

Supporting Information for

Quantitative Analysis of Transition-Metal Migration Induced

Electrochemically in Lithium-Rich Layered Oxide Cathode and

Its Contribution to Properties at High and Low Temperatures

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Table S1. Ni *K*-edge absorption edge energies, E_0 , (are defined the energy value at half absorbance of the peak) top at HT and LT with x in $\text{Li}_{1.2-x}\text{Ni}_{0.13}\text{Co}_{0.13}\text{Mn}_{0.53}\text{O}_2$ in charging.

Charge	x	0	0.45	0.80	1.04
E_0 / eV	LT	8341.3	8343.3	8344.1	-
	HT	8341.3	8342.1	-	8344.2

Table S2. Ni *K*-edge absorption edge energies, E_0 , (are defined the energy value at half absorbance of the peak) top at HT and LT with x in $\text{Li}_{1.2-x}\text{Ni}_{0.13}\text{Co}_{0.13}\text{Mn}_{0.53}\text{O}_2$ in discharging.

Discharge	x	0	0.33	0.51	0.99
E_0 / eV	LT	-	8340.9	8340.7	8343.3
	HT	8340.9	-	8341.3	8343.3

Table S3. Atomic ratio change of Mn, and Ni of x in $\text{Li}_{1.2-x}\text{Ni}_{0.13}\text{Co}_{0.13}\text{Mn}_{0.53}\text{O}_2$ in Li site during the charge process at 40 °C (HT) and –10 °C (LT).

Charge	x	0	0.45	0.80	1.04
Mn / %	LT	3.1	8.3	11	-
	HT	3.1	9.3	-	12
Ni / %	LT	13	15	15	-
	HT	13	14	-	15

Table S4. Atomic ratio change of Mn, and Ni of x in $\text{Li}_{1.2-x}\text{Ni}_{0.13}\text{Co}_{0.13}\text{Mn}_{0.53}\text{O}_2$ in Li site during the discharge process at 40 °C (HT) and –10 °C (LT).

Discharge	x	0	0.33	0.51	0.99
Mn / %	LT	-	8.2	11	15
	HT	4.0	-	11	15
Ni / %	LT	-	15	18	19
	HT	8.7	-	18	19

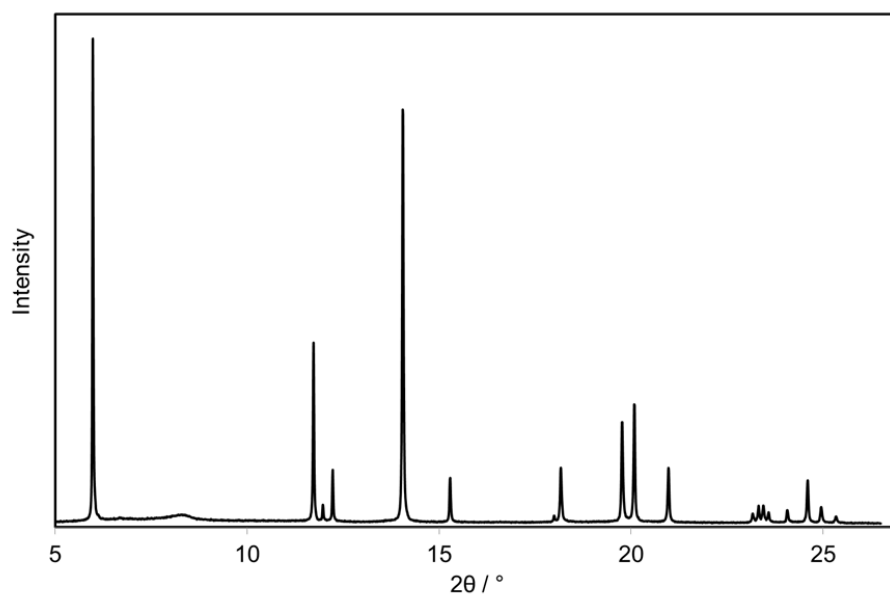


Figure S1. XRD pattern of x in $\text{Li}_{1.2-x}\text{Ni}_{0.13}\text{Co}_{0.13}\text{Mn}_{0.53}\text{O}_2$ ($x=0$) after activation.

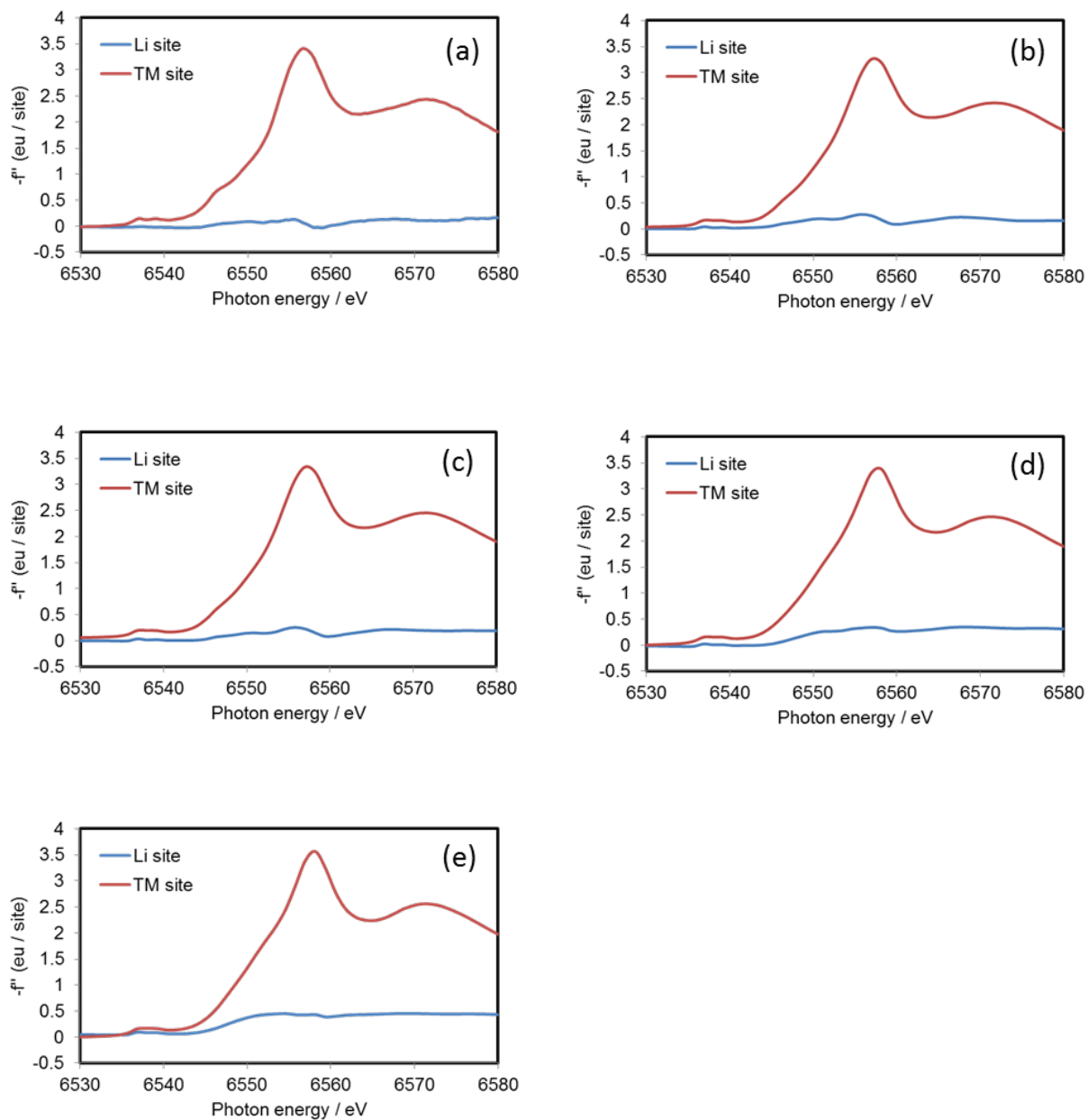


Figure S2. XAFS-like spectra of Mn at TM site and Li site in charging process with x in $\text{Li}_{1.2-x}\text{Ni}_{0.13}\text{Co}_{0.13}\text{Mn}_{0.53}\text{O}_2$ (a) $x=0$ (b) $x=0.45$ (LT) (c) $x=0.45$ (HT) (d) $x=0.80$ (LT) (e) $x=1.04$ (HT).

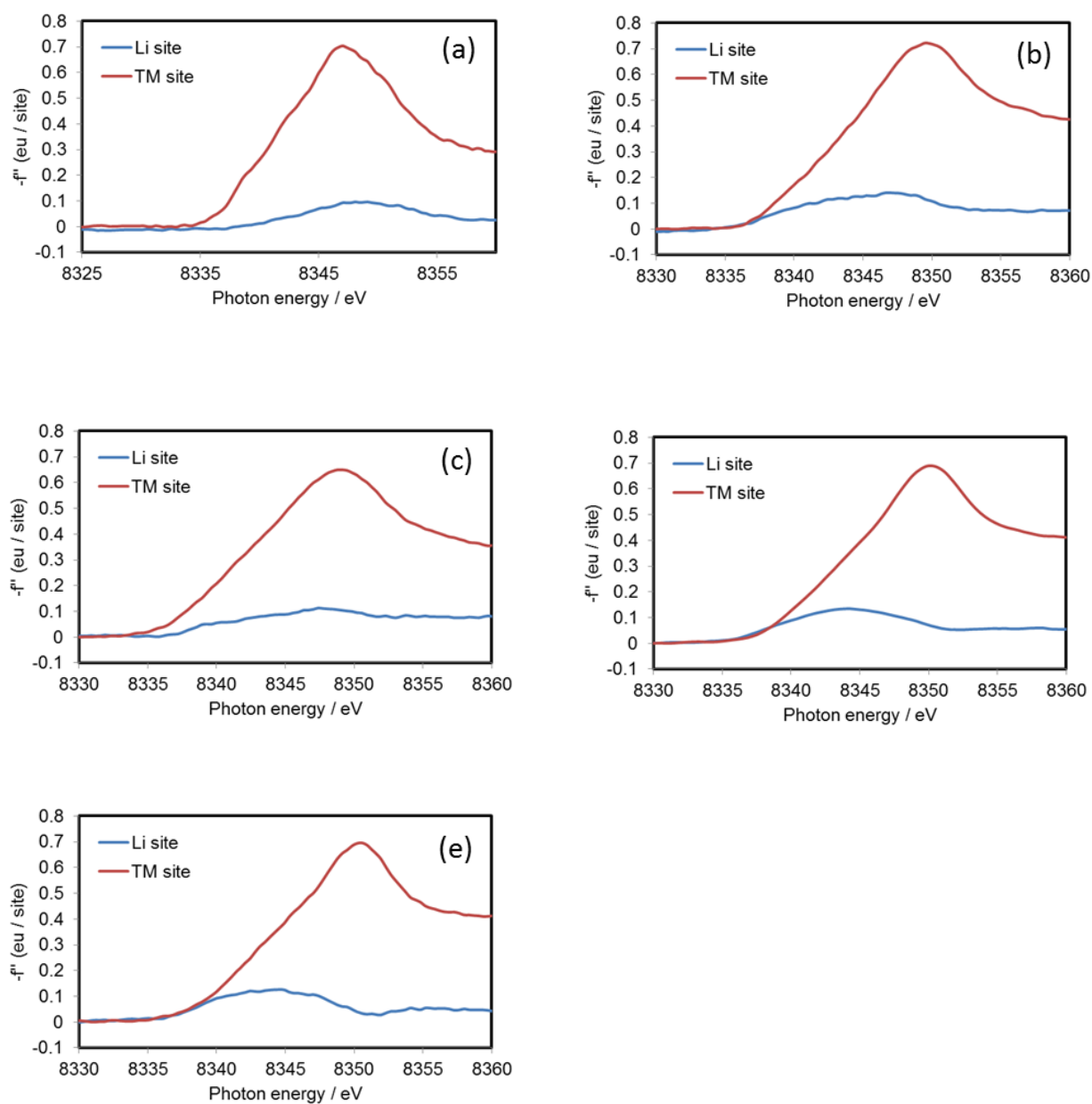


Figure S3. XAFS-like spectra of Ni at TM site and Li site in charging process with x in $\text{Li}_{1.2-x}\text{Ni}_{0.13}\text{Co}_{0.13}\text{Mn}_{0.53}\text{O}_2$ (a) $x = 0$ (b) $x = 0.45$ (LT) (c) $x = 0.45$ (HT) (d) $x = 0.80$ (LT) (e) $x = 1.04$ (HT).

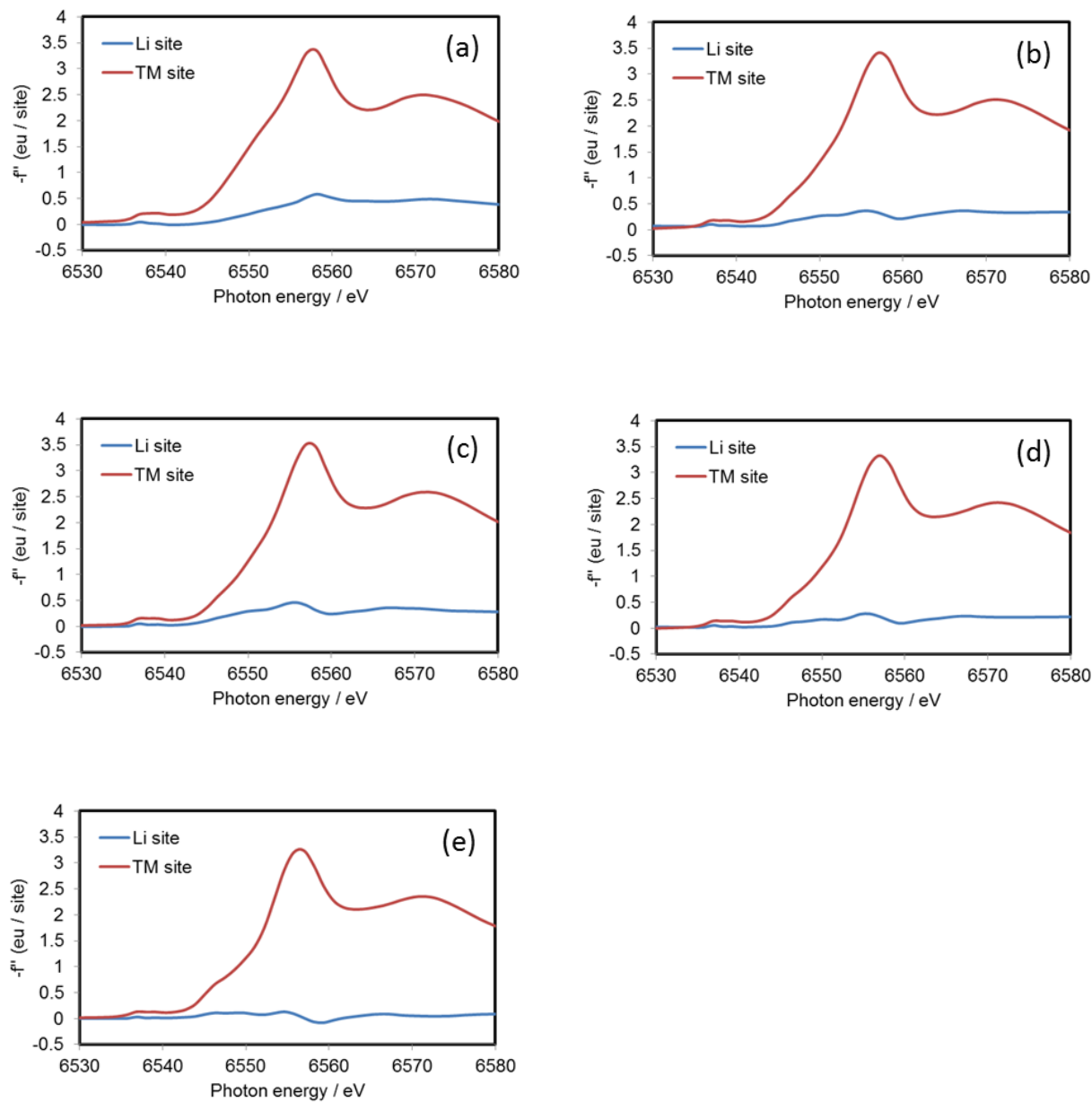


Figure S4. XAFS-like spectra of Mn at TM site and Li site in discharging process with x in $\text{Li}_{1.2-x}\text{Ni}_{0.13}\text{Co}_{0.13}\text{Mn}_{0.53}\text{O}_2$ (a) $x = 1.0$ (b) $x = 0.51$ (LT) (c) $x = 0.51$ (HT) (d) $x = 0.33$ (LT) (e) $x = 1.0$ (HT).

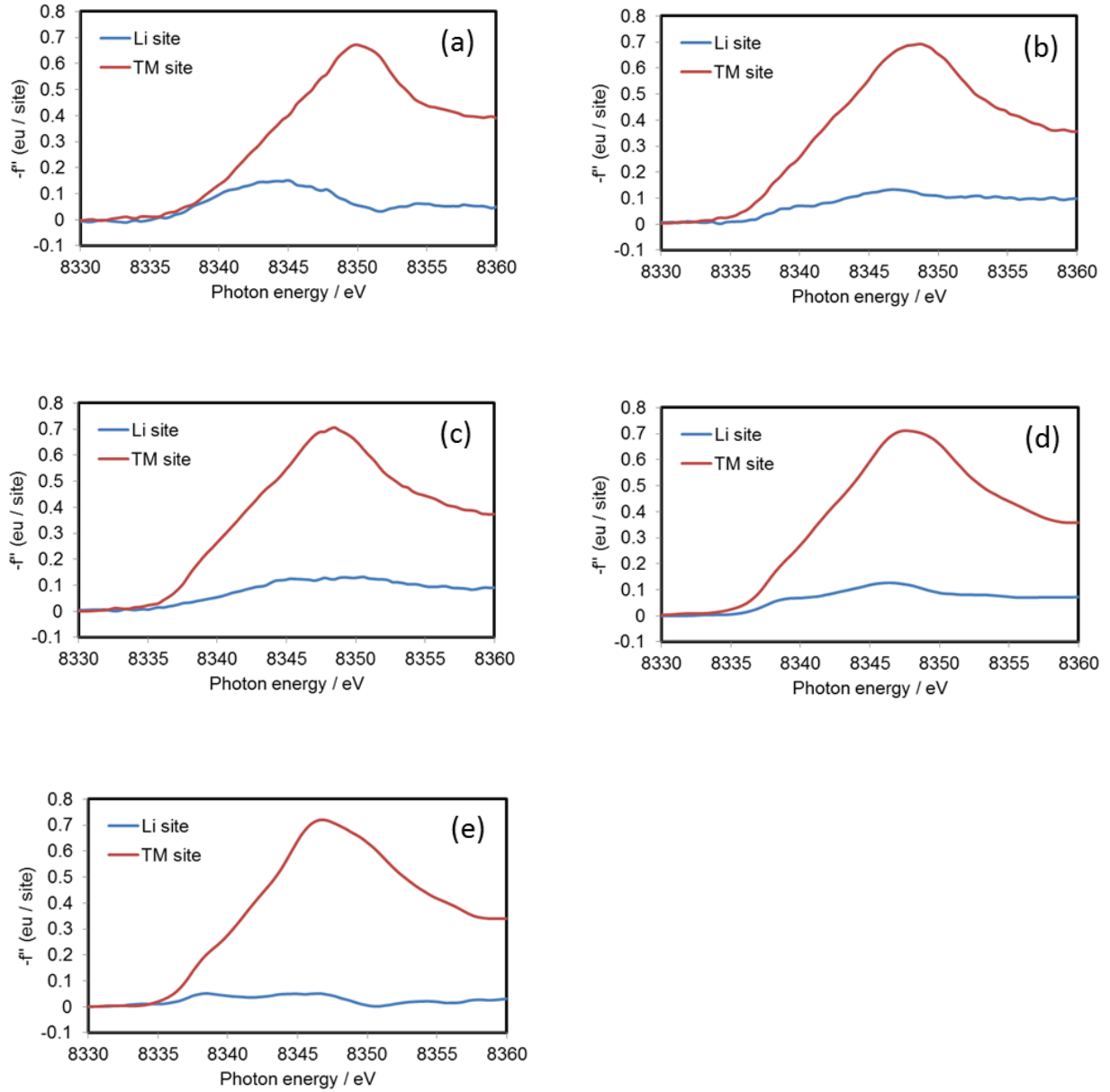


Figure S5. XAFS-like spectra of Ni at TM site and Li site in discharging process with x in $\text{Li}_{1.2-x}\text{Ni}_{0.13}\text{Co}_{0.13}\text{Mn}_{0.53}\text{O}_2$ (a) $x=1.0$ (b) $x = 0.51$ (LT) (c) $x = 0.51$ (HT) (d) $x = 0.33$ (LT) (e) $x = 1.0$ (HT).