Electronic Supplementary Information

Facile Synthesis of Nanostructured Perovskites by Precursor Accumulation on Nanocarbons

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Table S1 Preparation conditions of PA methods.

A-site		B-site		solvent	Carbon	Drying temp. (°C)	Calcination temp. (°C)
precursor	concentration (M)	precursor	concentration (M)				
$La(NO_3)_3{\cdot}6H_2O$	0.15	$Mn(NO_3)_2{\cdot}6H_2O$	0.15	EtOH	KB	R.T.	600
$La(NO_3)_3{\cdot}6H_2O$	0.15	$Co(NO_3)_2{\cdot}6H_2O$	0.15	EtOH	KB	130	600
$La(NO_3)_3{\cdot}6H_2O$	0.15	$Fe(NO_3)_3{\cdot}9H_2O$	0.15	EtOH	KB	130	650
$La(NO_3)_3{\cdot}6H_2O$	0.15	$Ni(NO_3)_2{\cdot}6H_2O$	0.15	EtOH	KB	130	750
$La(NO_3)_3{\cdot}6H_2O$	0.15	$Al(NO_3)_3{\cdot}9H_2O$	0.15	EtOH	KB	130	800
$La(NO_3)_3{\cdot}6H_2O$	0.15	$Ga(NO_3)_3{\cdot}nH_2O$	0.15	EtOH	KB	130	850
$La(NO_3)_3{\cdot}6H_2O$	0.15	$Cu(NO_3)_2{\cdot}3H_2O$	0.075	EtOH	KB	130	700
$Ca(CH_3COO)_2{\cdot}H_2O$	0.15	$Mn(CH_3COO)_2{\cdot}4H_2O$	0.15	H_2O	KB [a)]	130	850
$Ca(NO_3)_2{\cdot}4H_2O$	0.15	$Fe(NO_3)_3{\cdot}9H_2O$	0.15	EtOH	KB	130	650
$Ba(CH_3COO)_2$	0.15	$Mn(CH_3COO)_2{\cdot}4H_2O$	0.15	H_2O	KB [a)]	130	700
$Sr(CH_3COO)_2{\cdot}0.5H_2O$	0.15	$Mn(CH_3COO)_2{\cdot}4H_2O$	0.15	H_2O	KB [a)]	130	700
$La(NO_3)_3{\cdot}6H_2O$ + $Sr(NO_3)_2$	0.105 0.045	$Fe(NO_3)_3{\cdot}9H_2O$	0.15	H_2O	KB [a)]	130	650
$La(NO_3)_3{\cdot}6H_2O$	0.15	$Mn(NO_3)_2{\cdot}6H_2O$	0.15	EtOH	CNF	R.T.	650
$La(NO_3)_3{\cdot}6H_2O$	0.15	$Fe(NO_3)_3{\cdot}9H_2O$	0.15	EtOH	CNF	R.T.	650
$La(NO_3)_3{\cdot}6H_2O$	0.15	$Ni(NO_3)_2{\cdot}6H_2O$	0.15	EtOH	CNF	130	750
$La(NO_3)_3{\cdot}6H_2O$	0.15	$Al(NO_3)_3{\cdot}9H_2O$	0.15	EtOH	CNF	130	800
$La(NO_3)_3{\cdot}6H_2O$	0.15	$Cu(NO_3)_2{\cdot}3H_2O$	0.075	EtOH	CNF	130	700
$Ca(NO_3)_2{\cdot}4H_2O$	0.15	$Fe(NO_3)_3{\cdot}9H_2O$	0.15	EtOH	CNF	130	650
$La(NO_3)_3{\cdot}6H_2O$	0.15	$Mn(NO_3)_2{\cdot}6H_2O$	0.15	EtOH	KB	R.T.	520~560
$La(NO_3)_3{\cdot}6H_2O$	0.15	-	-	EtOH	KB	R.T.	520
-	-	$Mn(NO_3)_2{\cdot}6H_2O$	0.15	EtOH	KB	R.T.	520
$La(NO_3)_3{\cdot}6H_2O$	0.15	$Mn(NO_3)_2{\cdot}6H_2O$	0.15	EtOH	absent	R.T.	650
$La(NO_3)_3{\cdot}6H_2O$	0.15	$Fe(NO_3)_3{\cdot}9H_2O$	0.15	EtOH	absent	R.T.	650
$La(NO_3)_3{\cdot}6H_2O$	0.15	$Ni(NO_3)_2{\cdot}6H_2O$	0.15	EtOH	absent	R.T.	650
$Sr(CH_3COO)_2{\cdot}0.5H_2O$	0.15	$Mn(NO_3)_2{\cdot}6H_2O$	0.15	H_2O	absent	R.T.	650
$Ba(CH_3COO)_2$	0.15	$Mn(NO_3)_2{\cdot}6H_2O$	0.15	H_2O	absent	R.T.	650

[a)] KB was calcined at 773 K for 4 h to enhance the wettability of KB to water.

Table S2 Comparison of specific surface area of perovskites prepared by the PA method to previous studies.

Perovskites	Specific surface area (m^2g^{-1})	Preparation method	Reference
$LaFeO_3$	36	PA method	this work
$LaFeO_3$	26	Sol-gel auto-combustion method	[1]
$LaFeO_3$	15	Combustion synthesis method	[2]
$LaNiO_3$	7	PA method	this work
$LaNiO_3$	15	Sol–gel combustion technique.	[3]
$LaNiO_3$	7	Citrate method	[4]
La_2CuO_4	4	PA method	this work
La_2CuO_4	46	PMMA templating and citric acid complexing method	[5]
$LaAlO_3$	24	PA method	this work
$LaAlO_3$	21	Pyrolysis of complex compounds with triethanolamine	[6]
$LaGaO_3$	4	PA method	this work
$LaGaO_3$	2	Pechini method	[7]
$La_{0.7}Sr_{0.3}FeO_3$	33	PA method	this work
$La_{0.7}Sr_{0.3}FeO_3$	7	Pechini method	[8]
$CaMnO_3$	5	PA method	this work
$CaMnO_3$	32	Citric acid assisted sol-gel method	[9]
$Ca_2Fe_2O_5$	32	PA method	this work
$Ca_2Fe_2O_5$	60	Citric acid assisted sol-gel method	[10]
$BaMnO_3$	9	PA method	this work
$BaMnO_3$	2	Sol-gel method using glycol and citric acid	[11]
$SrMnO_3$	10	PA method	this work
$SrMnO_3$	2	Sol–gel self-combustion method	[12]

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Table S3 Physicochemical properties of the perovskites using CNFs. Crystallite sizes were evaluated from XRD patterns using Scherrer's equation.

perovskite	Crystallite size (nm)	Specific surface area (m^2 g^{-1})
$LaMnO_3$	14	21
$LaFeO_3$	20	39
$LaNiO_3$	16	6
$LaAlO_3$	32	11
La_2CuO_4	58	2
$Ca_2Fe_2O_5$	31	25

Table S4 Comparison for specific surface area of samples prepared with or without nanocarbons.

	Specific surface area (m^2 g^{-1})	
	without C	with KB
La + Mn	16	44
La + Fe	8	36
La + Ni	5	7
Sr + Mn	9	10
Ba + Mn	5	9

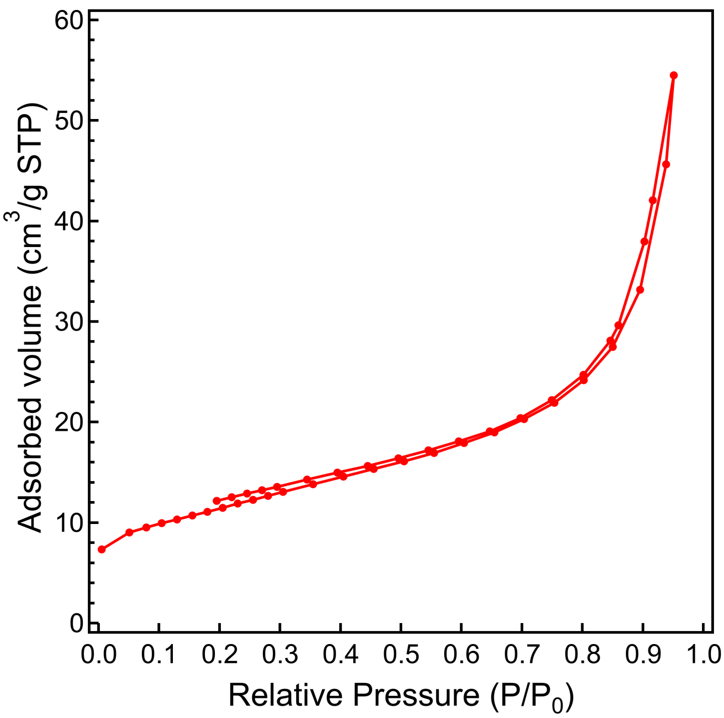


Fig. S1 Nitrogen adsorption/desorption isotherm for $LaMnO_3$.

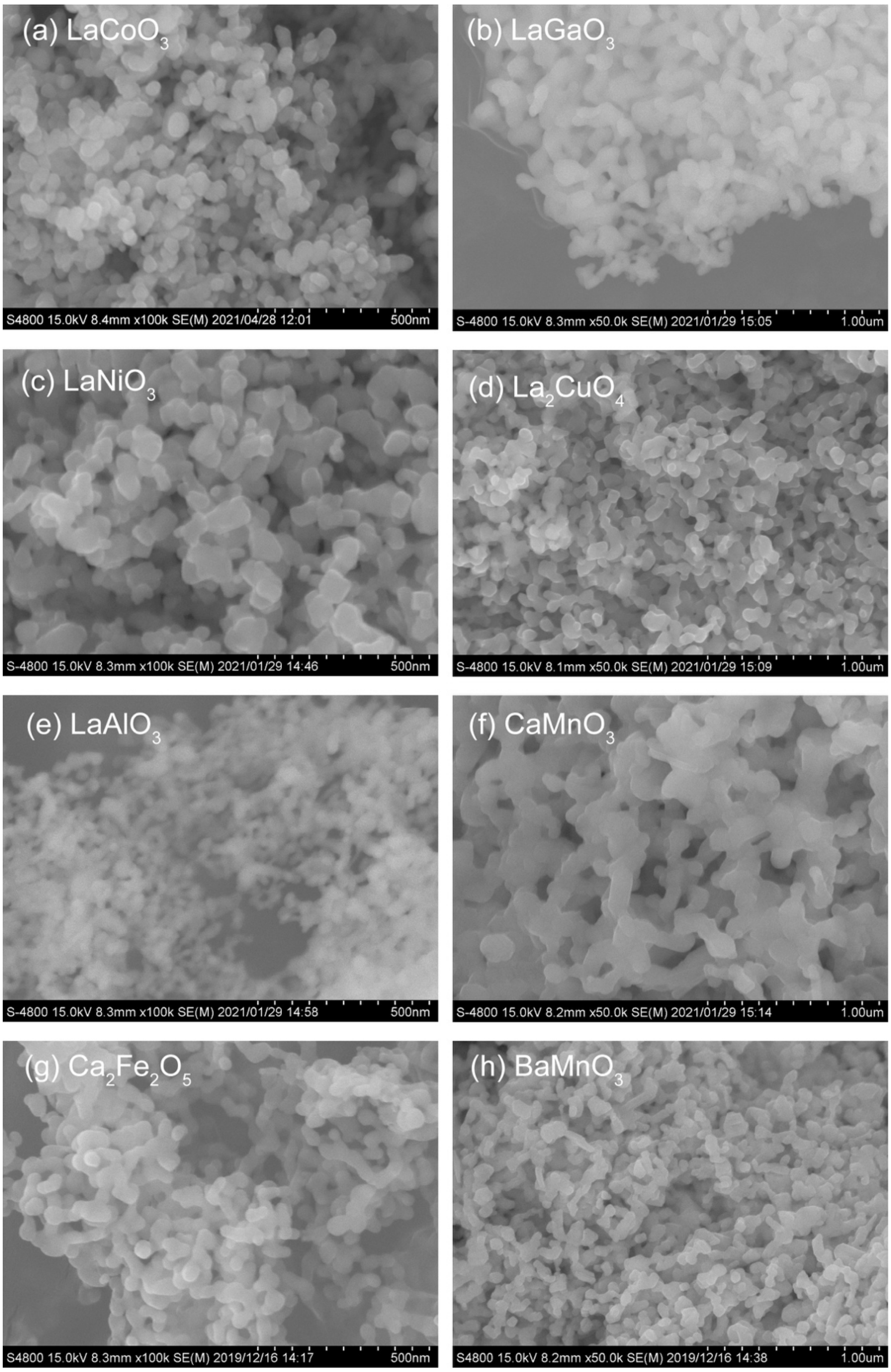


Fig. S2 SEM images of perovskites formed by the PA method using KB as carbon sources.

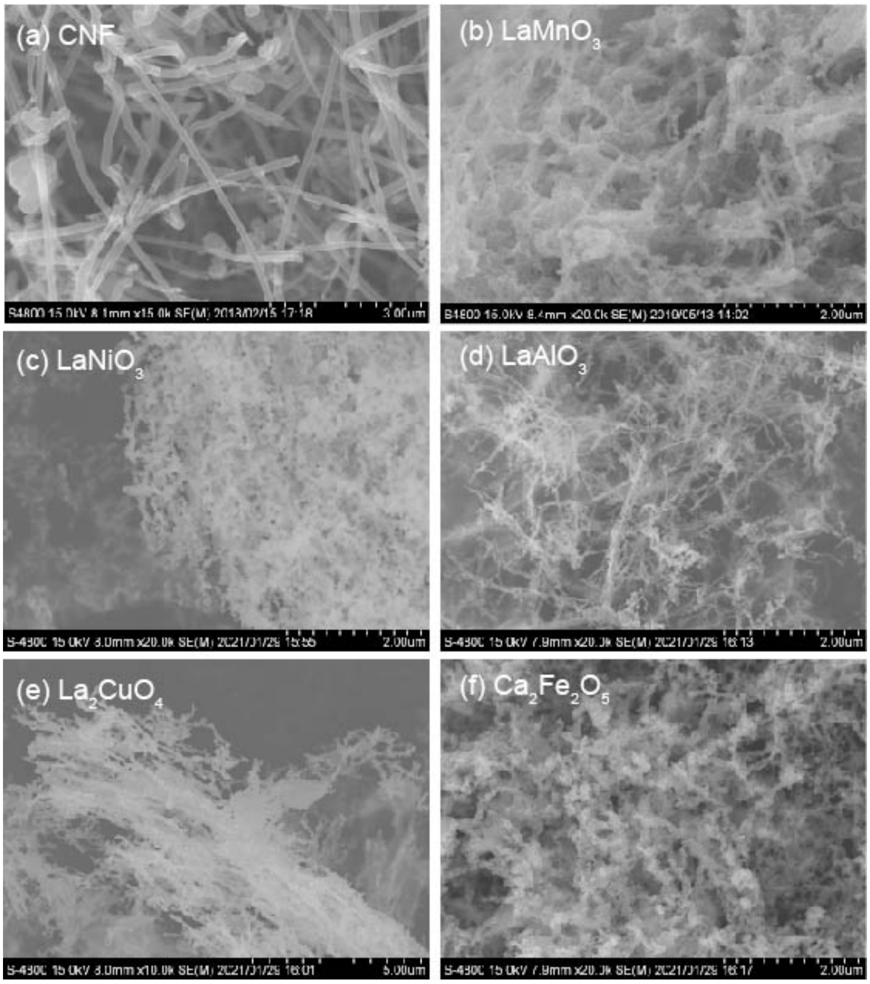


Fig. S3 SEM images of (a) CNFs and (b-f) perovskites formed by the PA method using CNFs as carbon sources.

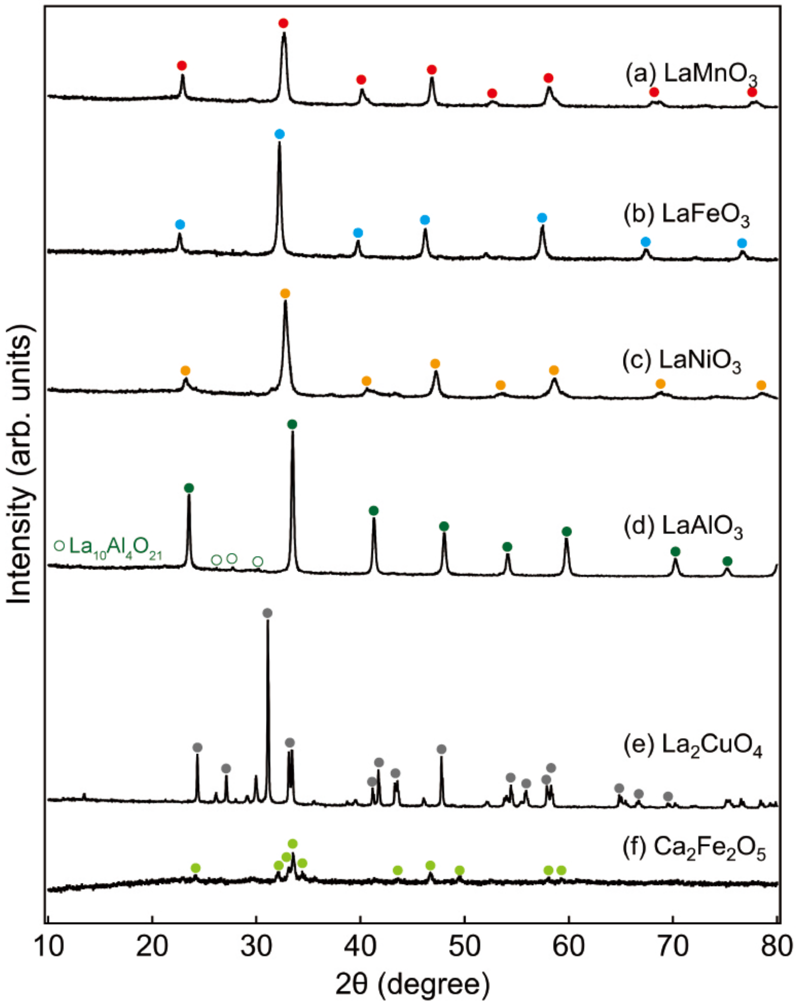
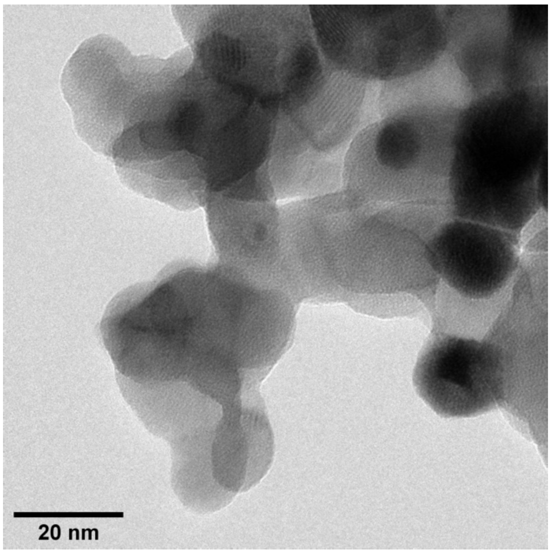


Fig. S4 XRD patterns of perovskites formed by the PA method using CNFs as carbon sources.



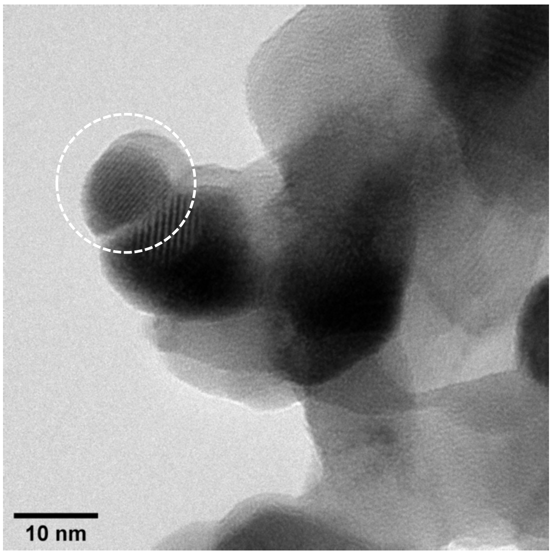


Fig. S5 TEM images of $LaMnO_3$. Concentration of $La(NO_3)_3{\cdot}6H_2O$ and $Mn(NO_3)_2{\cdot}6H_2O$: 0.01 M, solvent: ethanol, carbon: KB, drying temp.: 403 K, calcination temp.: 873 K.

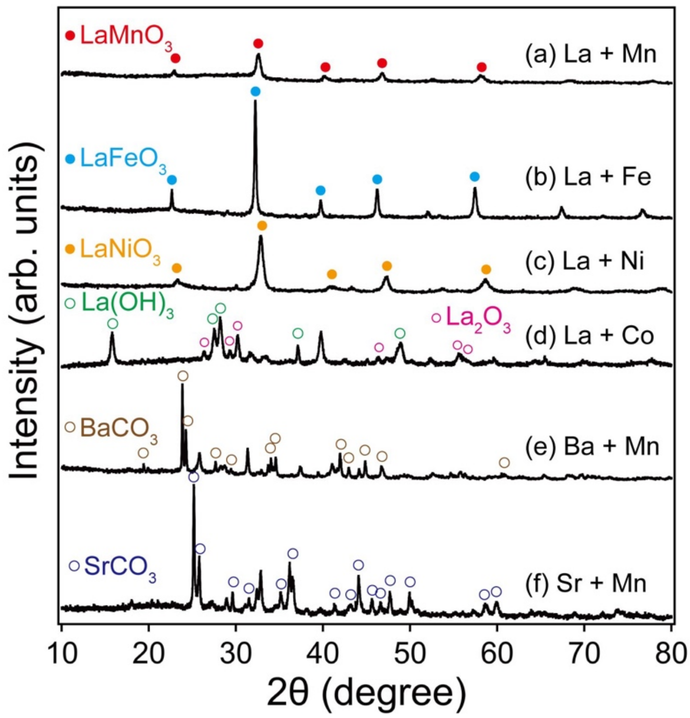


Fig. S6 XRD patterns of the samples prepared by the calcination of metal salts without carbons.

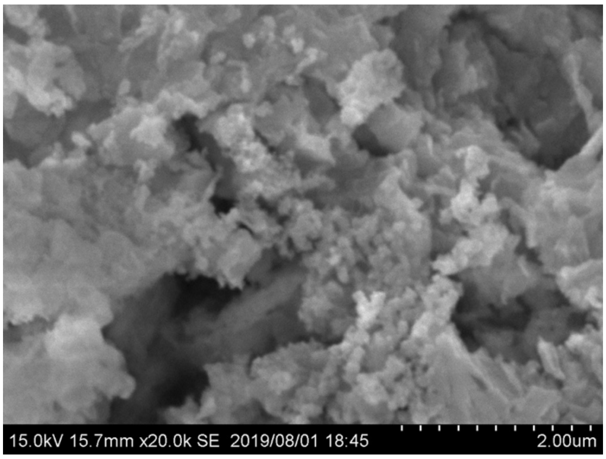


Fig. S7 SEM image of La/Mn sample prepared without carbons. The preparation condition was described in the experimental section.

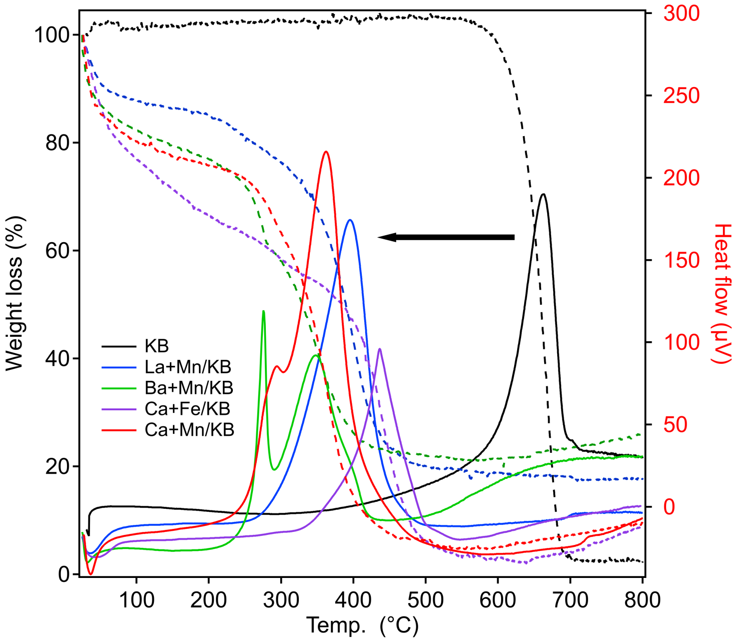


Fig. S8 TG/DTA profile of KB and KB accumulated with precursors.

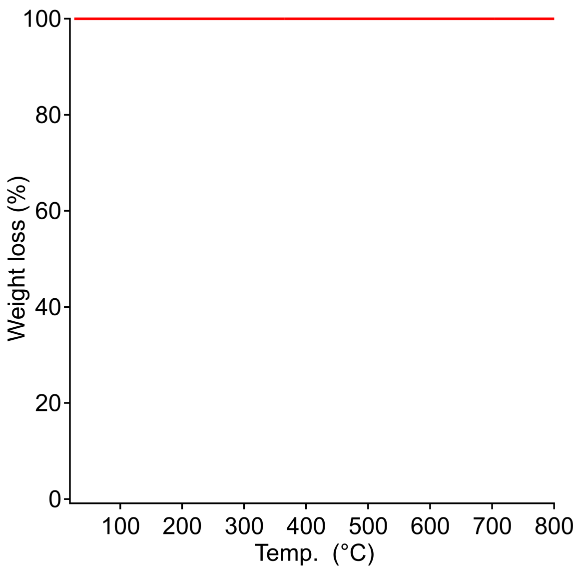


Fig. S9 TG profile of $LaMnO_3$ prepared by the calcination at 793 K.