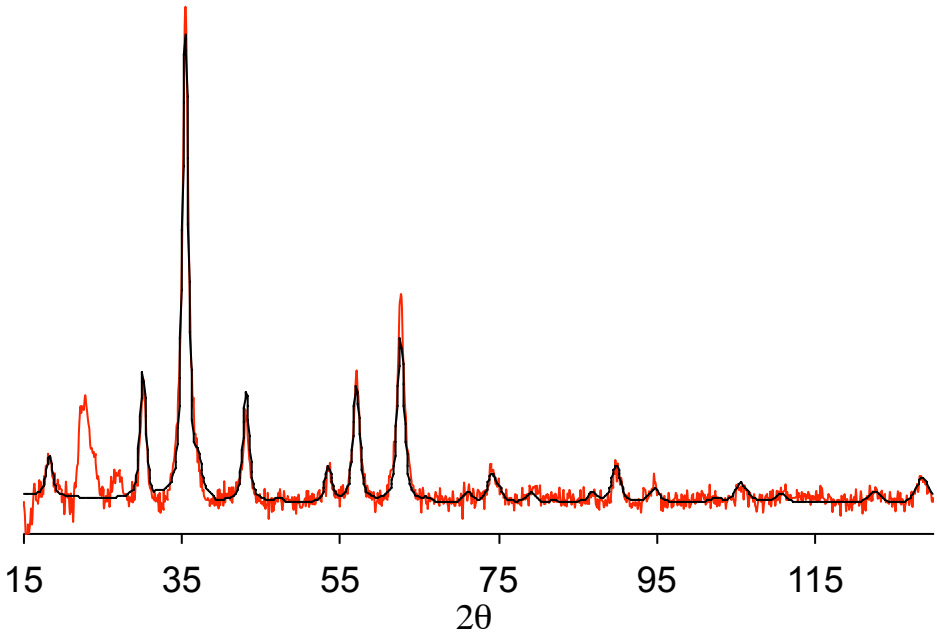

Figure S34: XRD pattern for $Tc_{0.1}Mg_{0.2}Fe_{2.7}O_4$-c (Data in color; Rietveld fit in black)

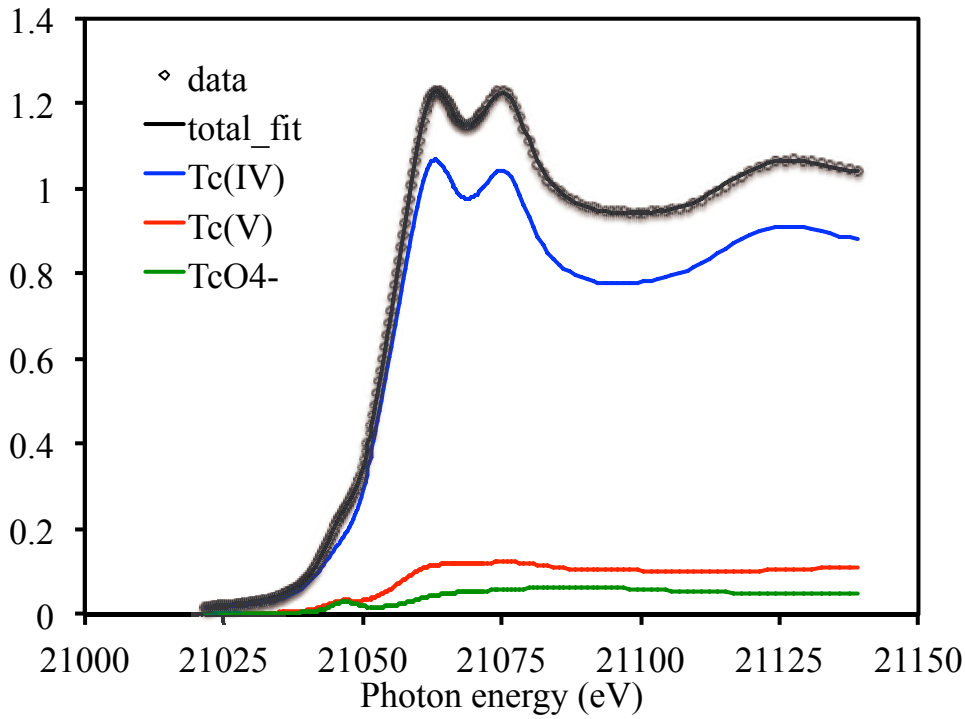

Figure S35: XANES fit for $Tc_{0.1}Mg_{0.2}Fe_{2.7}O_4$-c

Table S12: Best fit parameters for $Tc_{0.1}Mg_{0.2}Fe_{2.7}O_4$-c[a]

Neighbor	# of Neighbors	σ^2 (Å^2)	Distance (Å)	O_h Fe_3O_4 (Å)	p
O	0.33(8)	0.001	1.671(6)	--	0.021
O	5.67(9)[b]	0.0048(3)	2.027(8)	2.06	<0.001
Fe	3.73(8)	0.0032(7)	3.10(2)	2.97	<0.001
Tc	2.27(8)[b]	0.0032(7)[c]	3.10(2)[c]	2.97	0.002
Fe	6	0.0116(9)	3.51(3)	3.48	<0.001
O	8	0.04(3)	3.44(3)	3.48	0.336
O-Tc-O (MS)	6	0.015(2)	4.17(1)	4.12	0.002
Fe	12	0.015(2)	5.23(1)	5.14	0.012

a) Fit range: 2<k<13.5, 1<R<5.2; 32.4 independent data. 15 parameters, $S_0^2 = 0.8$, $\Delta E_0 = 2(1)$ eV, $\chi^2 = 1083$ $\chi_\nu^2 = 70$ R = 0.013. Parameters without errors are fixed.

b) Parameter is constrained to equal 6 minus the preceding parameter

c) Parameter constrained to equal the preceding parameter

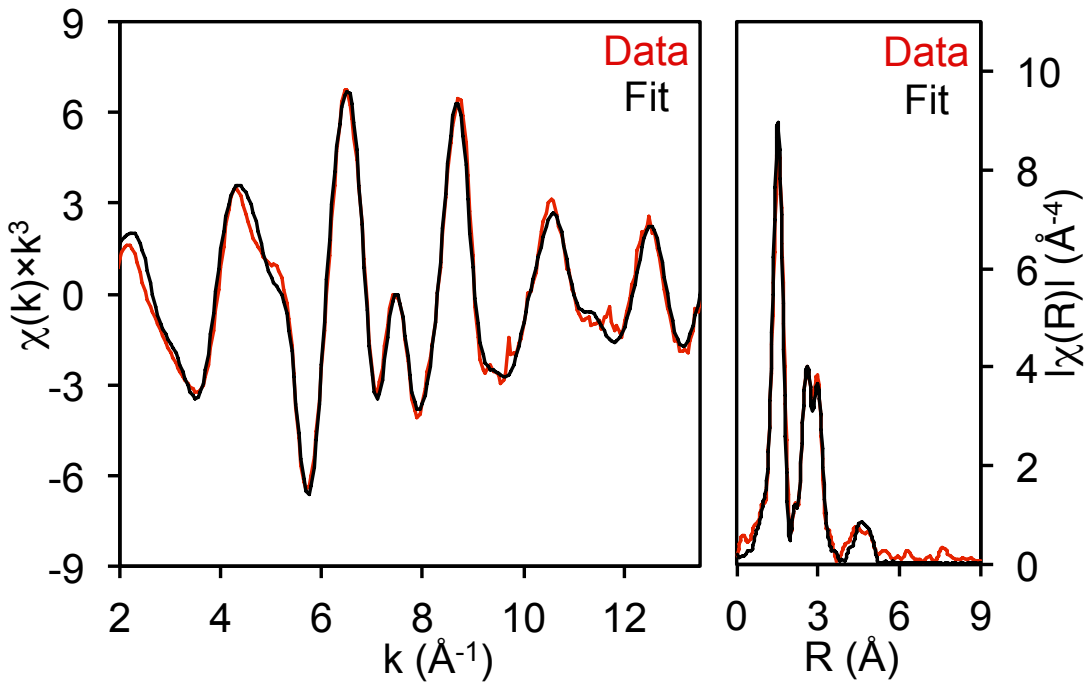

Figure S36: Tc K-edge EXAFS spectrum of Tc in $Tc_{0.1}Mg_{0.2}Fe_{2.7}O_4$-c

$Tc_{0.1}Mn_{0.2}Fe_{2.7}O_4$-c

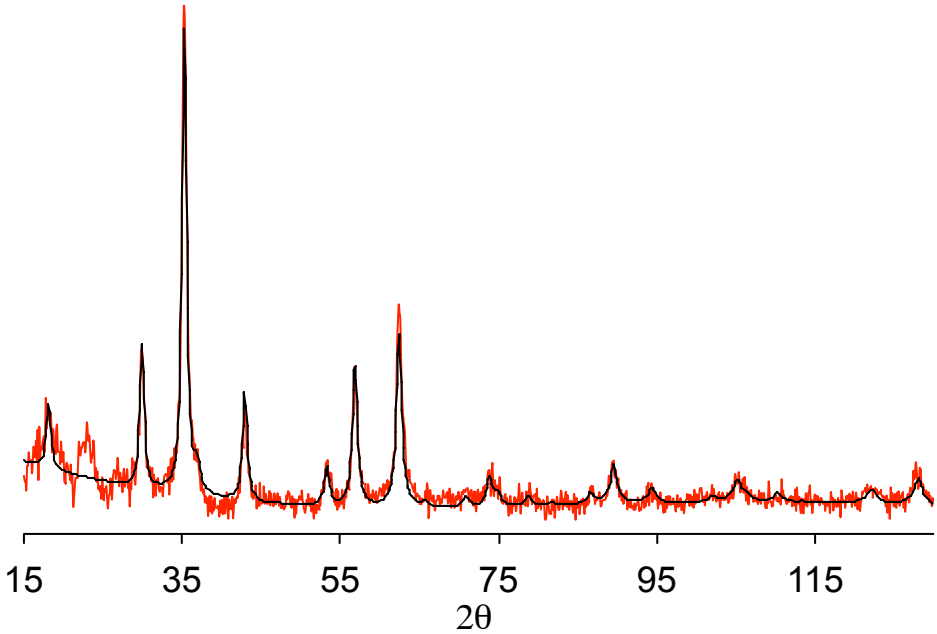

Figure S37: XRD pattern for $Tc_{0.1}Mn_{0.2}Fe_{2.7}O_4$-c (Data in color; Rietveld fit in black)

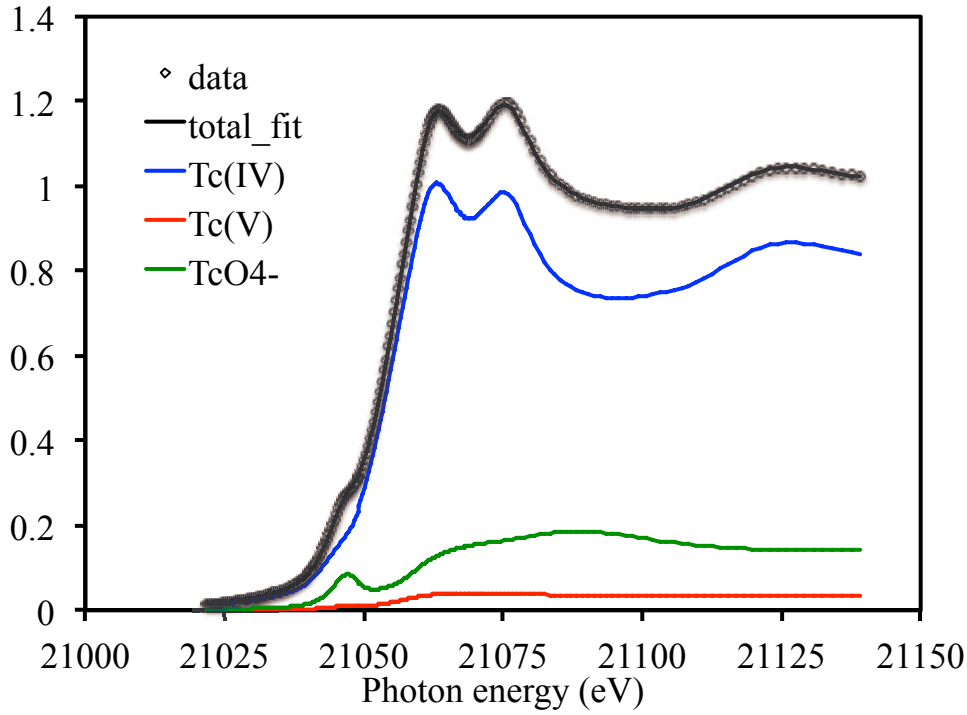

Figure S38: XANES fit for $Tc_{0.1}Mn_{0.2}Fe_{2.7}O_4$-c

Table S13: Best fit parameters for $Tc_{0.1}Mn_{0.2}Fe_{2.7}O_4$-c [a]

Neighbor	# of Neighbors	σ^2 (Å^2)	Distance (Å)	O_h Fe_3O_4 (Å)	p
O	0.66(6)	0.001	1.715(7)	--	<0.001
O	5.34(6)[b]	0.0051(3)	2.019(4)	2.06	<0.001
Fe	3.90(8)	0.0031(7)	3.083(7)	2.97	<0.001
Tc	2.10(8)[b]	0.0031(7)[c]	3.083(7)[c]	2.97	<0.001
Fe	6	0.0117(8)	3.509(9)	3.48	<0.001
O-Tc-O (MS)	6	0.014(2)	4.17(4)	4.12	<0.001
Fe	12	0.014(2)	5.23(2)	5.14	0.002

a) Fit range: 2<k<13.5, 1<R<5.2; 32.4 independent data. 13 parameters, $S_0^2 = 0.8$, $\Delta E_0 = 5.4(8)$ eV, $\chi^2 = 187$ $\chi_\nu^2 = 10.7$ R = 0.013. Parameters without errors are fixed.

b) Parameter is constrained to equal 6 minus the preceding parameter

c) Parameter constrained to equal the preceding parameter

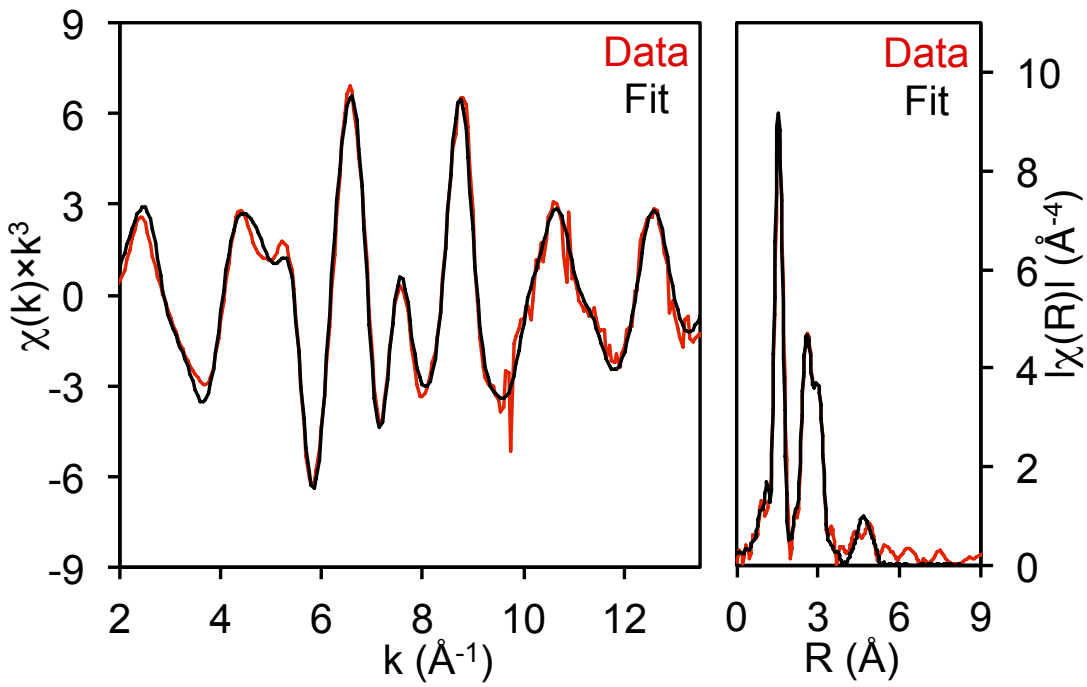

Figure S39: Tc K-edge EXAFS spectrum of Tc in $Tc_{0.1}Mn_{0.2}Fe_{2.7}O_4$-c

$Tc_{0.1}Fe_{2.9}O_4$-c

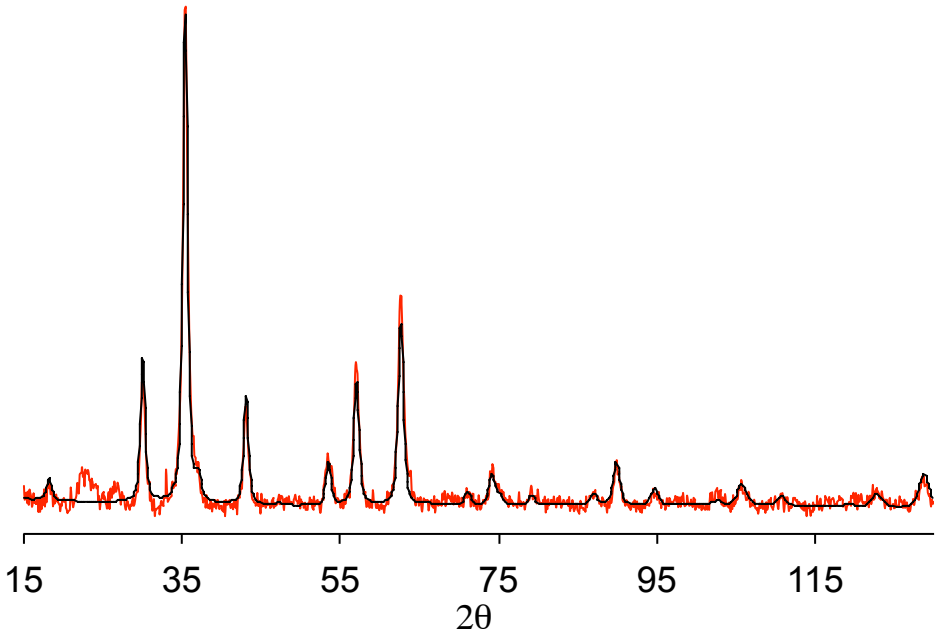

Figure S40: XRD pattern for $Tc_{0.1}Fe_{2.9}O_4$-c (Data in color; Rietveld fit in black)

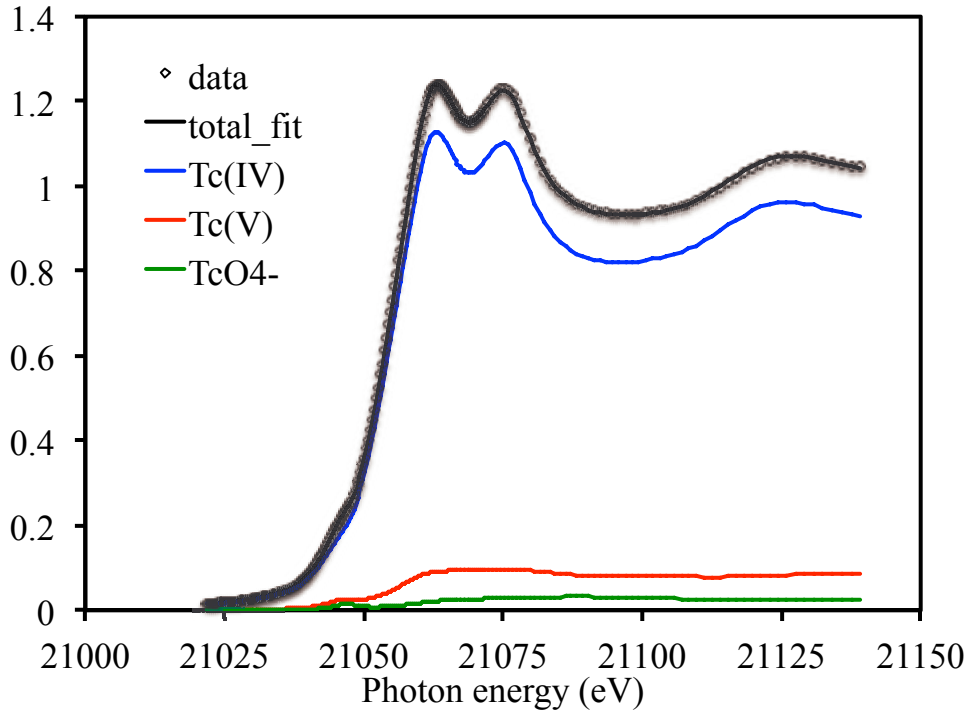

Figure S41: XANES fit for $Tc_{0.1}Fe_{2.9}O_4$-c

Neighbor	# of Neighbors	σ^2 (Å^2)	Distance (Å)	O_h Fe_3O_4 (Å)	p
O	0.29(6)	0.001	1.63(1)	--	0.001
O	5.71(6)[b]	0.0046(2)	2.020(3)	2.06	<0.001
Fe	3.83(6)	0.0024(6)	3.086(6)	2.97	<0.001
Tc	2.17(6)[b]	0.0024(6)[c]	3.086(6)[c]	2.97	<0.001
Fe	6	0.0113(7)	3.511(8)	3.48	<0.001
O-Tc-O (MS)	6	0.014(2)	4.17(3)	4.12	<0.001
Fe	12	0.014(2)[c]	5.23(2)	5.14	0.002

a) Fit range: 2<k<13.5, 1<R<5.2; 32.4 independent data. 15 parameters, $S_0^2 = 0.8$, $\Delta E_0 = 3(1)$ eV, $\chi^2 = 4425$ $\chi_\nu^2 = 287$ R = 0.020. Parameters without errors are fixed.

b) Parameter is constrained to equal 6 minus the preceding parameter

c) Parameter constrained to equal the preceding parameter

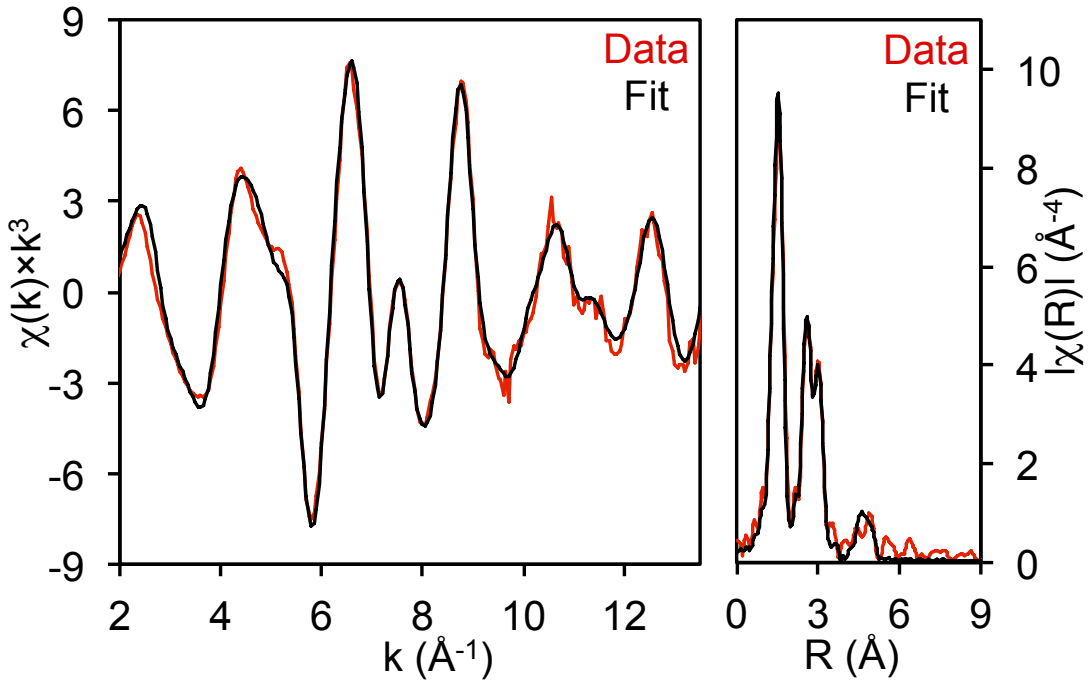

Figure S42: Tc K-edge EXAFS spectrum of Tc in $Tc_{0.1}Fe_{2.9}O_4$-c

$Tc_{0.1}Co_{0.2}Fe_{2.7}O_4$-c

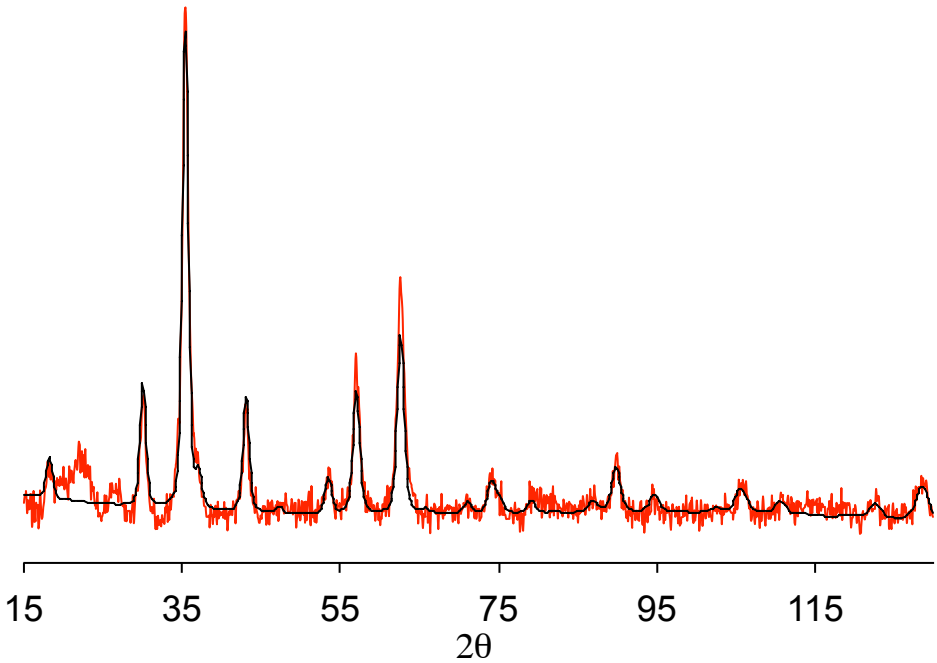

Figure S43: XRD pattern for $Tc_{0.1}Co_{0.2}Fe_{2.7}O_4$-c (Data in color; Rietveld fit in black)

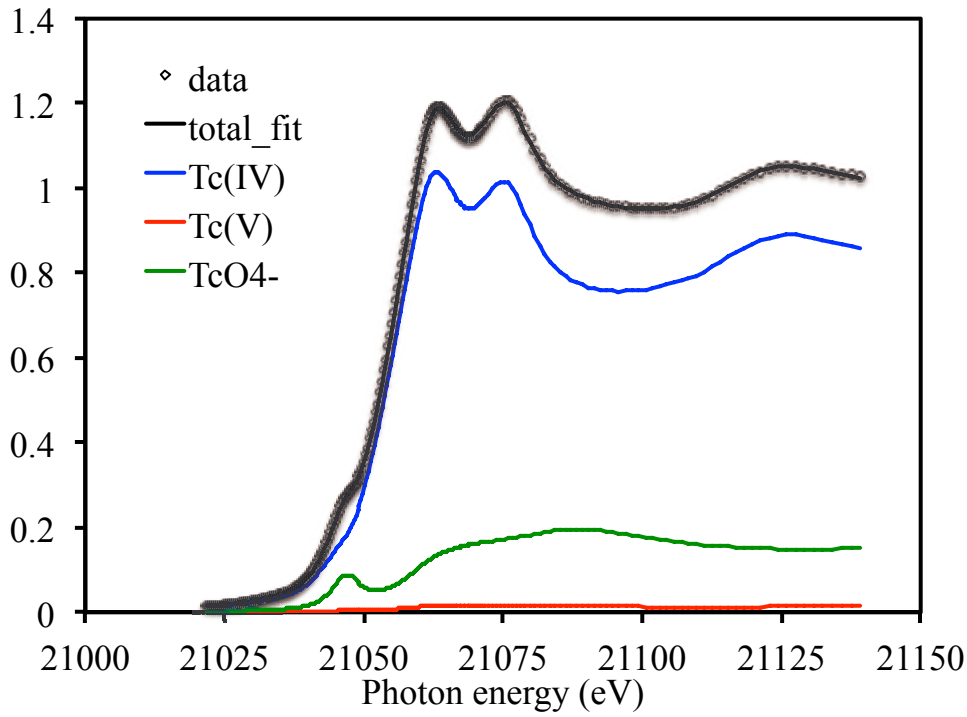

Figure S44: XANES fit for $Tc_{0.1}Co_{0.2}Fe_{2.7}O_4$-c

Table S15: Best fit parameters for $Tc_{0.1}Co_{0.2}Fe_{2.7}O_4$-c[a]

Neighbor	# of Neighbors	σ^2 (Å^2)	Distance (Å)	O_h Fe_3O_4 (Å)	p
O	0.58(8)	0.001	1.716(9)	--	<0.001
O	5.42(8)[b]	0.0049(3)	2.020(5)	2.06	<0.001
Fe	3.84(9)	0.0029(8)	3.077(9)	2.97	<0.001
Tc	2.16(9)[b]	0.0029(8)[c]	3.077(9)[c]	2.97	0.001
Fe	6	0.0110(9)	3.51(1)	3.48	<0.001
O-Tc-O (MS)	6	0.013(2)	4.17(5)	4.12	0.003
Fe	12	0.013(2)	5.22(2)	5.14	0.003

a) Fit range: 2<k<13.5, 1<R<5.2; 32.4 independent data. 13 parameters, $S_0^2 = 0.8$, $\Delta E_0 = 1(1)$ eV, $\chi^2 = 845$ $\chi_\nu^2 = 48.5$ R = 0.021. Parameters without errors are fixed.

b) Parameter is constrained to equal 6 minus the preceding parameter

c) Parameter constrained to equal the preceding parameter

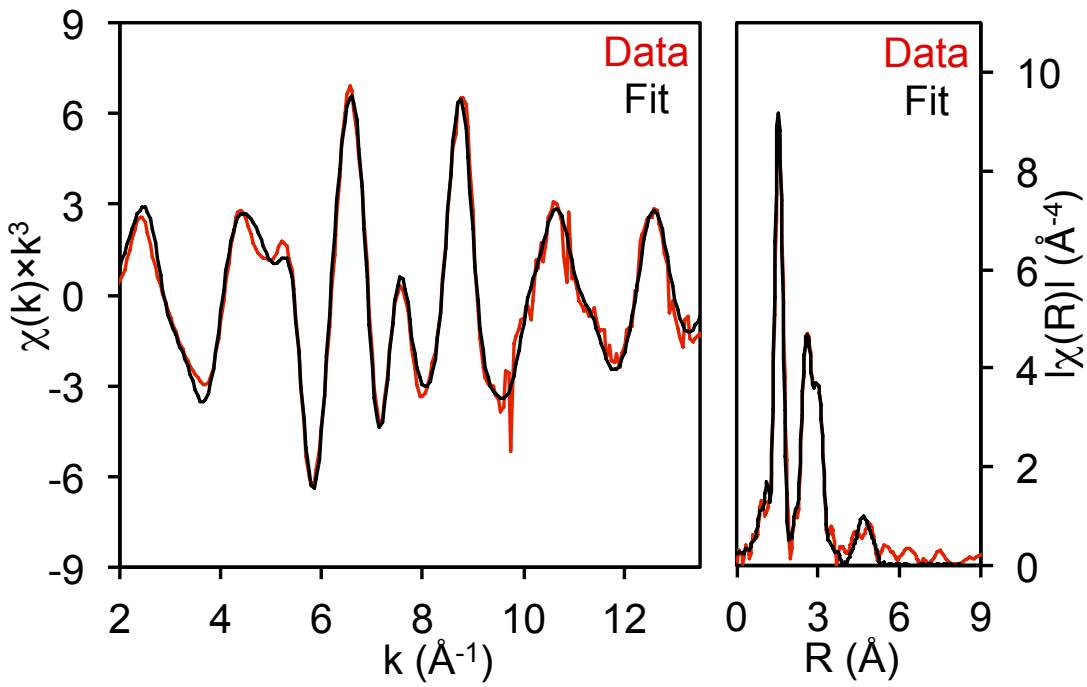

Figure S45: Tc K-edge EXAFS spectrum of Tc in $Tc_{0.1}Co_{0.2}Fe_{2.7}O_4$-c

$Tc_{0.1}Ni_{0.2}Fe_{2.7}O_4$-c

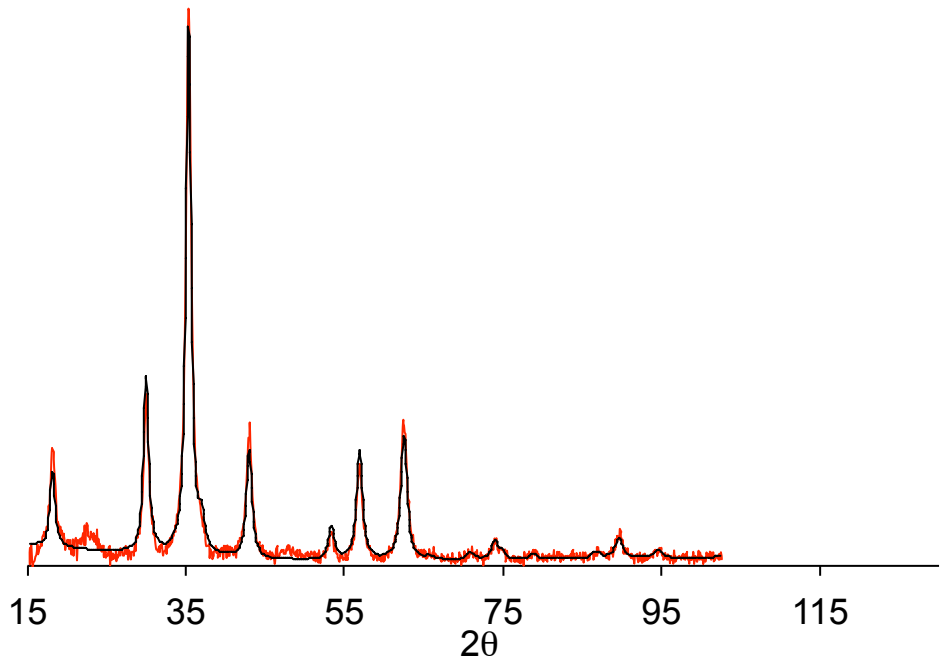

Figure S46: XRD pattern for $Tc_{0.1}Ni_{0.2}Fe_{2.7}O_4$-c (Data in color; Rietveld fit in black). Data was obtained using a Co source, but the 2θ values have been transformed to match the other data, which was obtained with a Cu source.

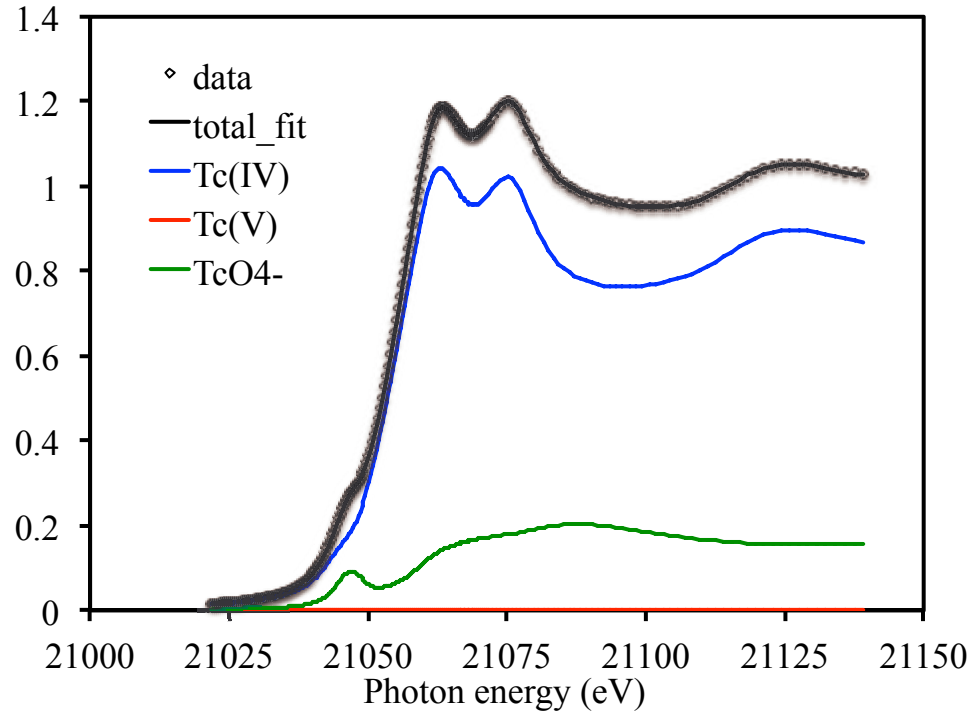

Figure S47: XANES fit for $Tc_{0.1}Ni_{0.2}Fe_{2.7}O_4$-c

Table S16: Best fit parameters $Tc_{0.1}Ni_{0.2}Fe_{2.7}O_4$-c

Neighbor	# of Neighbors	σ^2 (Å^2)	Distance (Å)	O_h Fe_3O_4 (Å)	p
O	0.61(8)	0.001	1.720(8)	--	<0.001
O	5.42(8)[b]	0.0051(3)	2.019(5)	2.06	<0.001
Fe	4.07(4)	0.0039(9)	3.074(9)	2.97	<0.001
Tc	1.93(4)[b]	0.0039(9)[c]	3.074(9)[c]	2.97	0.004
Fe	6	0.0107(8)	3.509(9)	3.48	<0.001
O-Tc-O (MS)	6	0.014(2)	4.16(4)	4.12	0.001
Fe	12	0.014(2)	5.21(2)	5.14	0.003

a) Fit range: 2<k<13.5, 1<R<5.2; 32.4 independent data. 13 parameters, $S_0^2 = 0.8$, $\Delta E_0 = 0(1)$ eV, $\chi^2 = 374$ $\chi_\nu^2 = 21.5$ R = 0.017. Parameters without errors are fixed.

b) Parameter is constrained to equal 6 minus the preceding parameter

c) Parameter constrained to equal the preceding parameter

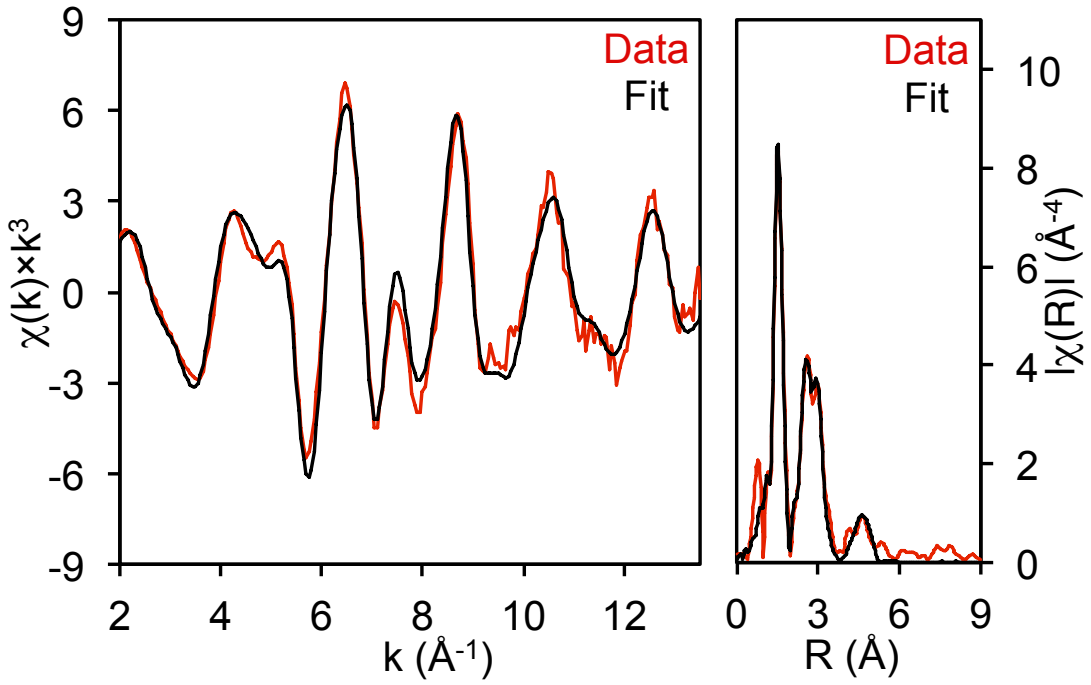

Figure S48: Tc K-edge EXAFS spectrum of Tc in $Tc_{0.1}Ni_{0.2}Fe_{2.7}O_4$-c

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