Supporting information for

$(Sb_{0.5}Li_{0.5})TiO_3$ doping effect and sintering condition tailoring in $BaTiO_3$-based ceramics

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Table S1. Energy storage performance of BSBiTZ-xSLT (x=0.025, 0.05, 0.075, 0.1) ceramics with the largest relative density at 50 kV/cm.

	P_{max} (μC/cm^2)	P_r (μC/cm^2)	E (kV/cm)	W_{rec} (mJ/cm^3)	W_t (mJ/cm^3)	η
x=0.025	2.7480	0.0383	50	65.59	67.61	97.02%
x=0.05	2.2171	0.0256	50	53.16	54.64	97.27%
x=0.075	1.9373	0.0601	50	44.94	48.37	92.90%
x=0.1	1.4218	0.0937	50	31.11	36.89	84.34%

Table S2. Charge/discharge performance of BSBiTZ-xSLT (x=0.025, 0.05, 0.075, 0.1) ceramics sintered at different temperatures at 30 kV/cm.

	Sintering temperature (℃)	E (kV/cm)	W_{dis} (mJ/cm^3)	I_{dis} (A)
x=0.025	1125	30	33.43	9.25
	1140	30	32.78	9.40
	1155	30	32.13	11.16
	1170	30	28.92	10.30
	1185	30	30.99	10.83
x=0.05	1140	30	30.22	10.16
	1155	30	24.00	10.01
	1170	30	26.27	10.67
x=0.075	1140	30	19.06	8.79
	1155	30	22.01	9.50
	1170	30	21.61	10.20
x=0.1	1155	30	20.40	9.89
	1170	30	16.46	9.40
	1185	30	17.83	9.69

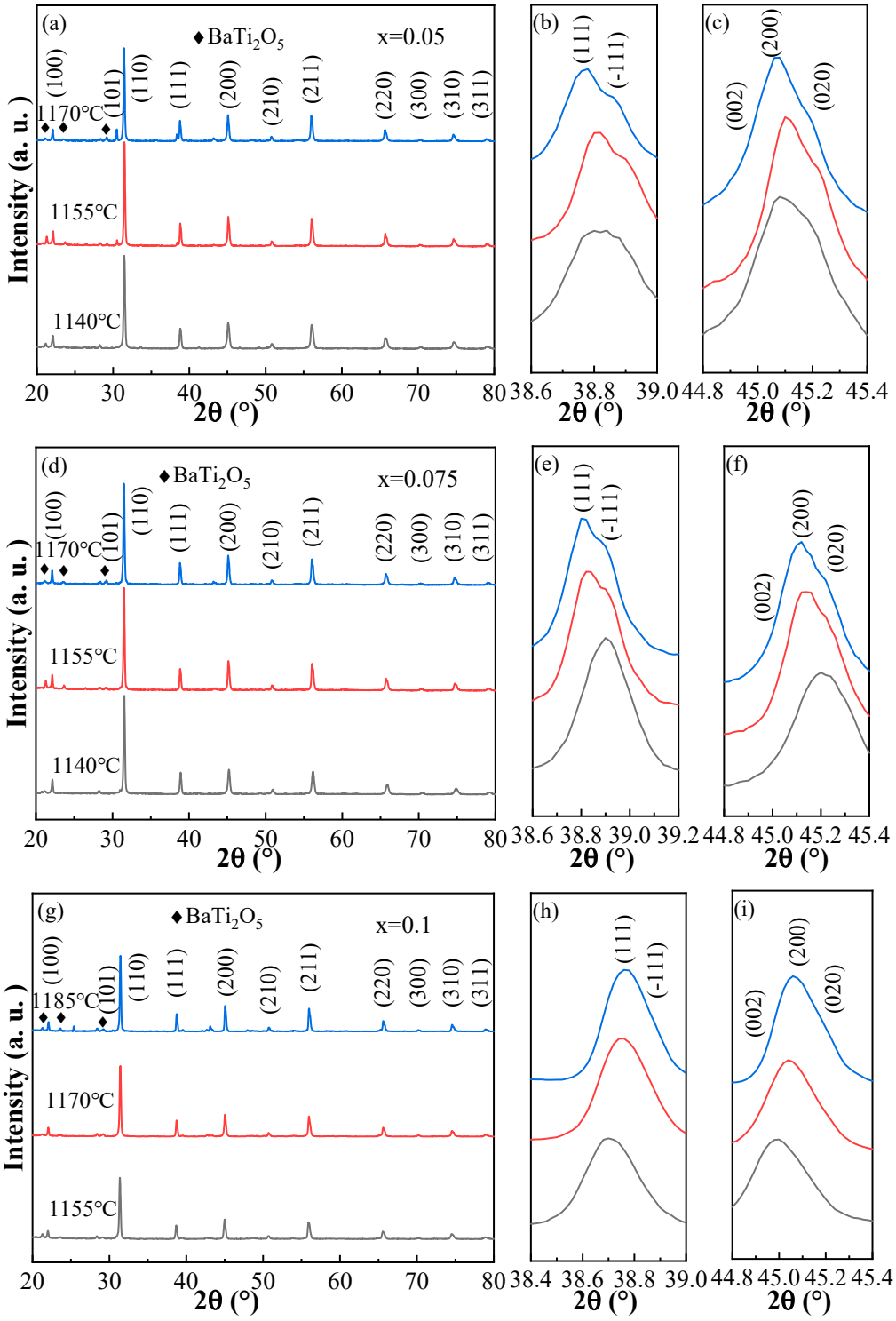
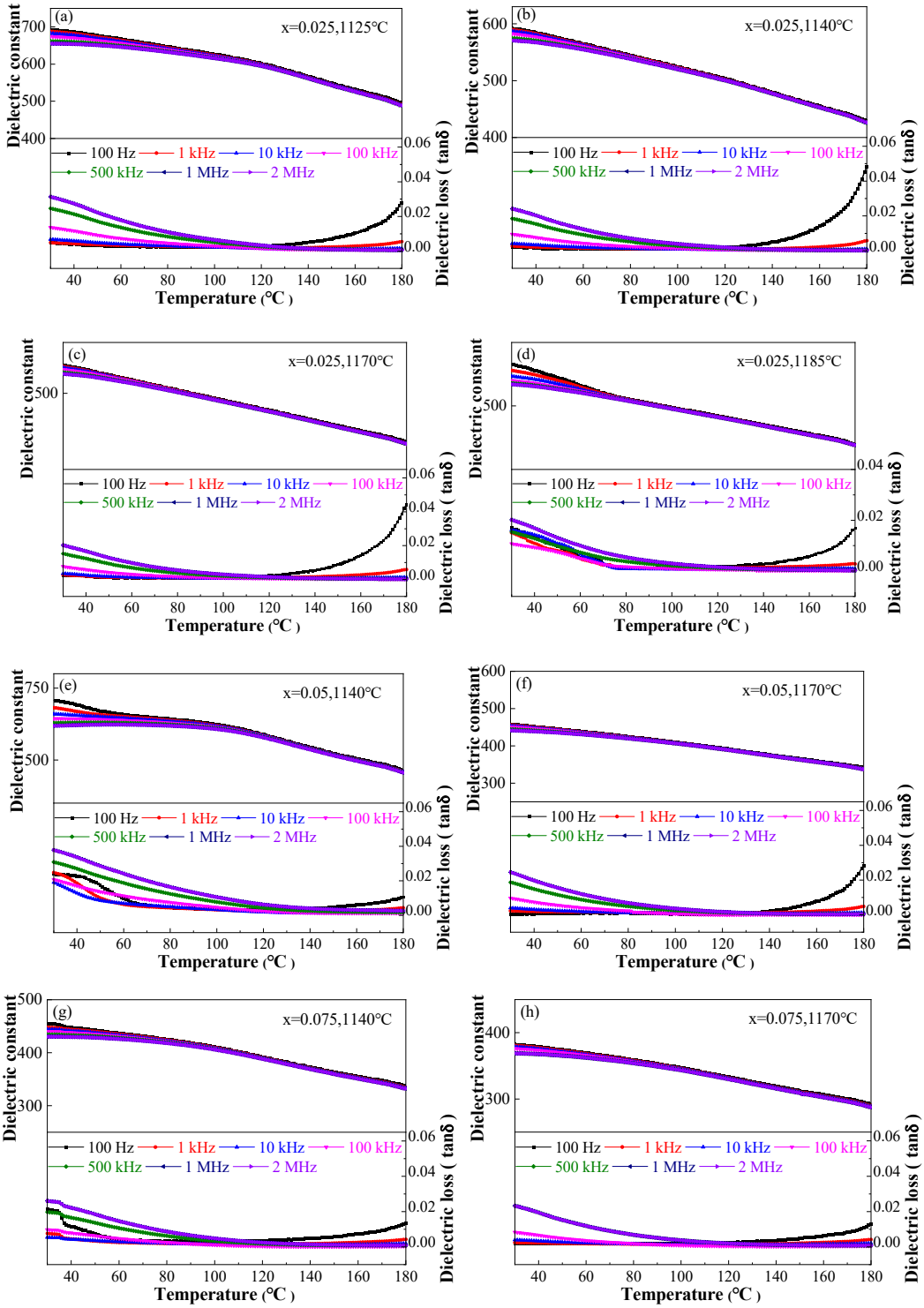


Figure S1. XRD patterns and enlarged XRD views of (111) and (200) diffraction peaks of BSBiTZ-xSLT (x=0.05, 0.075, 0.1) ceramics at different sintering temperatures.

(a)-(c) BSBiTZ-0.05SLT; (d)-(f) SBiTZ-0.075SLT; (g)-(i) BSBiTZ-0.1SLT.


(a)
x=0.025,1125℃
(b)
x=0.025,1140℃
(c)
x=0.025,1170℃
(d)
x=0.025,1185℃
(e)
x=0.05,1140℃
(f)
x=0.05,1170℃
(g)
x=0.075,1140℃
(h)
x=0.075,1170℃
100 Hz
1 kHz
10 kHz
100 kHz
500 kHz
1 MHz
2 MHz
Dielectric constant
Dielectric loss (tanδ)
Temperature (℃)

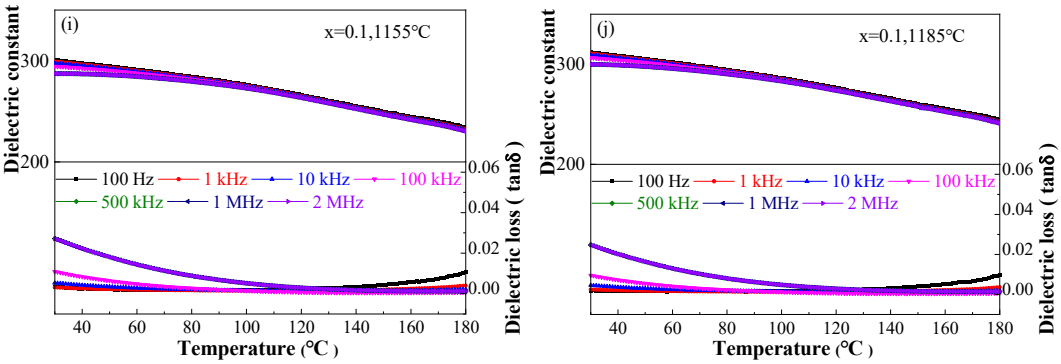
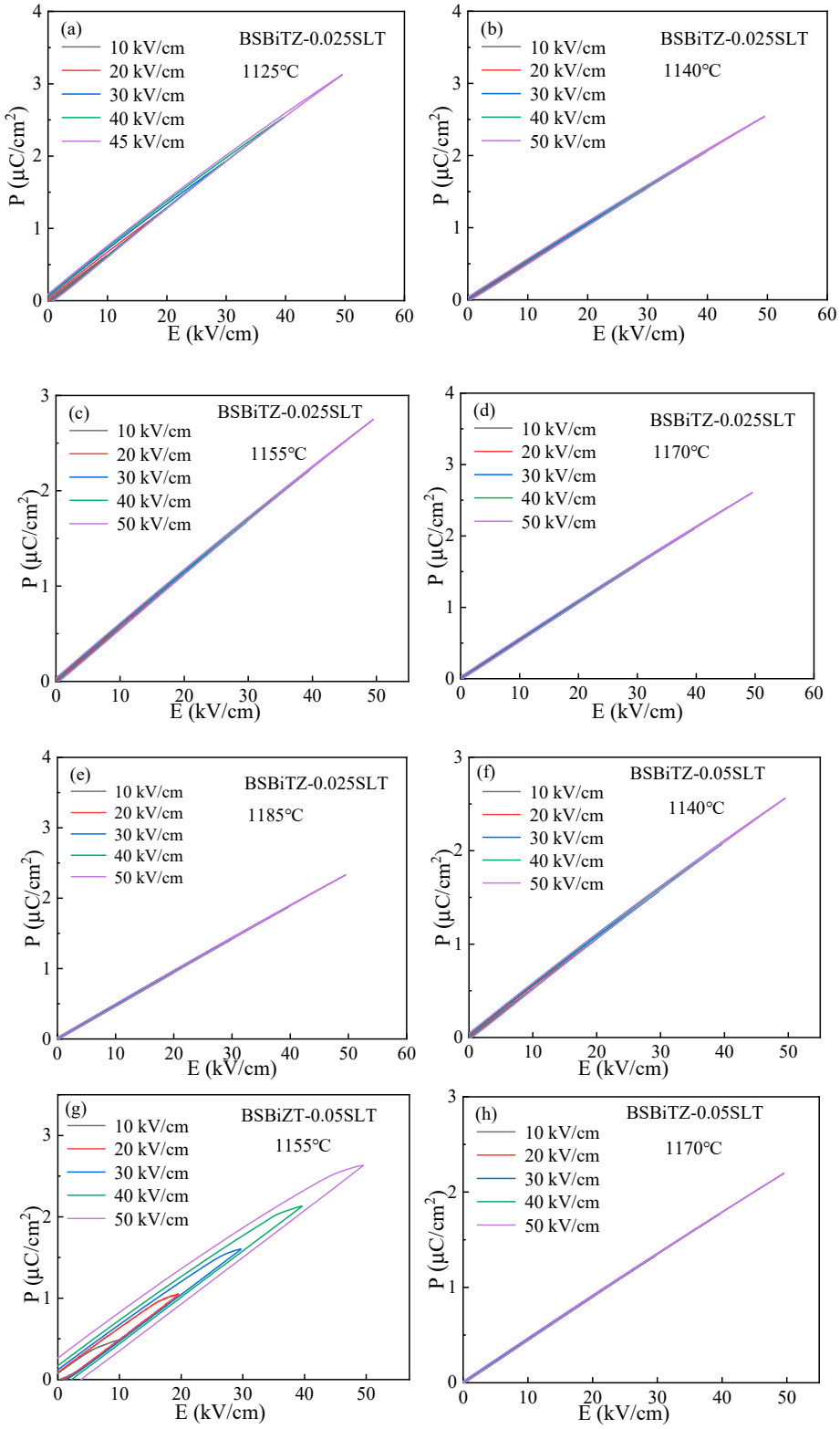


Figure S2. Dielectric-temperature curves of BSBiTZ-xSLT (x=0.025, 0.05, 0.075, 0.1) ceramics at different sintering temperatures. The composition of x and sintering temperature are shown in each figure.

(a)-(d) BSBiTZ-0.025SLT; (e)-(f) BSBiTZ-0.05SLT; (g) -(h) BSBiTZ-0.075SLT; (i)-(j) BSBiTZ-0.1SLT.


(a)
BSBiTZ-0.025SLT
1125℃
10 kV/cm
20 kV/cm
30 kV/cm
40 kV/cm
45 kV/cm
P (μC/cm²)
E (kV/cm)
(b)
BSBiTZ-0.025SLT
1140℃
10 kV/cm
20 kV/cm
30 kV/cm
40 kV/cm
50 kV/cm
P (μC/cm²)
E (kV/cm)
(c)
BSBiTZ-0.025SLT
1155℃
10 kV/cm
20 kV/cm
30 kV/cm
40 kV/cm
50 kV/cm
P (μC/cm²)
E (kV/cm)
(d)
BSBiTZ-0.025SLT
1170℃
10 kV/cm
20 kV/cm
30 kV/cm
40 kV/cm
50 kV/cm
P (μC/cm²)
E (kV/cm)
(e)
BSBiTZ-0.025SLT
1185℃
10 kV/cm
20 kV/cm
30 kV/cm
40 kV/cm
50 kV/cm
P (μC/cm²)
E (kV/cm)
(f)
BSBiTZ-0.05SLT
1140℃
10 kV/cm
20 kV/cm
30 kV/cm
40 kV/cm
50 kV/cm
P (μC/cm²)
E (kV/cm)
(g)
BSBiZT-0.05SLT
1155℃
10 kV/cm
20 kV/cm
30 kV/cm
40 kV/cm
50 kV/cm
P (μC/cm²)
E (kV/cm)
(h)
BSBiTZ-0.05SLT
1170℃
10 kV/cm
20 kV/cm
30 kV/cm
40 kV/cm
50 kV/cm
P (μC/cm²)
E (kV/cm)

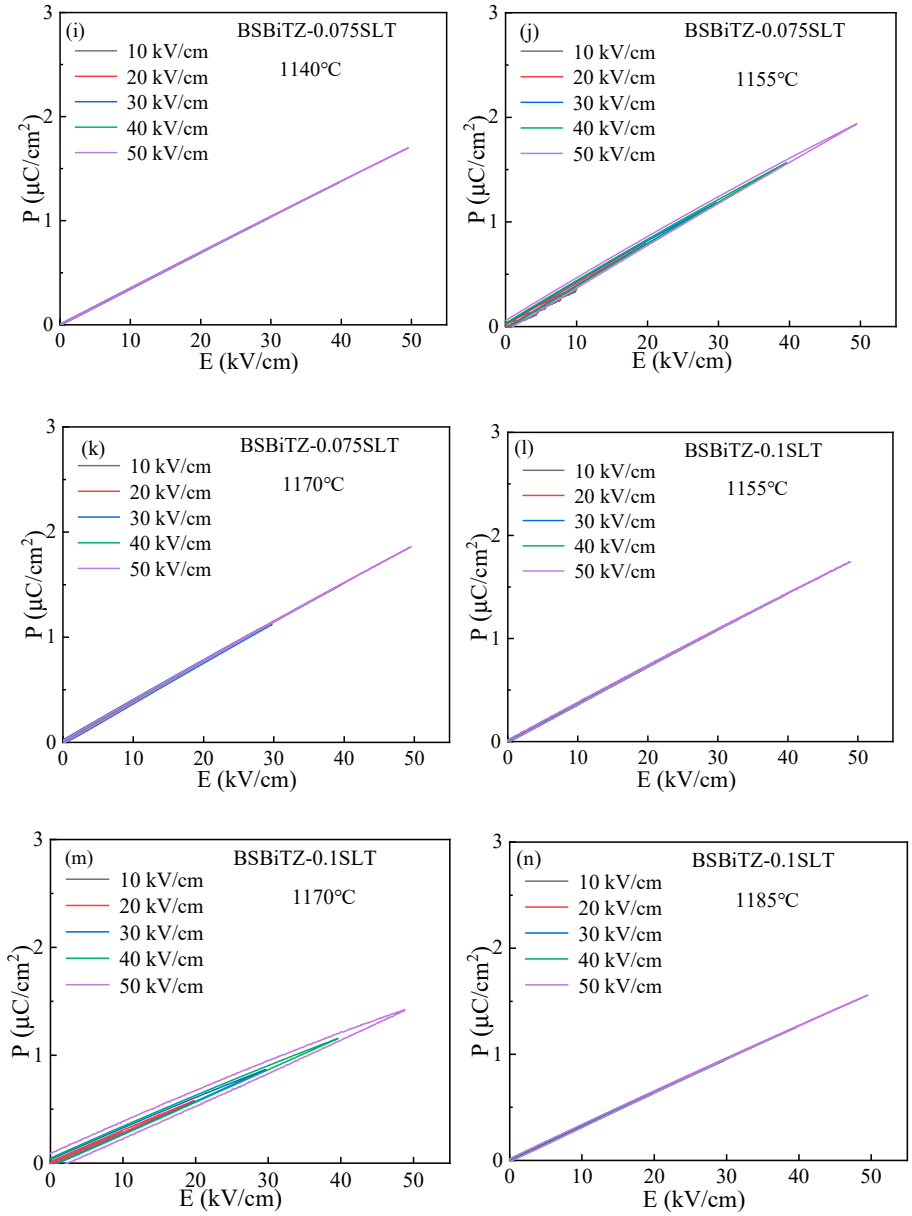
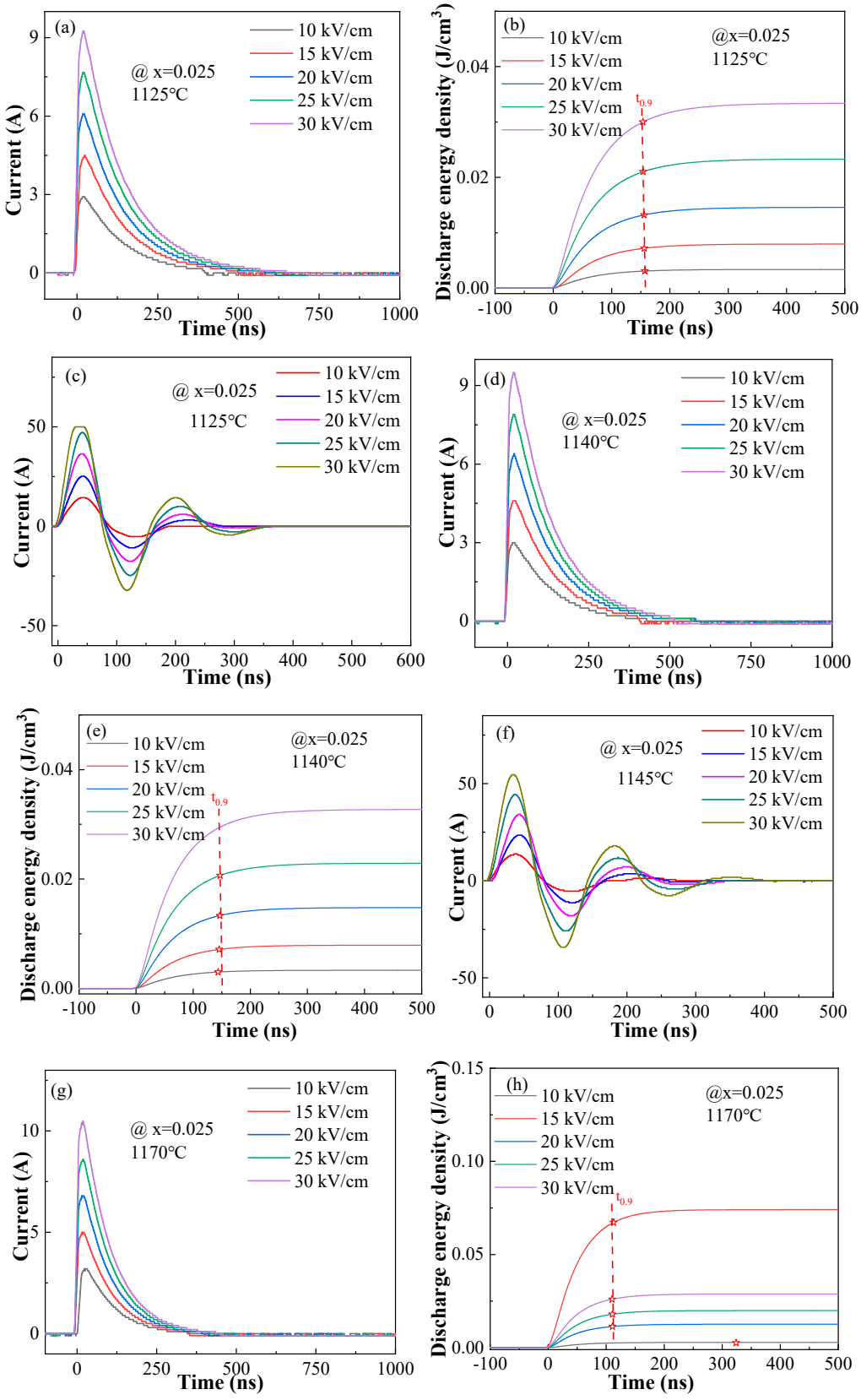
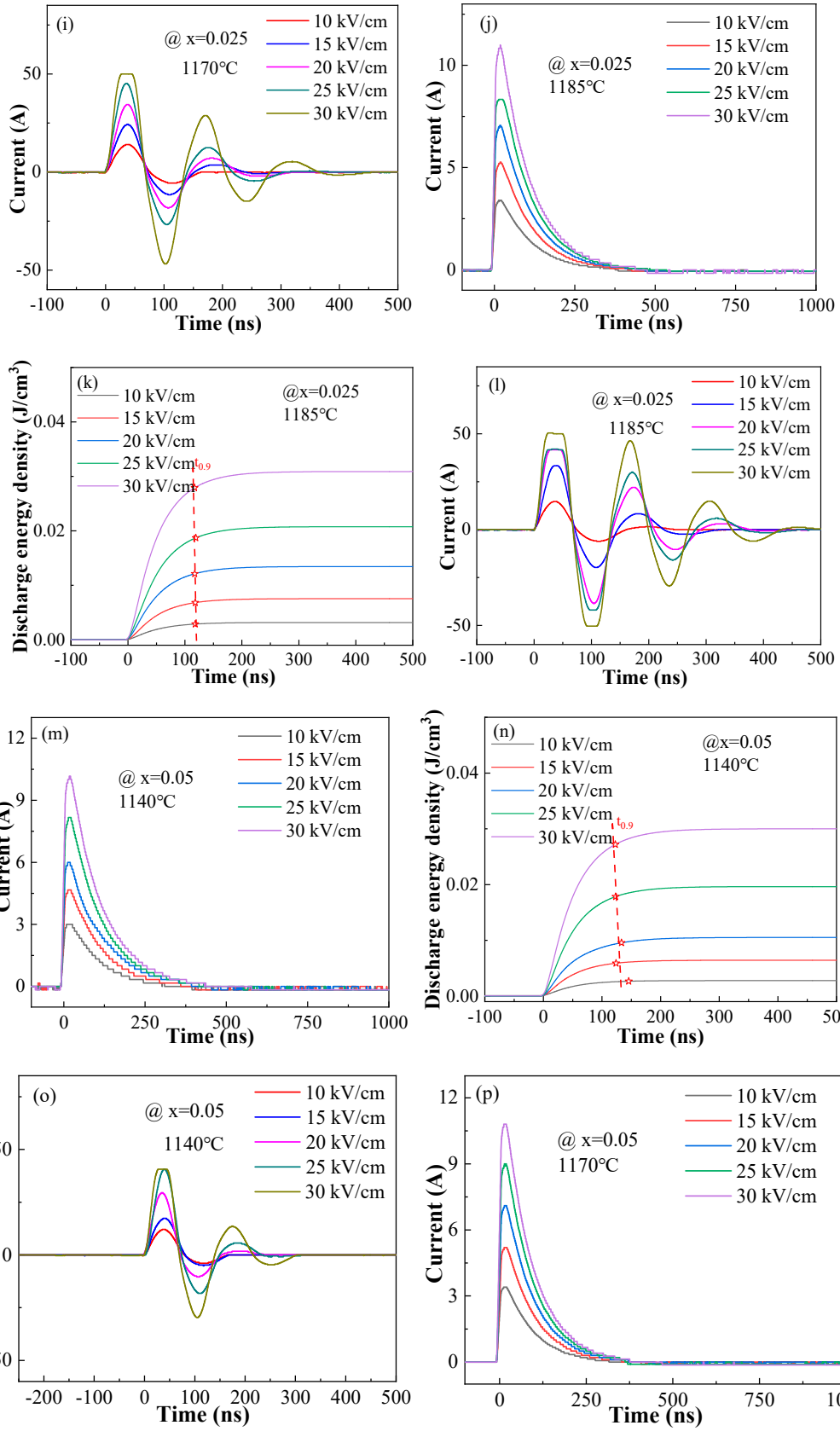
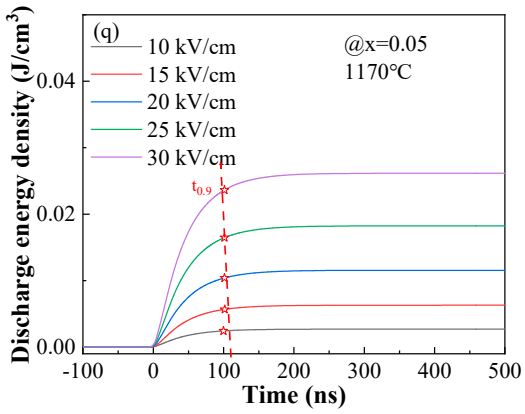


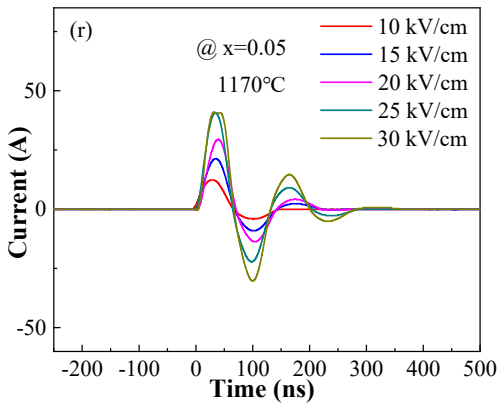
Figure S3. Unipolar hysteresis loops of BSBiTZ-xSLT (x=0.025, 0.05, 0.075, 0.1) ceramics at different sintering temperatures. The composition of x and sintering temperature are shown in each figure.

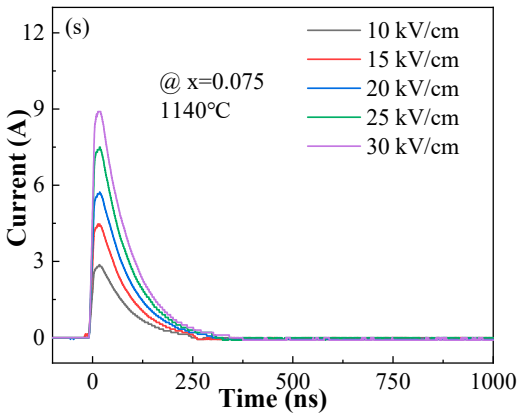
(a)-(e) BSBiTZ-0.025SLT; (f)-(h) BSBiTZ-0.05SLT; (i)-(k) BSBiTZ-0.075SLT; (l)-(n) BSBiTZ-0.1SLT.

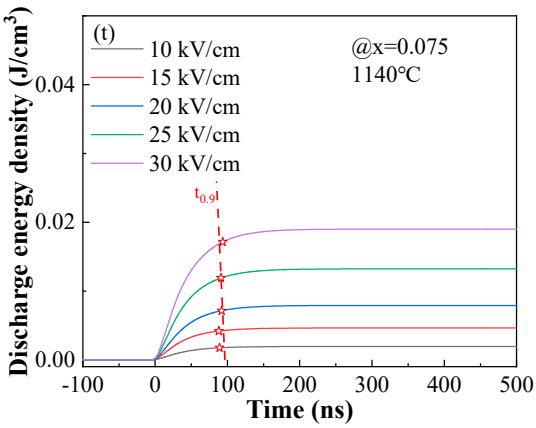

(a)
@ x=0.025
1125℃
10 kV/cm
15 kV/cm
20 kV/cm
25 kV/cm
30 kV/cm
Current (A)
Time (ns)
(b)
@x=0.025
1125℃
$t_{0.9}$
Discharge energy density (J/cm^3)
Time (ns)
(c)
@ x=0.025
1125℃
Current (A)
Time (ns)
(d)
@ x=0.025
1140℃
Current (A)
Time (ns)
(e)
@x=0.025
1140℃
$t_{0.9}$
Discharge energy density (J/cm^3)
Time (ns)
(f)
@ x=0.025
1145℃
Current (A)
Time (ns)
(g)
@ x=0.025
1170℃
Current (A)
Time (ns)
(h)
@x=0.025
1170℃
$t_{0.9}$
Discharge energy density (J/cm^3)
Time (ns)

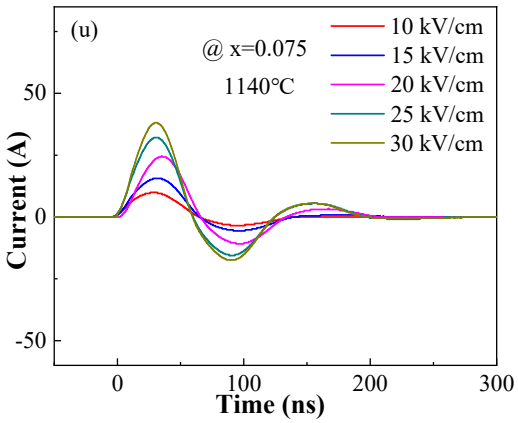

(i)
@ x=0.025
1170℃
10 kV/cm
15 kV/cm
20 kV/cm
25 kV/cm
30 kV/cm
Current (A)
Time (ns)
(j)
@ x=0.025
1185℃
(k)
@x=0.025
1185℃
Discharge energy density (J/cm3)
t0.9
(l)
(m)
@ x=0.05
1140℃
(n)
@x=0.05
1140℃
(o)
(p)
@ x=0.05
1170℃

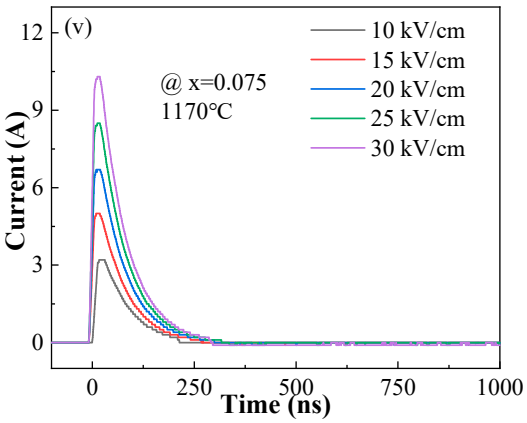

(q)
10 kV/cm
15 kV/cm
20 kV/cm
25 kV/cm
30 kV/cm
@x=0.05
1170℃
$t_{0.9}$
Discharge energy density (J/cm^3)
Time (ns)

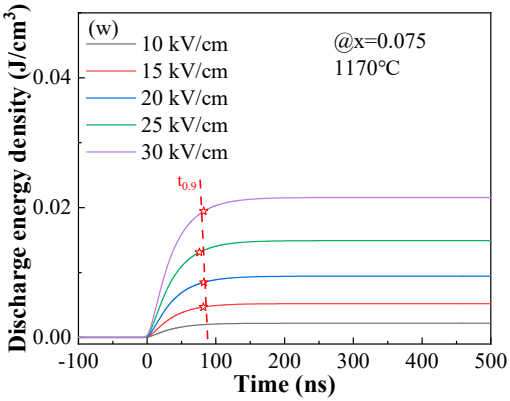

(r)
@ x=0.05
1170℃
10 kV/cm
15 kV/cm
20 kV/cm
25 kV/cm
30 kV/cm
Current (A)
Time (ns)

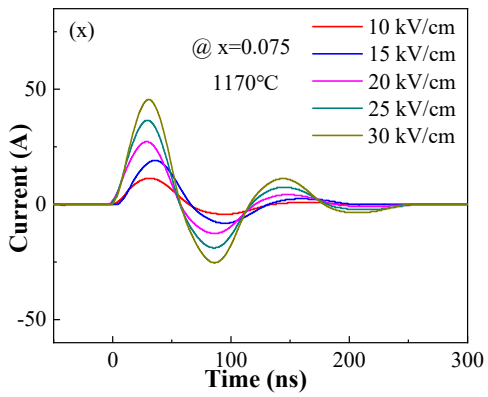

(s)
@ x=0.075
1140℃
10 kV/cm
15 kV/cm
20 kV/cm
25 kV/cm
30 kV/cm
Current (A)
Time (ns)


(t)
10 kV/cm
15 kV/cm
20 kV/cm
25 kV/cm
30 kV/cm
@x=0.075
1140℃
$t_{0.9}$
Discharge energy density (J/cm^3)
Time (ns)


(u)
@ x=0.075
1140℃
10 kV/cm
15 kV/cm
20 kV/cm
25 kV/cm
30 kV/cm
Current (A)
Time (ns)


(v)
@ x=0.075
1170℃
10 kV/cm
15 kV/cm
20 kV/cm
25 kV/cm
30 kV/cm
Current (A)
Time (ns)


(w)
10 kV/cm
15 kV/cm
20 kV/cm
25 kV/cm
30 kV/cm
@x=0.075
1170℃
$t_{0.9}$
Discharge energy density (J/cm^3)
Time (ns)


(x)
@ x=0.075
1170℃
10 kV/cm
15 kV/cm
20 kV/cm
25 kV/cm
30 kV/cm
Current (A)
Time (ns)

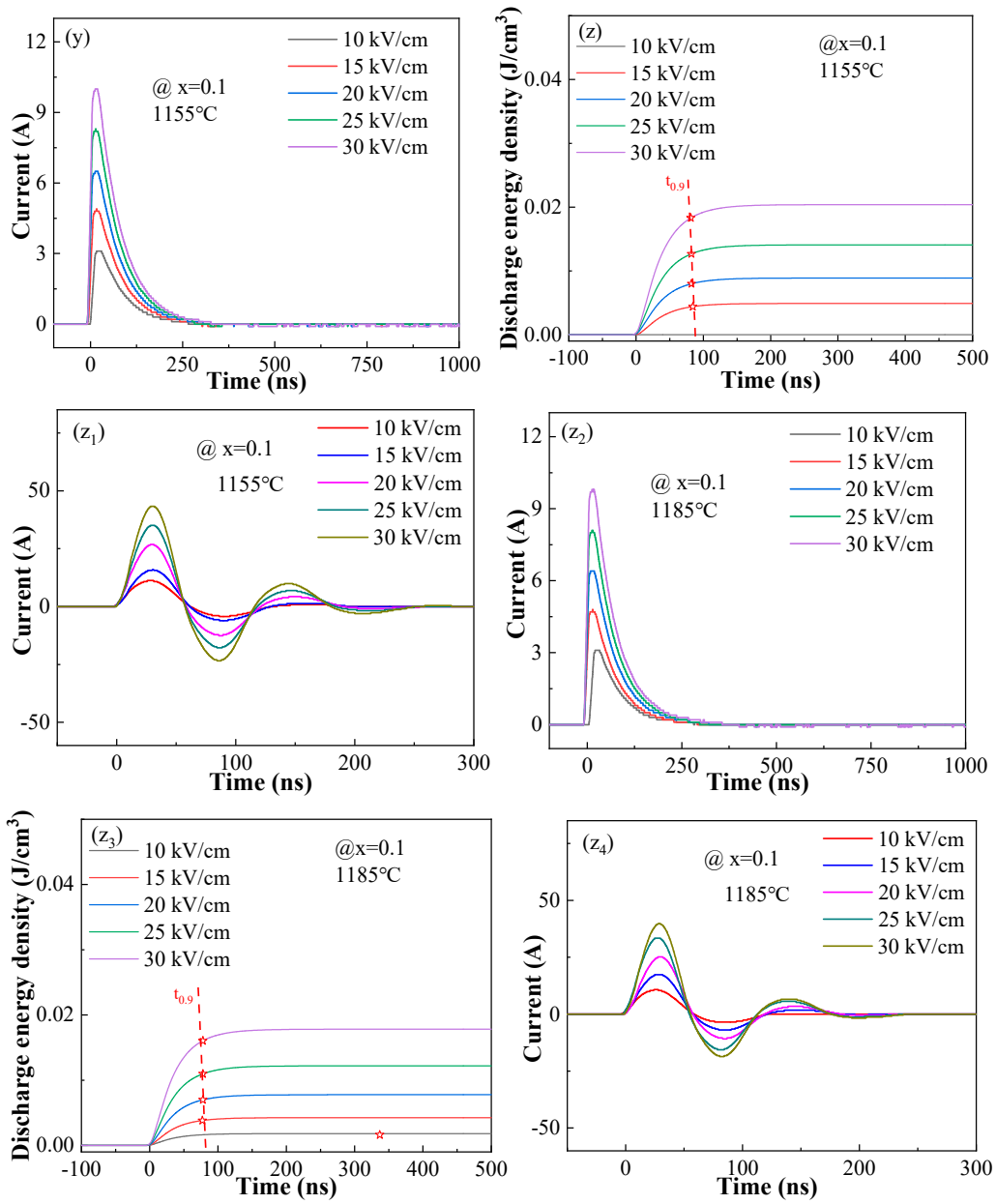


Figure S4. The pulse charge-discharge energy storage properties of BSBiTZ-xSLT (x=0.025, 0.05, 0.075, 0.1) ceramics at different sintering temperatures. The composition of x and sintering temperature are shown in each figure.

(a) Overdamped discharged voltage curve of BSBiTZ-0.025SLT at 1125 ℃; (b) The variation of discharge energy density and $t_{0.9}$ with time of BSBiTZ-0.025SLT at 1125 ℃; (c) Underdamped discharged voltage curve of BSBiTZ-0.025SLT at 1125 ℃; (d)-(f) BSBiTZ-

0.025SLT at 1140 ℃; (g)-(i) BSBiTZ-0.025SLT at 1170 ℃; (j)-(l) BSBiTZ-0.025SLT at 1185 ℃; (m)-(o) BSBiTZ-0.05SLT at 1140 ℃; (p)-(r) BSBiTZ-0.05SLT at 1170 ℃; (s)-(u) BSBiTZ-0.075SLT at 1140 ℃; (v)-(x) BSBiTZ-0.075SLT at 1170 ℃; (y)-(z_1) BSBiTZ-0.1SLT at 1155 ℃; (z_2)-(z_4) BSBiTZ-0.1SLT at 1185 ℃.