Supplementary Materials
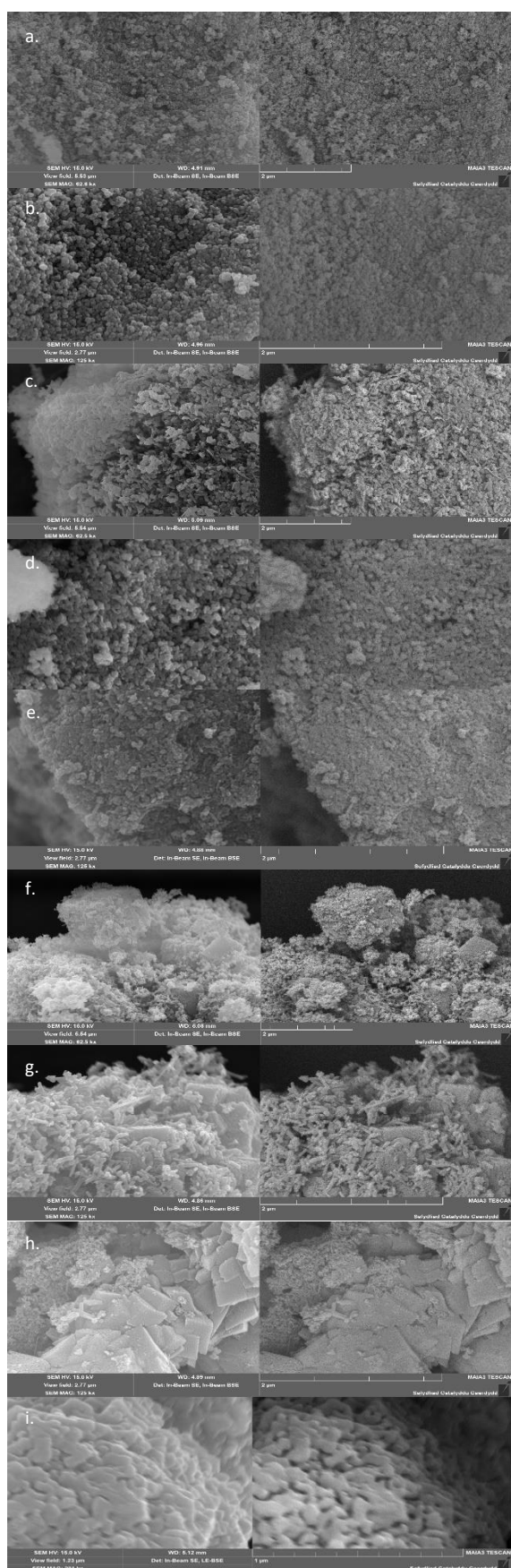
Figure S1: SEM images of (a.) FeO_x, (b.) $Fe_{0.99}Mn_{0.01}O_x$, (c.) $Fe_{0.90}Mn_{0.10}O_x$, (d.) $Fe_{0.80}Mn_{0.20}O_x$, (e.) $Fe_{0.50}Mn_{0.50}O_x$, (f.) $Fe_{0.20}Mn_{0.80}O_x$, (g.) $Fe_{0.10}Mn_{0.90}O_x$, (h.) $Fe_{0.01}Mn_{0.99}O_x$, (i.) MnO_x. Left image obtained using secondary electrons, right image obtained using backscattered electrons.
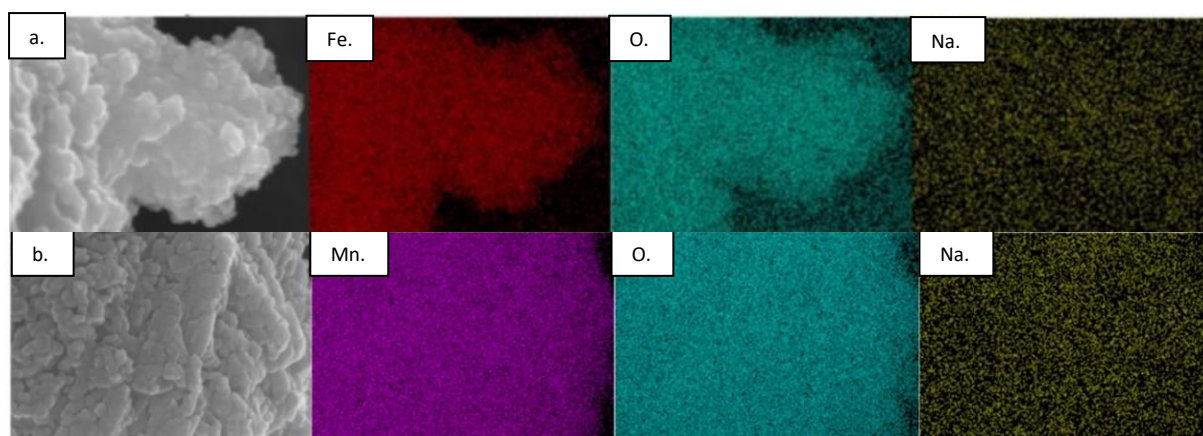
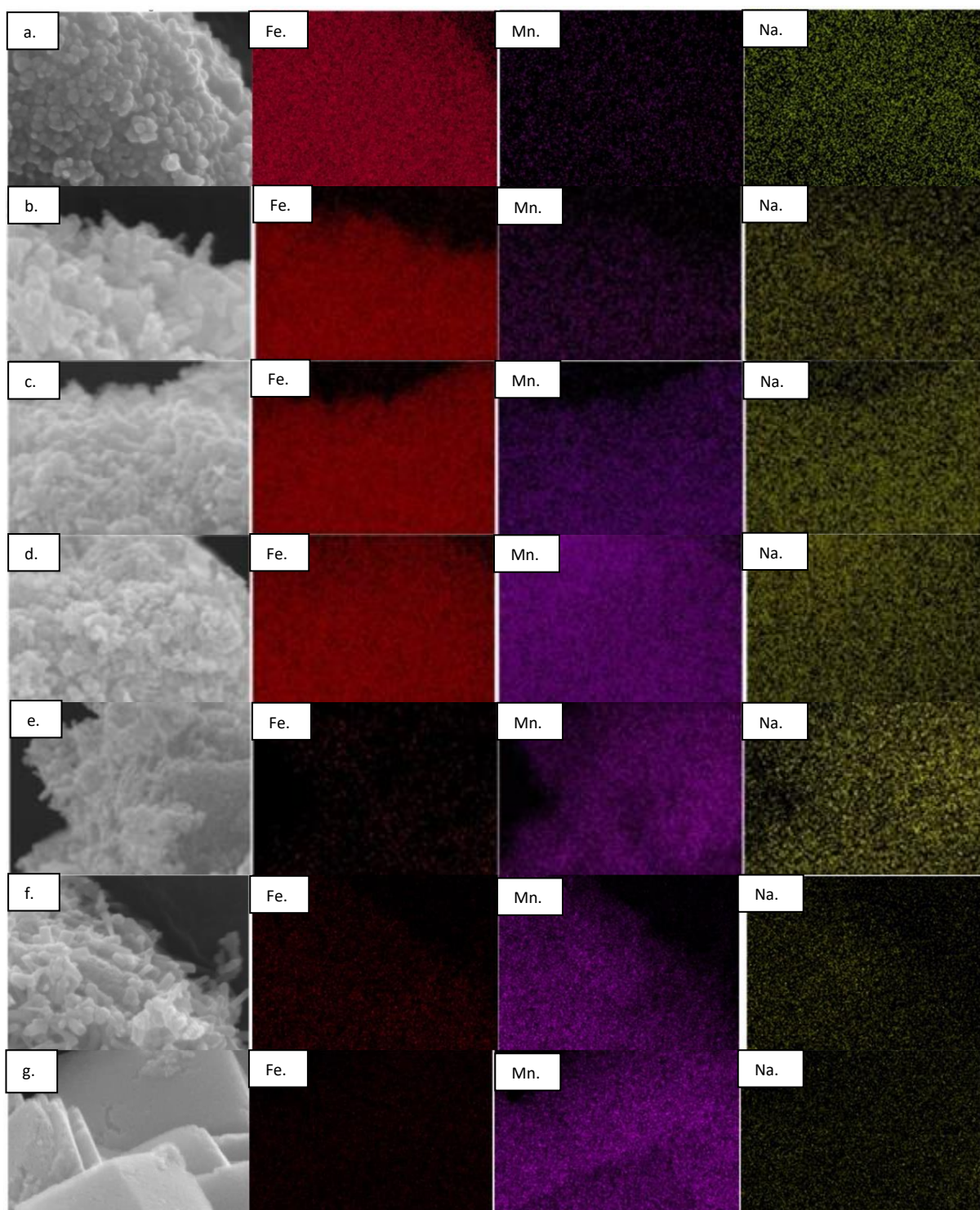*Figure S2: SEM-EDX images of (a.) FeO$_x$ and (b.) MnO$_x$*

Figure S3: SEM-EDX mapping of (a) $Fe_{0.99}Mn_{0.01}O_x$, (b) $Fe_{0.90}Mn_{0.10}O_x$, (c) $Fe_{-0.80}Mn_{0.20}O_x$, (d) $Fe_{0.50}Mn_{0.50}O_x$, (e) $Fe_{0.20}Mn_{0.80}O_x$, (f) $Fe_{0.10}Mn_{0.90}O_x$, (g) $Fe_{0.01}Mn_{0.99}O_x$
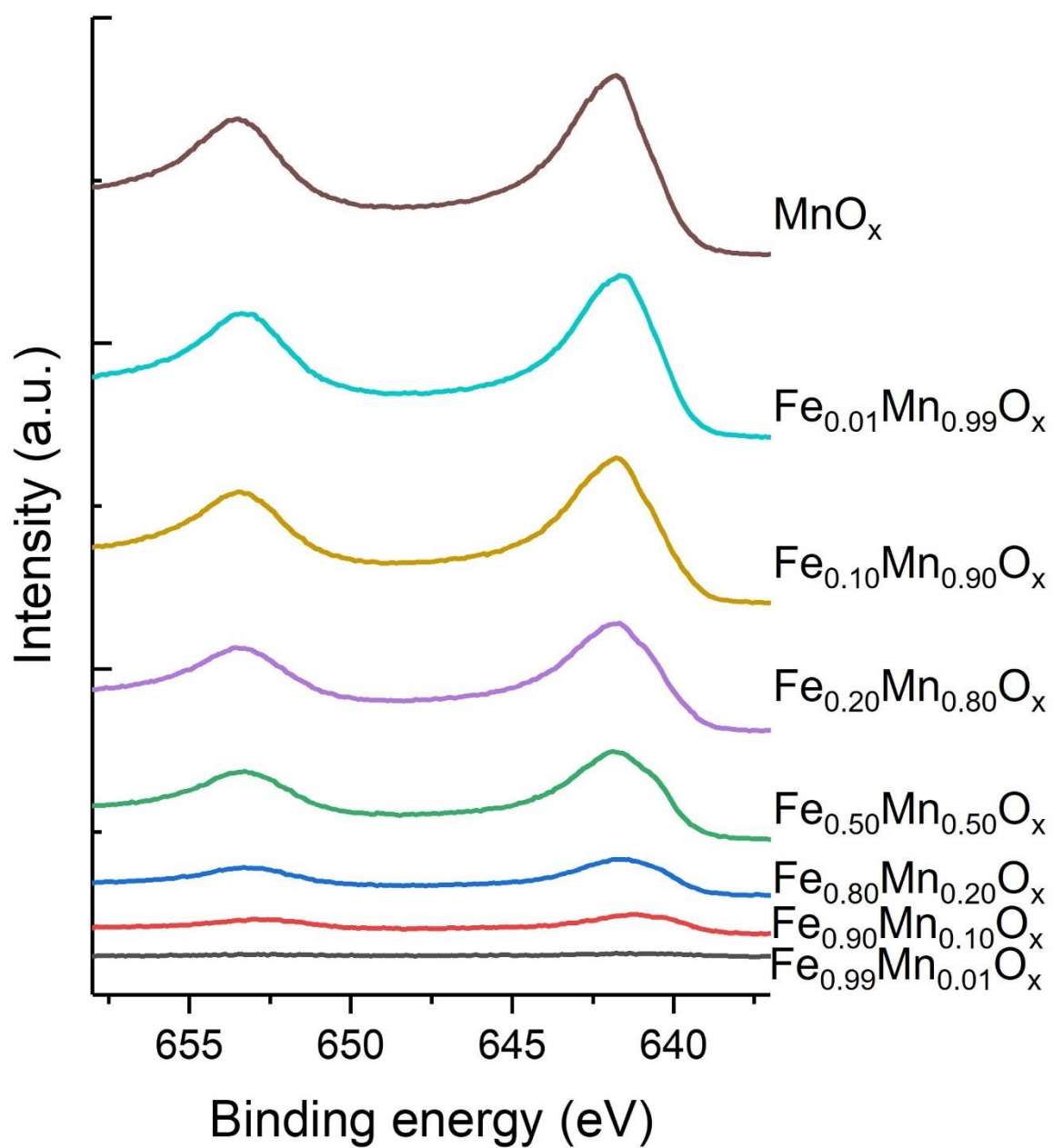
Figure S4: Mn 2p XPS spectra for the iron-manganese mixed metal oxide catalysts

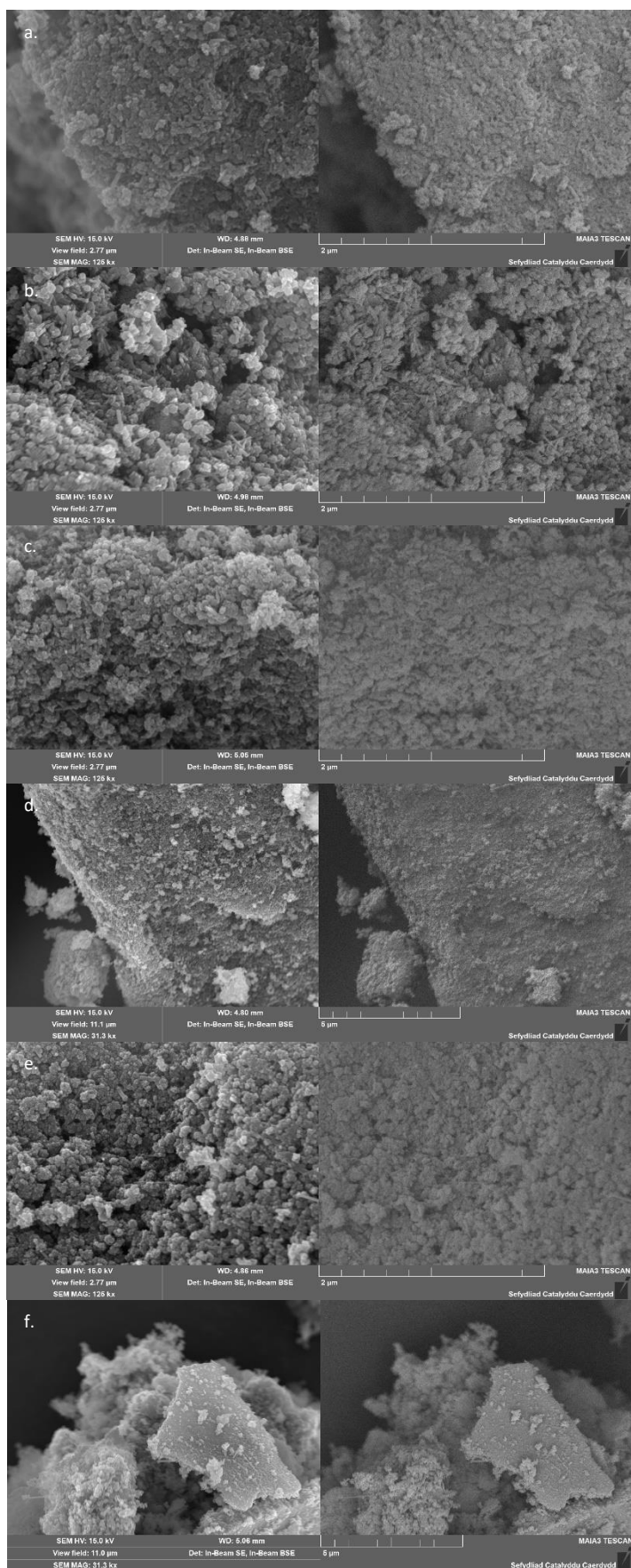*Figure S5: SEM images of the Fe$_{0.50}$Mn$_{0.50}$O$_x$ prepared using (a) Na$_2$CO$_3$, (b) K$_2$CO$_3$, (c) (NH$_4$)$_2$CO$_3$, (d) NaOH, (e) KOH and (f) NH$_4$OH. Left image obtained using secondary electrons, right image obtained using backscattered electrons.*
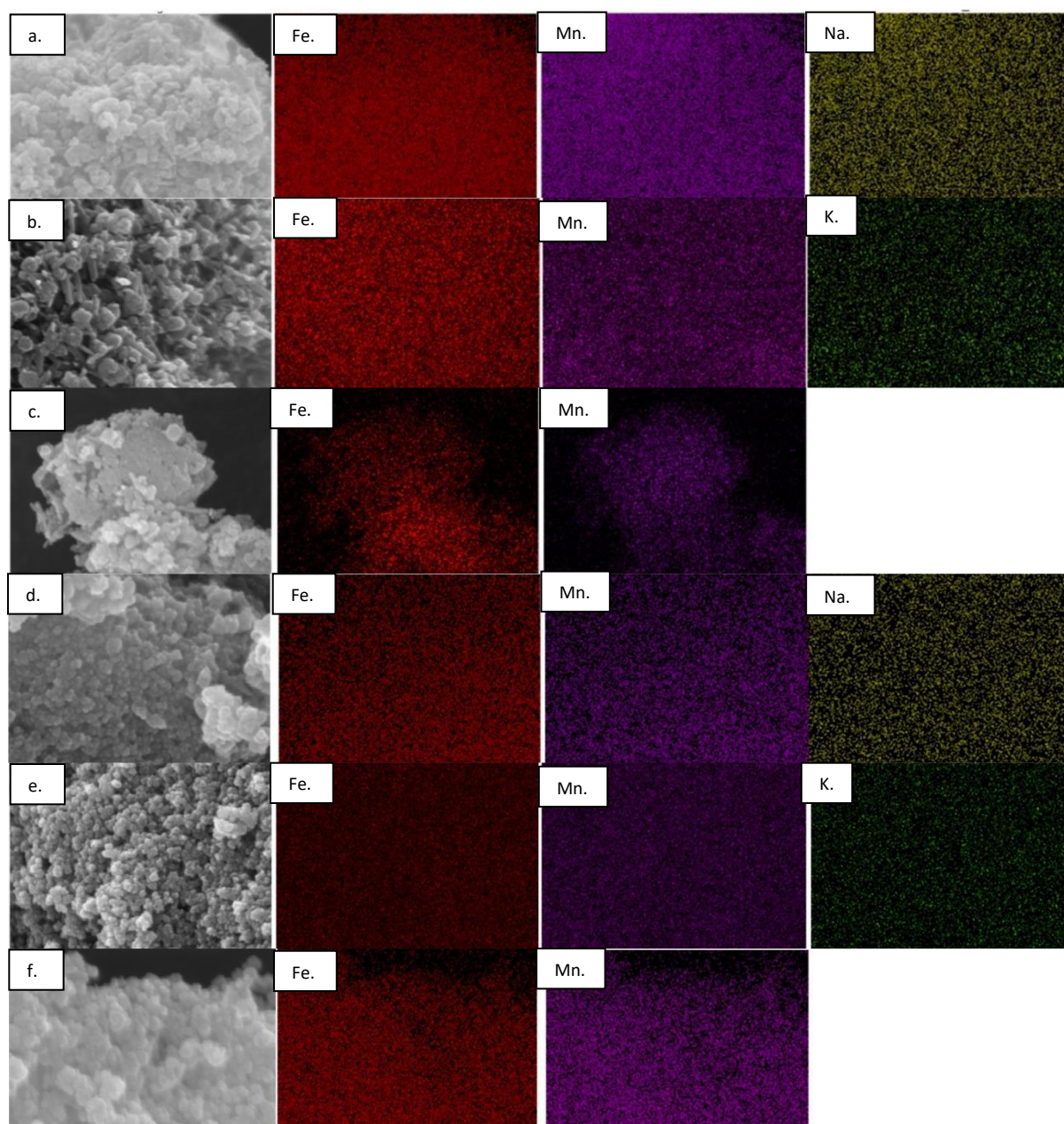
Figure S6: SEM-EDX mapping of Fe0.50Mn0.50Ox prepared via co-precipitation using different precipitating agents : (a) Na₂CO₃, (b) K₂CO₃, (c) (NH₄)₂CO₃, (d) NaOH, (e) KOH and (f) NH₄OH

Table S1: Elemental surface composition for the $Fe_{0.50}Mn_{0.50}O_x$ catalysts prepared using different precipitating agents derived from XPS data.

Sample	Surface concentration (%)					Relative surface Fe (%)	Relative Surface Mn (%)
	Fe	Mn	O	K	Na		
Na_2CO_3	13.6	18.9	62.6	-	4.9	42.0	58.0
K_2CO_3	21.4	18.6	60.1	4.9	-	53.5	46.5
$(NH_4)_2CO_3$	21.5	19.1	59.5	-	-	53.0	47.0
NaOH	21.4	19.0	59.3	-	0.4	53.0	47.0
KOH	20.1	14.2	64.7	1.1	-	58.6	41.4
NH_4OH	20.3	20.3	59.4	-	-	50.1	49.9