Supplementary Information

Oxygen vacancy mediated room-temperature ferromagnetism and bandgap narrowing in $DyFe_{0.5}Cr_{0.5}O_3$ nanoparticles

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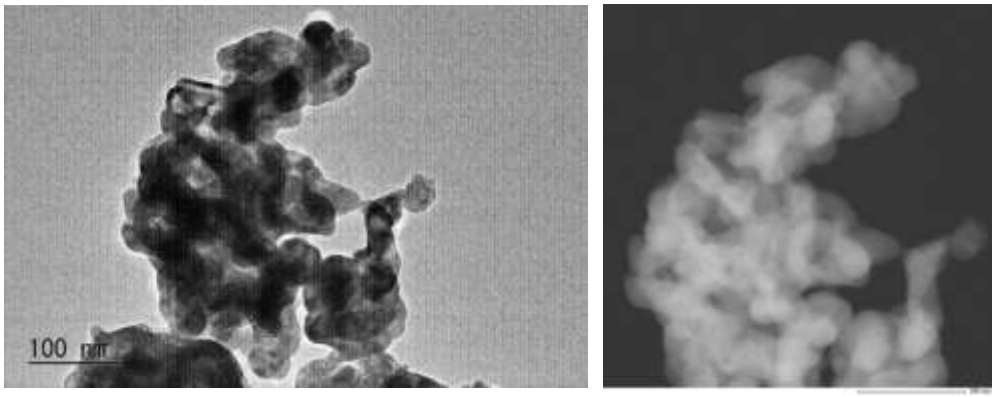

Figure S1. (left) TEM and (right) HAADF-STEM image of $DyFe_{0.5}Cr_{0.5}O_3$ nanoparticles.

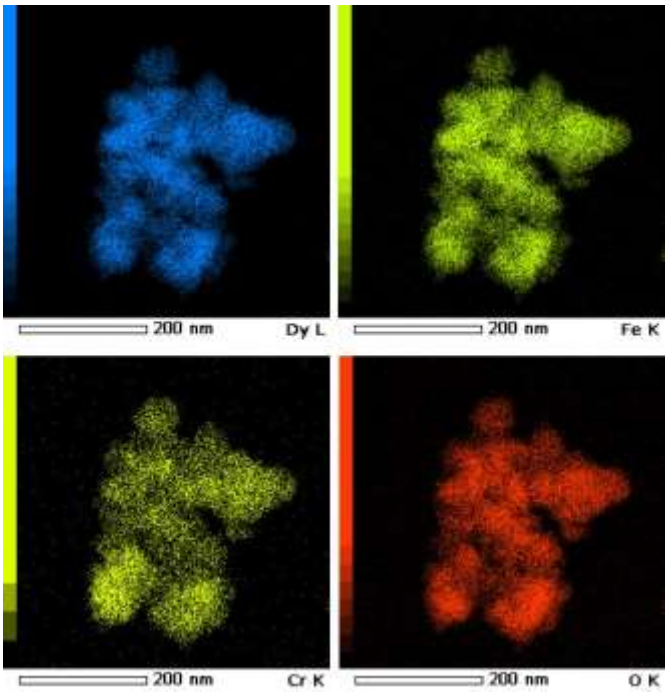

Figure S2. The elemental mapping pattern of Dy, Fe, Cr and O in $DyFe_{0.5}Cr_{0.5}O_3$ nanoparticles respectively.

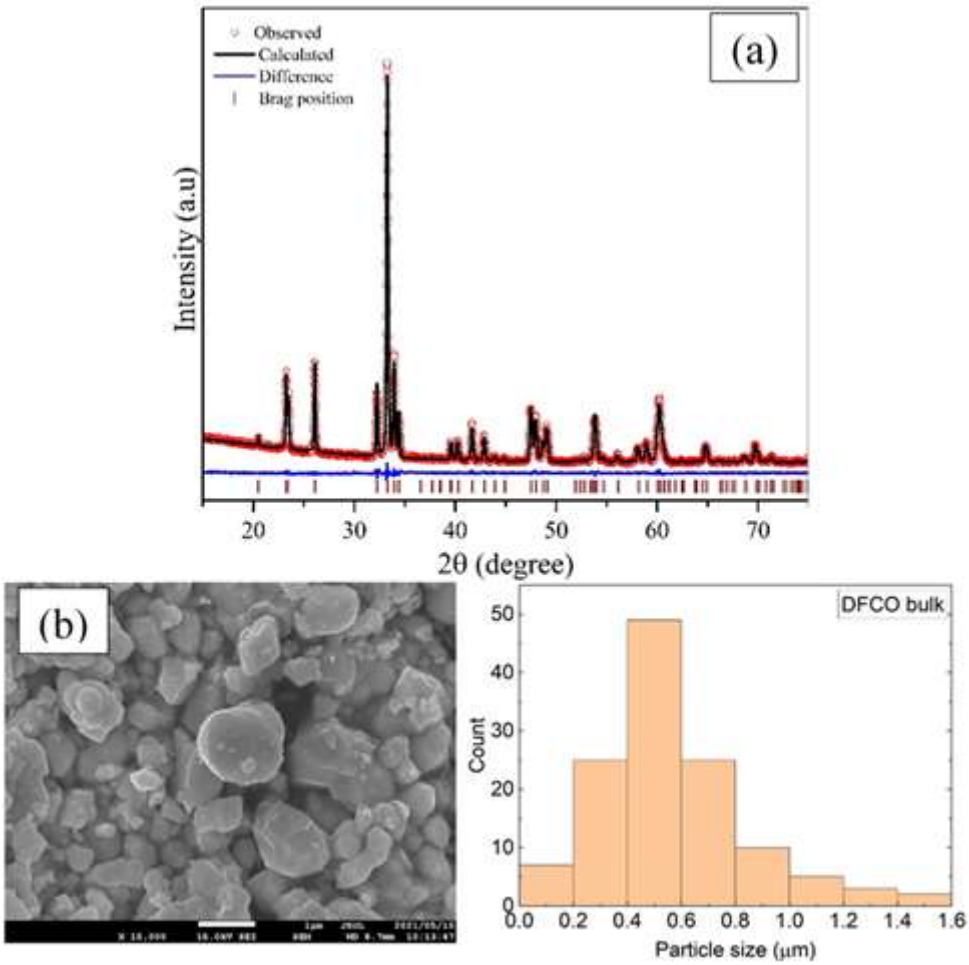

Figure S3: (a) XRD and corresponding Rietveld refinement of bulk sized $DyFe_{0.5}Cr_{0.5}O_3$ prepared by solid-state reaction technique. (b) FSEM image and histogram of the particle size distribution.

Table S1: Comparison of lattice parameters of $DyFe_{0.5}Cr_{0.5}O_3$ with reported $DyFeO_3$ and $DyCrO_3$ perovskites.

	a	b	c	Reference
$DyFeO_3$	5.595	7.629	5.300	[1]
	5.598	7.623	5.302	[2]
$DyFe_{0.5}Cr_{0.5}O_3$	5.543	7.586	5.281	This work (nano)
	5.554	7.584	5.283	This work (bulk)
	5.556	7.588	5.286	[3]
$DyCrO_3$	5.481	7.549	5.177	[4]
	5.508	7.537	5.254	[5]

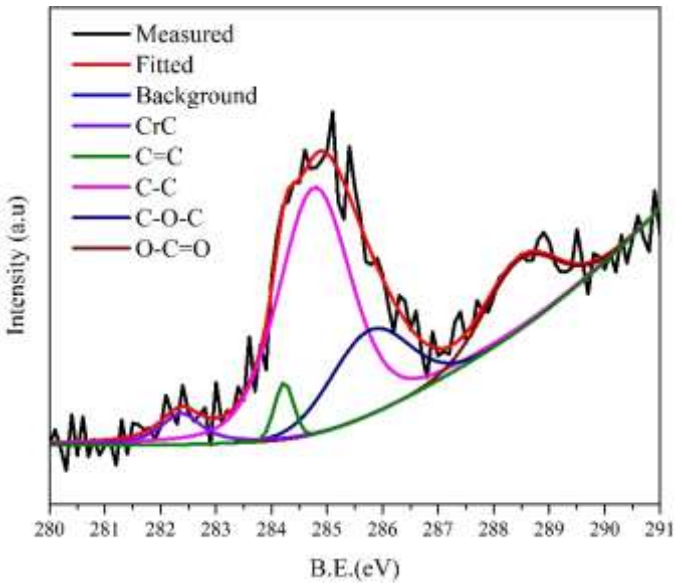

Figure S4: XPS spectra of C 1s. The peaks found at 284.28 eV, 284.8 eV, 285.56 eV and 288.5 eV are the adventitious carbon peaks present in all air exposed material due to surface contamination [6,7]. The peak at 282.3 eV is associated to carbon in chromium carbide (CrC) [8]. The presence of CrC is found to be only ≥0.8% of total elemental composition of $DyFe_{0.5}Cr_{0.5}O_3$ nanoparticles, therefore no distinguishable peak in XRD pattern corresponding to this phase have found.

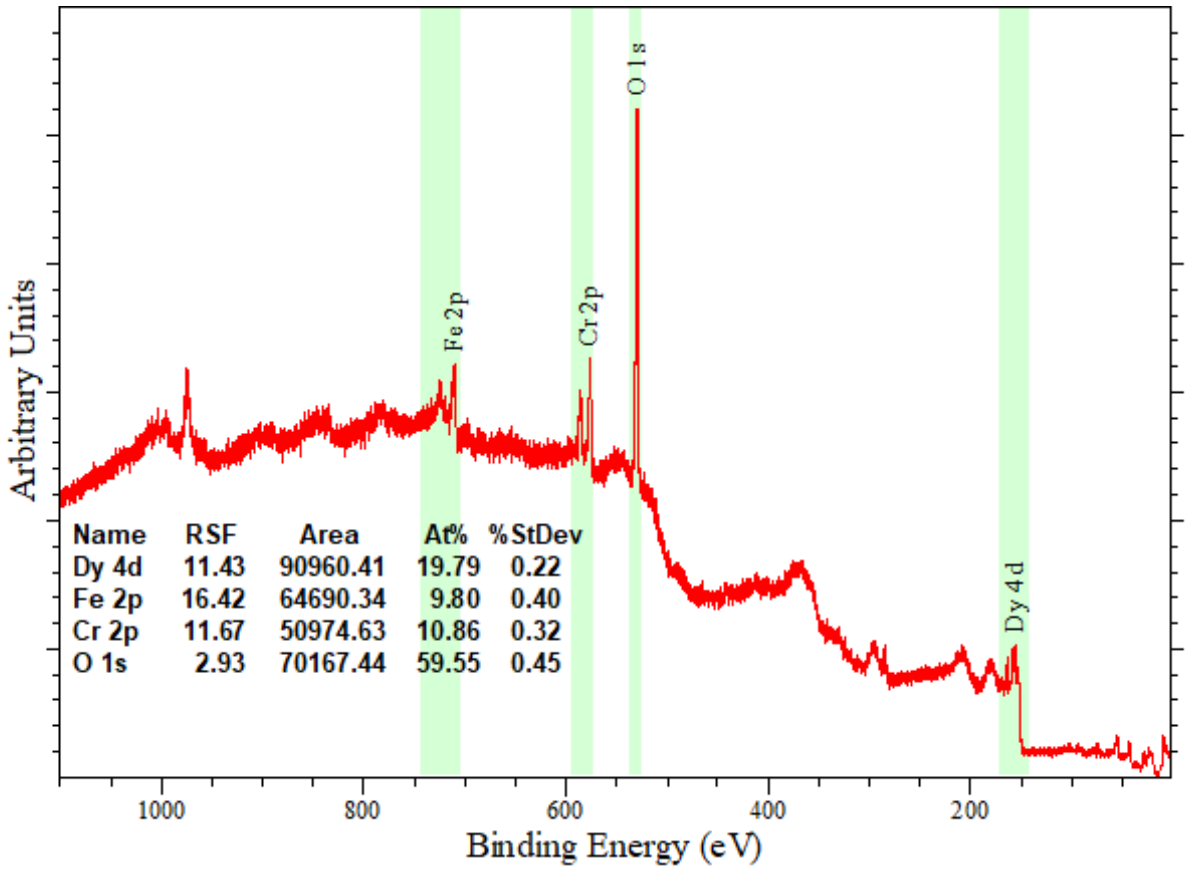

Figure S5. XPS survey spectra of synthesized nanoparticles.

Table S2: Elemental composition of synthesized nanoparticles calculated from XPS survey spectra. Parenthesis is showing the standard deviation of quantification.

At%	Dy	Fe	Cr	O
Theoretical	19.85	9.93	10.66	59.56
XPS	19.79(0.22)	9.80(0.40)	10.86(0.32)	59.55(0.45)

Table S3: Surface quantification of the ratio of lattice Oxygen (O^{2-})/Oxygen vacancy (O_v) and Fe^{2+} /Fe^{3+} and Cr^{2+}/Cr^{3+} cations present on the surface of nanoparticles using common relative sensitivity factor (RSF) of for Al Kα.

Elements	Position	Area	RSF	Area (%)	Oxidation state
O 1s	529.26	42039.4	2.93	64.72	O^{2-}
	530.95	22919.7		35.28	O_v
Fe $2p_{3/2}$	709.72	7182.6	10.82	34.37	Fe^{2+}
	711.15	8414.9		39.78	Fe^{3+}
	713.11	5372.1		25.85	Fe^{3+}
Cr $2p_{3/2}$	575.52	10152.9	7.69	37.77	Cr^{2+}
	576.72	10573.2		39.34	Cr^{3+}
	578.12	6153.3		22.89	Cr^{3+}
Dy 4d	152.51	18478.5	11.43	36.63	Dy^{0}
Dy $4d_{5/2}$	155.59	18849.1	6.74	63.37	Dy^{3+}

References

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