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Electronic Supplementary Information

Unique pure barium titanate foams with three-dimensional interconnecting pore channels and their high-*k* cyanate ester resin composites at very low barium titanate loading

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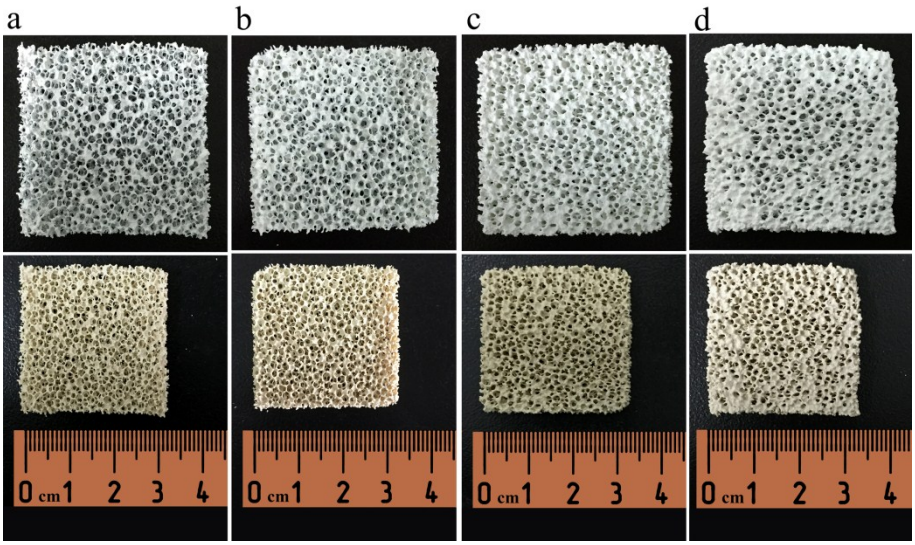

Fig. S1 Digital photos of green bodies (top) and sintered FCs (bottom) at 1200 °C (a: BTF3, b: BTF4, c: BTF5, d: BTF6).

Table S1 Dielectric constants of ceramic/polymer composites [a)]

Filler [b)]	Filler loading (vol%)	Polymer matrix [c)]	Dielectric constant	Frequency (Hz)	Refer
BCZT	61	PVDF	100	1000	[S1]
BSCT	33	PVDF	～50	100	[S2]
BST	55	PVDF	89	100	[S3]
BST	50	P(VDF-TrFE)	～76	100	[S4]
BST	40	P(VDF-CTFE)	70	1000	[S5]
BST	40	P(VDF-CTFE)	～50	100	[S6]
BT	50	CE	～26	100	[S7]
BT	40	CR-S	～80	100	[S8]
BT	50	ENR-50	～50	1000	[S9]
BT	60	epoxy	～40	1000	[S10]
BT	40	epoxy	44	100	[S11]
BT	40	epoxy	～30	100	[S12]
BT	50	EVM	～14.2	100	[S13]
BT	50	PES	～63	100	[S14]
BT	45	PFCB	～33	1000	[S15]
BT	50	PI	～37	100	[S16]
BT	50	PI	＜35	1000	[S17]
BT	50	PI	～24	1000	[S18]
BT	60	PVDF	～100	100	[S19]
BT	55	PVDF	～60	1000	[S20]
BT	50	PVDF	～78	100	[S21]
BT	50	PVDF	53.9	1000	[S22]
BT	50	PVDF	～52	1000	[S23]
BT	45	PVDF	～57	100	[S24]
BT	40	PVDF	～51	1000	[S25]
BT	40	PVDF	～50	1000	[S26]
BT	40	PVDF	～45	1000	[S27]
BT	40	PVDF	～70	100	[S28]
BT	40	PVDF	～40	100	[S29]
BT	40	PVDF	～38	1000	[S30]
BT	30	PVDF	～28	100Hz	[S31]
BT	30	PVDF	22.02	1000	[S32]
BT	40	P(VDF-CTFE)	＜80	100	[S33]
BT	50	PVDF-HFP-GMA	～43	1000	[S34]
BT	40	P(VDF-TrFE)	70	1000	[S35]
BT	30	P(VDF-TrFE-CTFE)	～55	1000	[S36]

Table S1 Continued.

Filler	Filler loading (vol%)	Polymer matrix	Dielectric constant	Frequency (Hz)	Refer
BT NWs	30	PVDF	＜45	1000	[S37]
BT-OPA	50	P(VDF-HFP)	～25	120	[S38]
BT-PFBPA	50	P(VDF-HFP)	37 ± 2	1000	[S39]
BT-TDPA	40	PVDF	74.9	100	[S40]
BT@TiO_2	40	P(VDF-HFP)	～73	1000	[S41]
CCTO ^{Semi}	40	PVDF	2.49×10^6	100	[S42]
CCTO	55	PVDF	95	100	[S43]
CCTO	40	PVDF	35	100	[S42]
CCTO	30	PVDF	90	100Hz	[S44]
CCTO	50	P(VDF-HFP)	＜30	120	[S45]
CCTO	40	epoxy	50	100	[S46]
CCTO	40	PI	49	100	[S47]
CCTO	40	silicone resin	～10	1000	[S48]
CCTO	30	CE	～12	100	[S49]
CCTO-sg	50	PVDF	62.3	100	[S50]
FTN	30	PVDF	～100	100	[S51]
KTNO ^{Semi}	30	PVDF	～200	1000	[S52]
LTNO-0	40	PVDF	～90	100	[S53]
LTNO-1 ^{Semi}	40	PVDF	～600	100	[S53]
PMN–PT	40	P(VDF-TrFE)	～125	100	[S54]
PMN-PT	40	P(VDF-TrFE)	37.3	1000	[S55]
PSTM	50	PEKK	42	1000	[S56]
PZT	70	PVDF	140	100	[S57]
PZT	40	PVDF	～45	1000	[S58]
PZT	40	PVDF	～40	1000	[S59]
PZT	40	PVDF	～36	100	[S28]
PZT	50	P(VDF-CTFE)	80	1000	[S60]
PZT	40	Polyester resin	45	1000	[S61]
SiC	47	P(VDF-CTFE-DB)	83	100	[S62]
TiO_2	35	PVDF	～13.5	1000	[S63]
BTF	33.5	CE	141.3 117.8	100 1000	This work

a) The data of high-*k* composites are arranged, while some of them not reported directly in the references are derived from the corresponding curves, the symbol "～" is used to indicate that the datum is an approximate value.

b) BCZT: Calcium barium zirconate titanate ($Ba_{0.95}Ca_{0.05}Zr_{0.15}Ti_{0.85}O_3$).
BSCT: $(Ba_{0.5}Sr_{0.4}Ca_{0.1})TiO_3$.

BST: $Ba_xSr_yTiO_3$.

BT: Barium titanate.

BT NWs: Barium titanate nanowires.

OPA: n-Octylphosphonic acid.

PFBPA: Pentafluorobenzyl phosphonic acid.

TDPA: 1-Tetradecylphosphonic acid.

TiO_2: Titanium dioxide.

CCTO ^{Semi}: Calcium copper titanate ($CaCu_3Ti_4O_{12}$) with semiconductor feature.

CCTO: $CaCu_3Ti_4O_{12}$.

CCTO-sg: $CaCu_3Ti_4O_{12}$ were prepared by the sol–gel method.

FTN: $FeTiNbO_6$.

KTNO: $K_{0.05}Ti_{0.02}Ni_{0.93}O$.

KTNO ^{Semi}: $K_{0.05}Ti_{0.02}Ni_{0.93}O$ with semiconductor feature.

LTNO: Li and Ti codoped NiO.

LTNO-0: LTNO sintered at 1250 ^oC.

LTNO-1: LTNO used without further sintering.

LTNO-1 ^{Semi}: LTNO with semiconductor feature.

PMN–PT: Lead magnesium niobate–lead titanate.

PSTM: Samarium and manganese modified lead titanate.

PZT: Lead zirconate titanate.

SiC: Silicon carbide.

BTF: Barium titanate foam ceramic.

c) PVDF: Poly(vinylidene fluoride).

P(VDF-TrFE): Poly(vinylidenefluoride-trifluoroethylene).

P(VDF-CTFE): Poly(vinylidene fluoride-chlorotrifluoroethylene).

CE: Cyanate ester.

CR-S: Cyanoethylated cellulose polymer

ENR-50: Epoxidized natural rubber with 50 mol% epoxide.

EVM: Ethylene vinyl-acetate copolymer.

PES: Polyethersulfone.

PFCB: Poly 1,1,1-triphenyl ethane perfluorocyclobutyl ether.

PI: Polyimide.

PVDF-HFP-GMA: Poly(vinylidene fluoride-cohexafluoropropylene) functionalized with glycidyl methacrylate.

P(VDF-TrFE-CTFE): Poly(vinylidene fluoride-*ter*-trifluoroethylene-*ter*-chlorotrifluoroethylene).

P(VDF-HFP): Poly(vinylidenefluoride-co-hexafluoropropylene).

PEKK: Polyetherketoneketone.

P(VDF-CTFE-DB): Poly(vinylidenefluoride-co-chlorotrifluoroethylene) with internal double bonds.

Table S2 Parameters from simulating results for BTFn(1200)/CE, BTFp33.5%/CE and BT33.5%/CE composites

	BTFp33.5%/CE	BT33.5%/CE	BTF3(1200)/CE	BTF4(1200)/CE	BTF5(1200)/CE	BTF6(1200)/CE
R1(Ω)	7.938×10^{4}	1.902×10^{12}	3.558×10^{10}	1.557×10^{9}	1.185×10^{9}	5.108×10^{8}
C1(F)	7.339×10^{-10}	2.233×10^{-11}	2.408×10^{-11}	2.511×10^{-10}	2.164×10^{-10}	3.081×10^{-10}
R2(Ω)	9.966×10^{20}	1.006×10^{24}	1.946×10^{9}	8.771×10^{8}	6.870×10^{8}	2.550×10^{8}
C2(F)	/	/	1.326×10^{-11}	1.783×10^{-11}	2.423×10^{-11}	3.906×10^{-11}
CPE(F)	5.720×10^{-12}	2.042×10^{-11}	5.810×10^{-11}	1.258×10^{-10}	1.005×10^{-10}	2.125×10^{-10}
n	0.997	0.993	0.702	0.567	0.703	0.674
Cv(F)	6.092×10^{-12}	2.519×10^{-11}	2.298×10^{-11}	2.342×10^{-11}	3.256×10^{-11}	5.181×10^{-11}
Rt(Ω)	9.966×10^{20}	1.006×10^{24}	3.753×10^{10}	2.434×10^{9}	1.872×10^{9}	7.658×10^{8}
Ct(F)	6.042×10^{-12}	1.184×10^{-11}	1.447×10^{-11}	3.543×10^{-11}	4.498×10^{-11}	7.017×10^{-11}

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