The supporting information

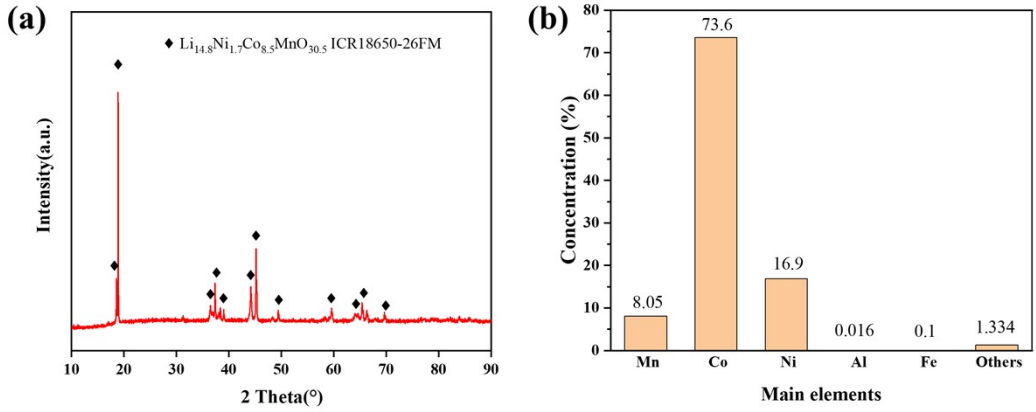

Fig. S1 (a) XRD and (b) XRF images of spent LIBs.

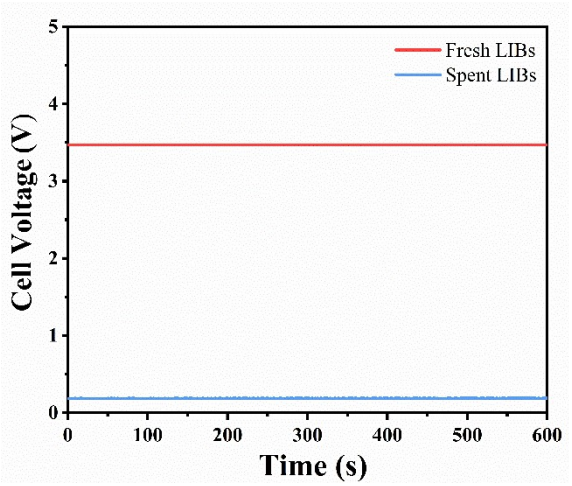

Fig. S2 Open-circuit voltage of spent lithium-ion batteries after discharge

Table S1 Recovery ratios (%) of the major elements by calculations

Element	Mn	Co	Ni
Recovery ratios (%)	73.52	87.38	92.21

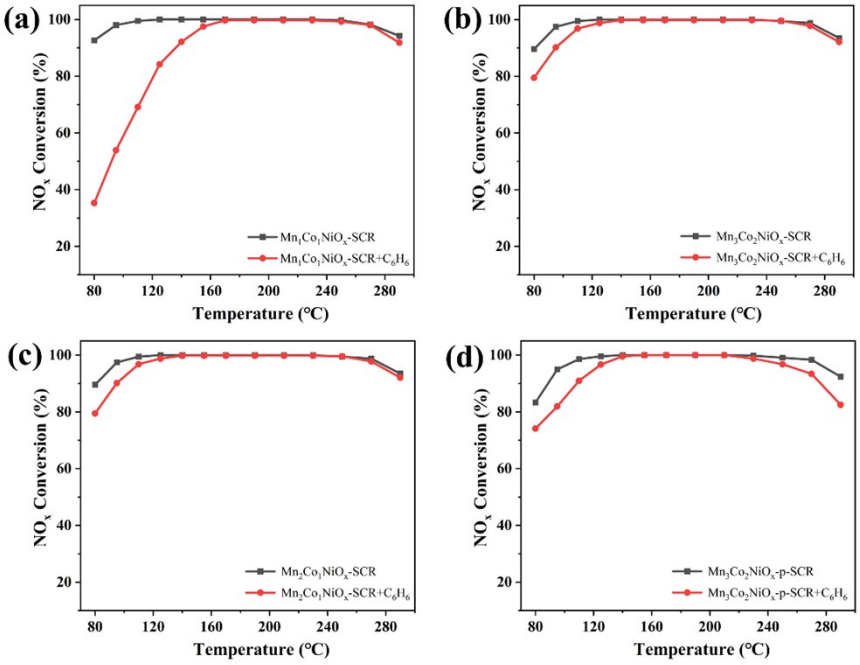

Fig.S3. (a) NO_x conversion of catalysts with different manganese contents in different atmospheres (a) $MnCo_2NiO_x$; (b) $Mn_1Co_1NiO_x$; (c) $Mn_3Co_2NiO_x$; (d) $Mn_3Co_2NiO_x$-p

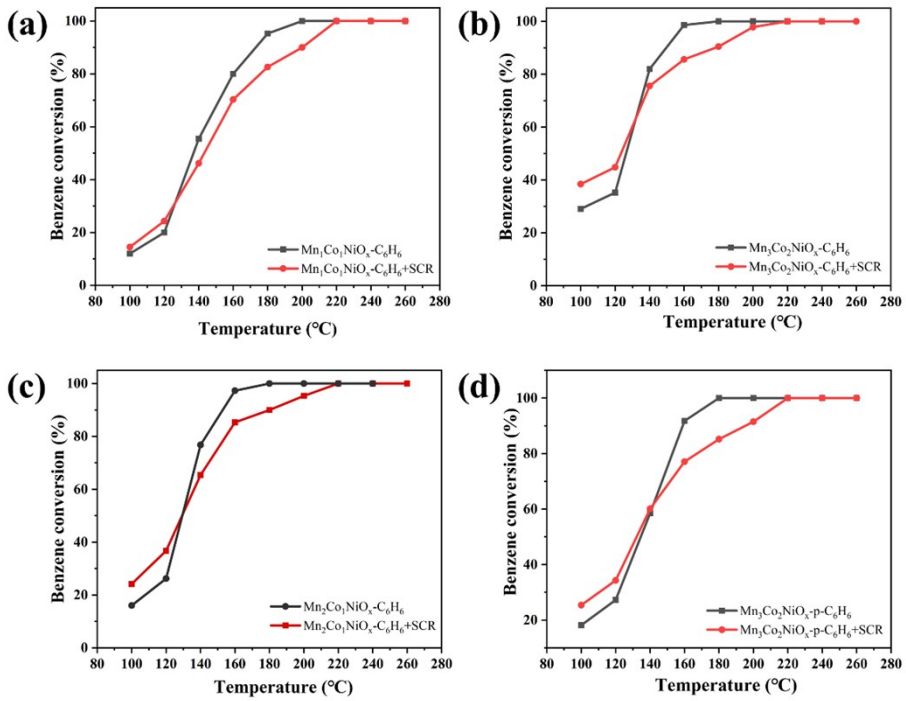

Fig.S4. (a) Benzene conversion of catalysts with different manganese contents in different atmospheres (a) $MnCo_2NiO_x$; (b) $Mn_1Co_1NiO_x$; (c) $Mn_3Co_2NiO_x$; (d) $Mn_3Co_2NiO_x$-p

Table S2 Different crystallite parameters of $Mn_3Co_2NiO_x$ and $Mn_3Co_2NiO_x$-p by XRD results**.**

Sample	(3 1 1) plane		
	2 theta(°)	FWHM(°)	D (nm)
$Mn_3Co_2NiO_x$	36.3	0.694	14.8
$Mn_3Co_2NiO_x$-p	36.28	0.658	15.6

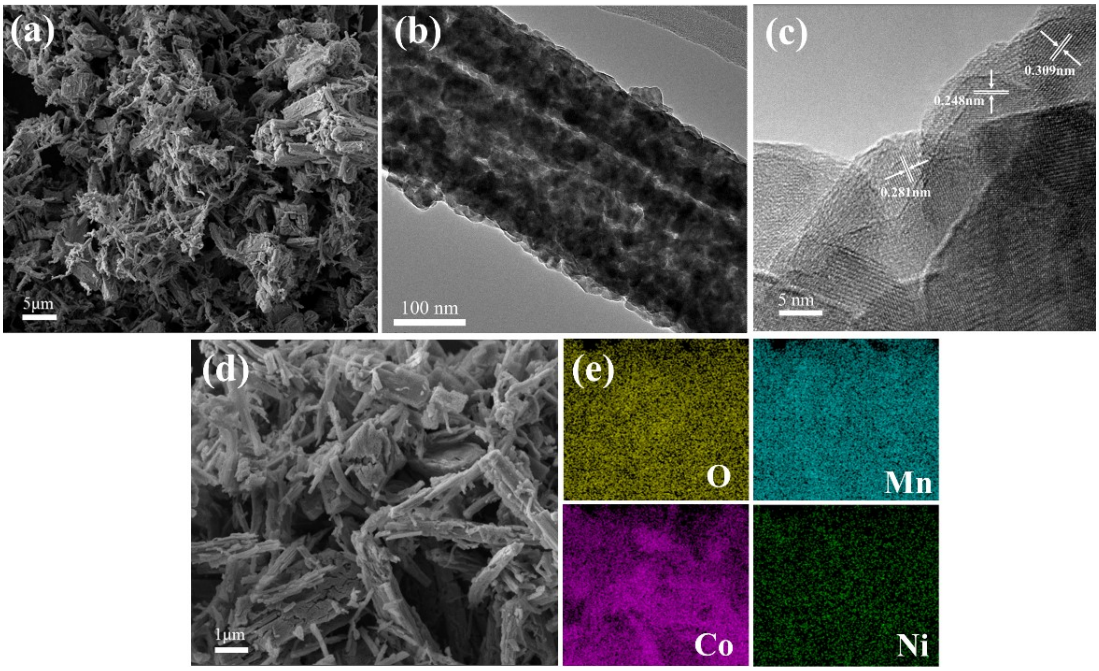

Fig. S5 SEM images of $Mn_3Co_2NiO_x$-MS catalyst at (a) 5 μm and (d) 1 μm; (b-c) HR-TEM images; (e-f) EDS elemental mapping of $Mn_3Co_2NiO_x$-MS catalyst

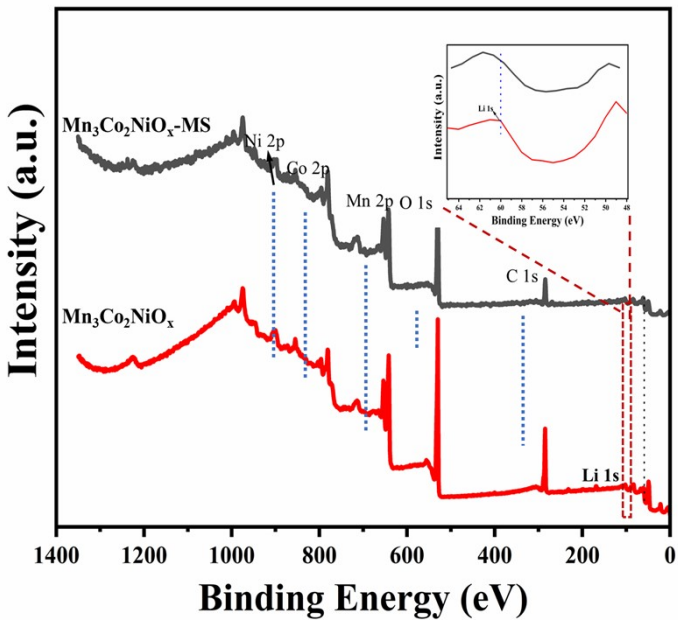

Fig. S6 XPS survey spectra of $Mn_3Co_2NiO_x$ and $Mn_3Co_2NiO_x$-MS

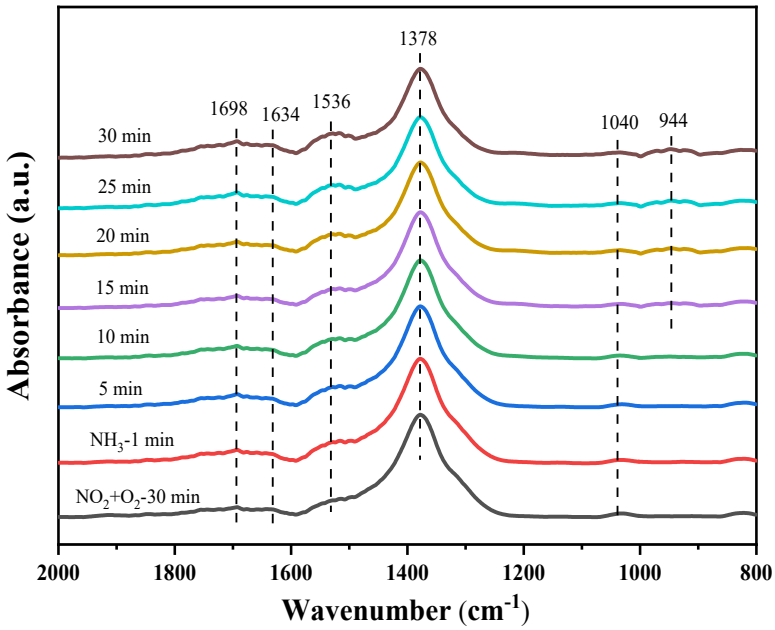

Fig. S7. In situ DRIFTS of $Mn_3Co_2NiO_x$ catalysts with NH_3 after pre-adsorption of NO + O_2 for different times at 190°C

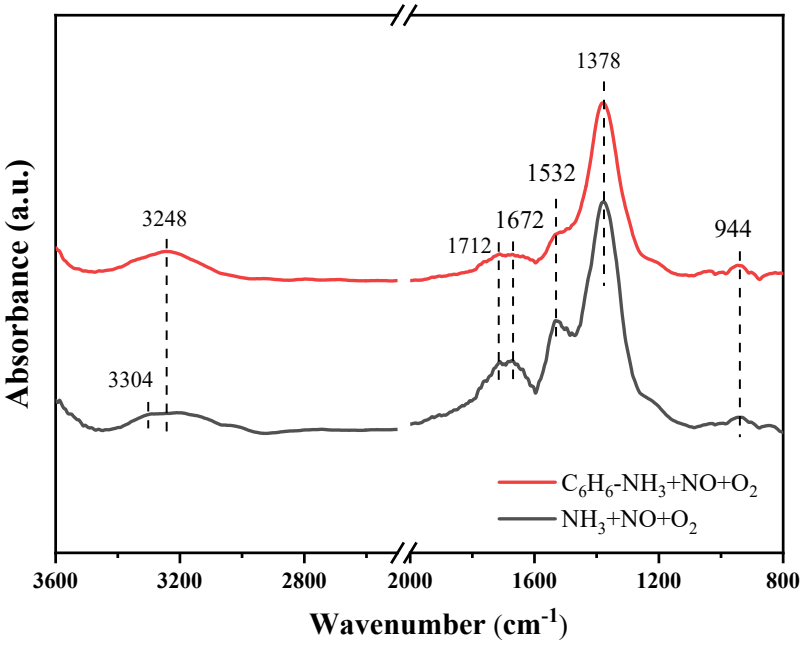

Fig S8 In situ DRIFTS spectra of $Mn_3Co_2NiO_x$ catalysts after reaction with SCR gases in the presence or absence of benzene at 190°C