Supporting Information:

Excellent energy storage density and superior discharge properties of NBT-NN-ST/$x$$HfO_2$ ceramics via 0-3 type heterogeneous structure designing

Meng Shen [a, *] Guanghui Zhang [a], Husheng Wang [a] , Wen Zhou [a], Yifei Zhang [a], Qifan Li [a], Qingfeng Zhang [c, *], Shenglin Jiang [b], Guangzu Zhang [b],Yong Chen [a, *]

[a]Hubei Key Laboratory of Ferro & Piezoelectric Materials and Devices, Hubei Collaborative Innovation Center for Advanced Organic Chemical Materials, Key Laboratory of Green Preparation and Application for Functional Materials, Ministry of Education, and School of Microelectronics, Hubei University, Wuhan 430062, China

[b]School of Optical and Electronic Information and Wuhan National Laboratory for Optoelectronics, Huazhong University of Science and Technology, Wuhan, Hubei 430074, China

[c]Ministry of Education Key Laboratory of Green Preparation and Application for Functional Materials, Hubei Key Lab of Ferro & Piezoelectric Materials and Devices, Hubei Key Laboratory of Polymer Materials, School of Materials Science & Engineering, Hubei University, Wuhan 430062, China

E-mail: chenyong@hubu.edu.cn, sm@hubu.edu.cn

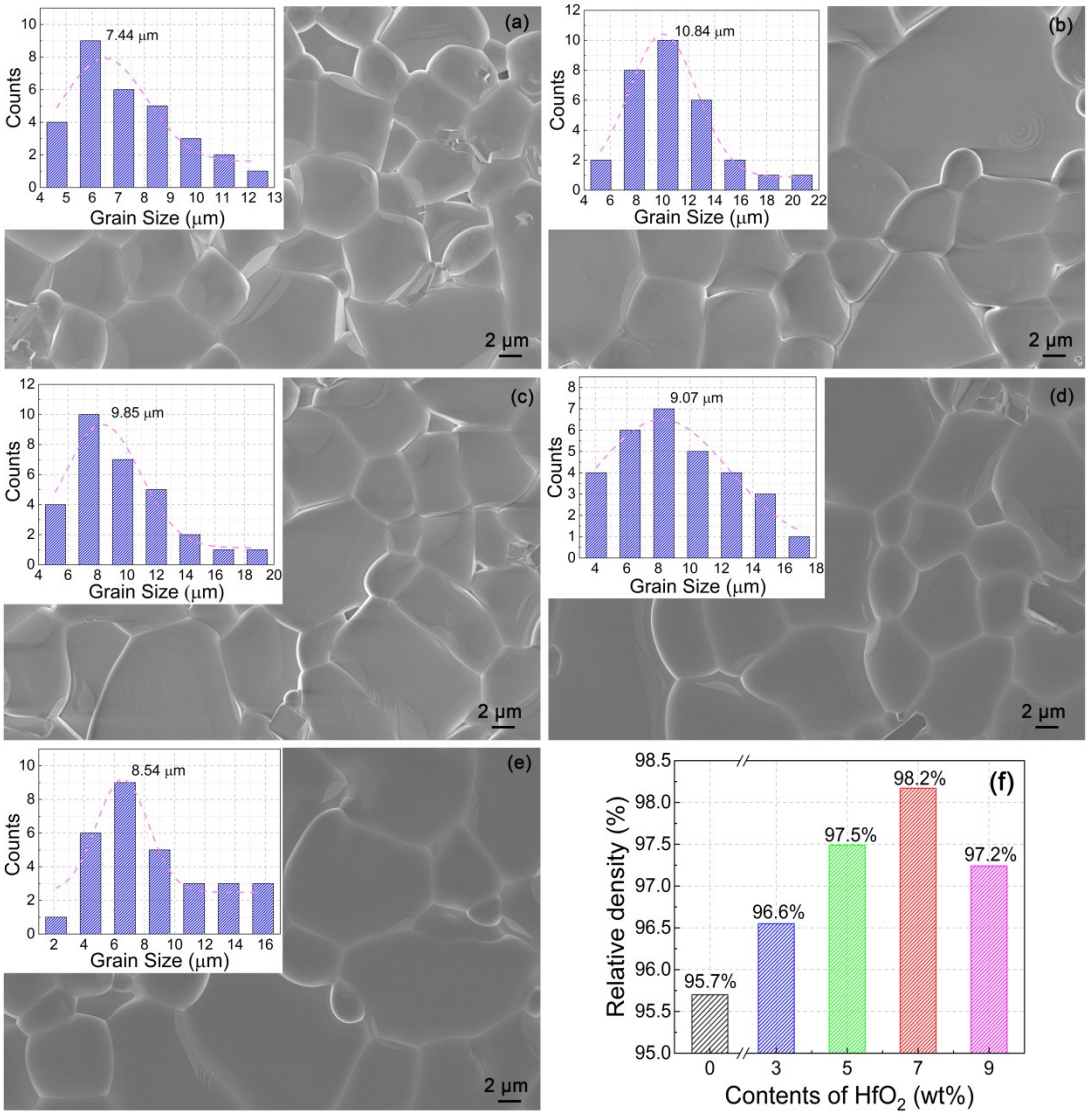

Fig. S1 The SEM images and average grain sizes of NBT-NN-ST/xHfO$_2$ composite ceramics, (a) x=0, (b) x=3 wt%, (c) x=5 wt%, (d) x=7 wt% and (e) x=9 wt%, respectively. *(f) The relative density of NBT-NN-ST/xHfO$_2$ composites with x=0~9 wt%.*

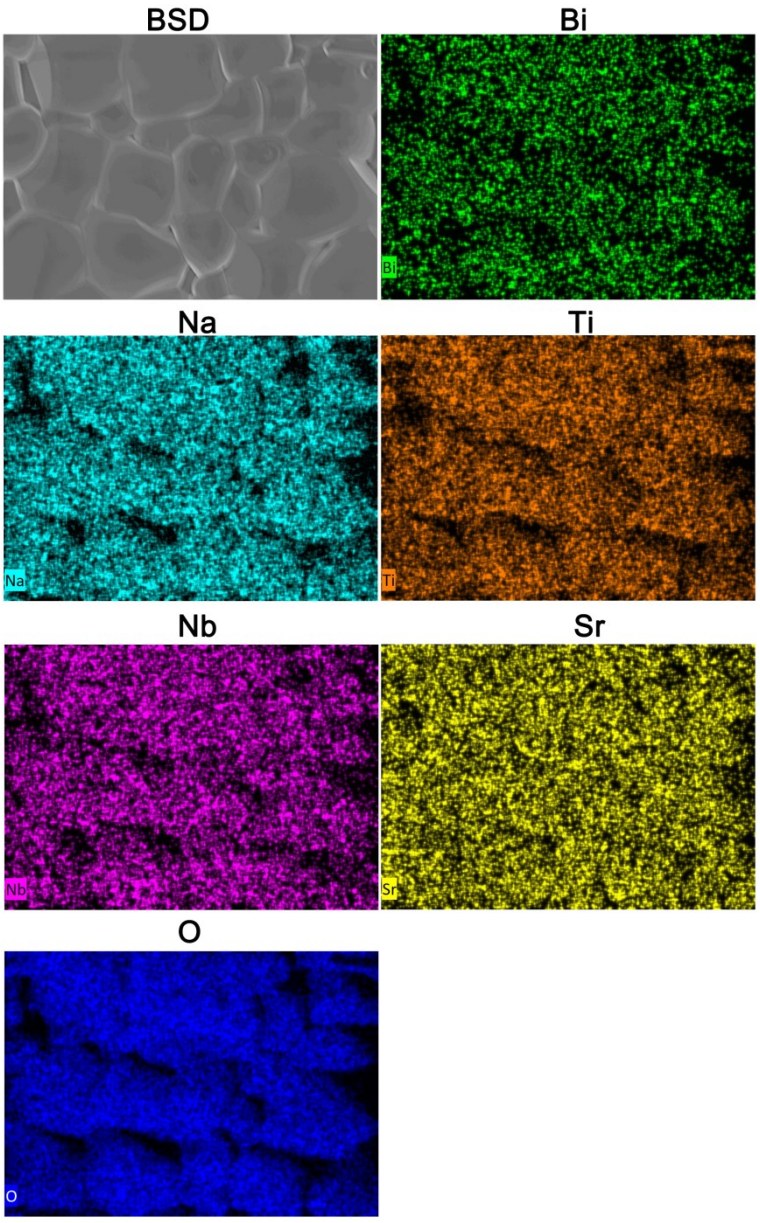

Fig. S2 The BSD image and EDS mapping of NBT-NN-ST/xHfO$_2$ composite ceramics with x=0.

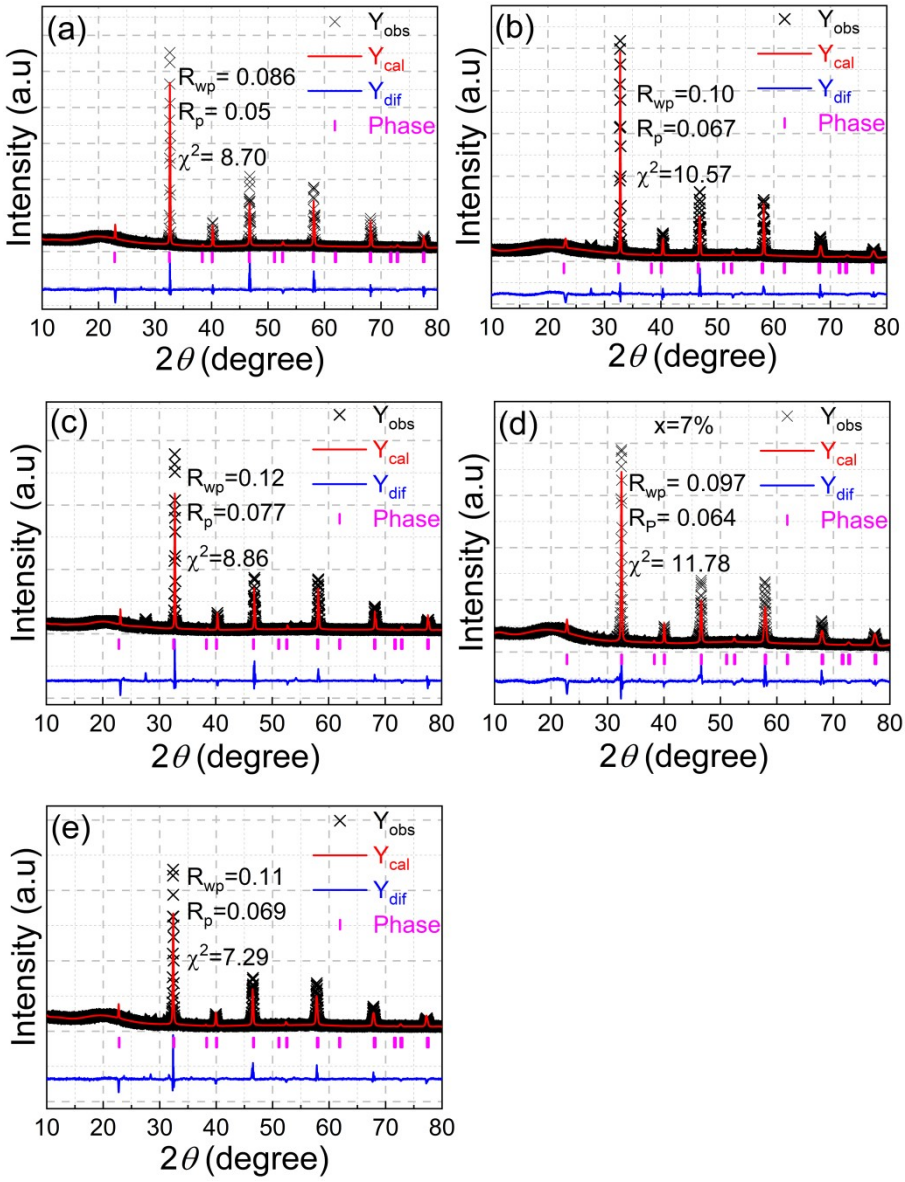

Fig. S3 The XRD Rietveld refinements of NBT-NN-ST/$x$$HfO_2$ ceramics, (a) x=0 mol, (b) x=3 wt%, (c) x=5 wt%, (d) x=7 wt%, (e) x=9 wt% mol.

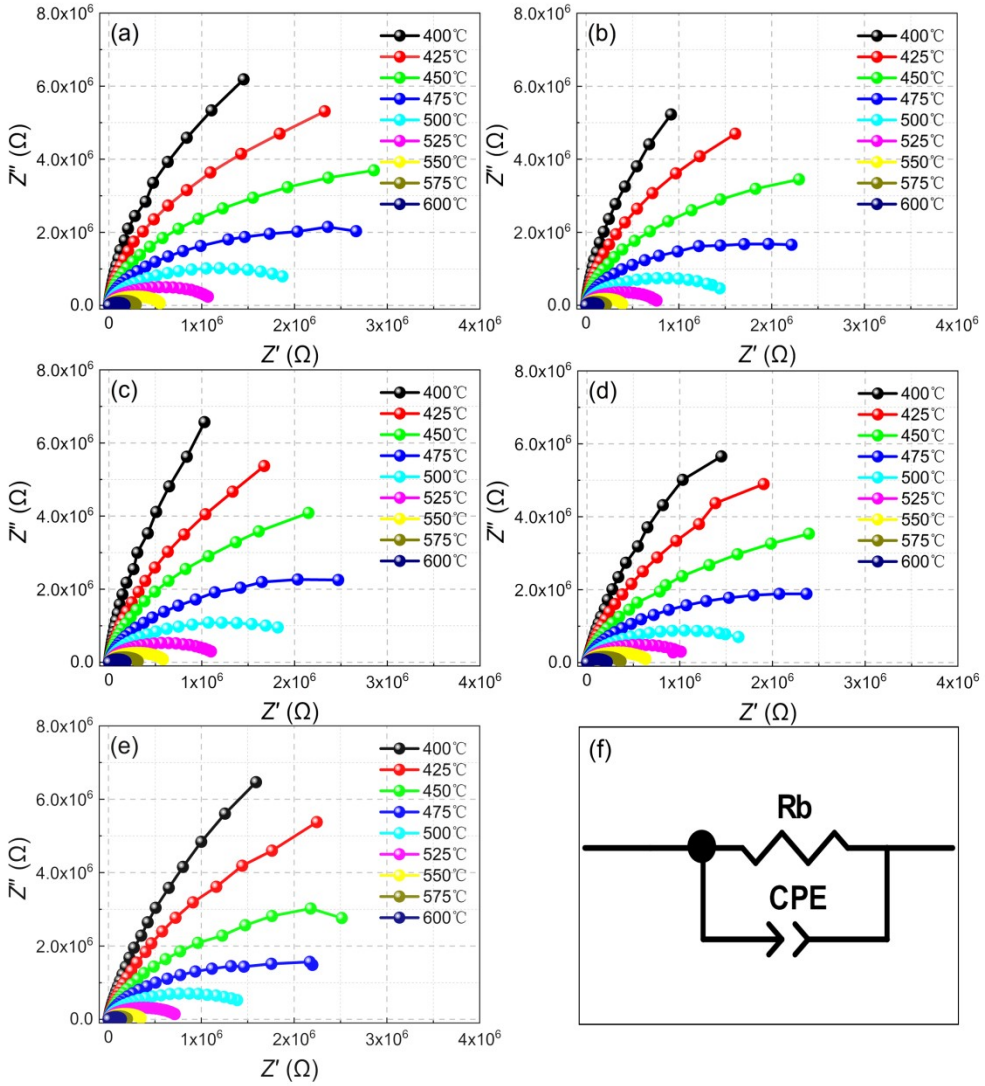

Fig. S4 (a)-(e) The Z'-Z'' spectra of NBT-NN-ST/$x$$HfO_2$ ceramic composites with various contents of HfO_2 over the temperature range of 400~600 °C. (f) The equivalent circuit proposed for impedance data fitting (CEP is the constant phase element, which uses in a model in place of a capacitor to compensate for non-homogeneity in the system).

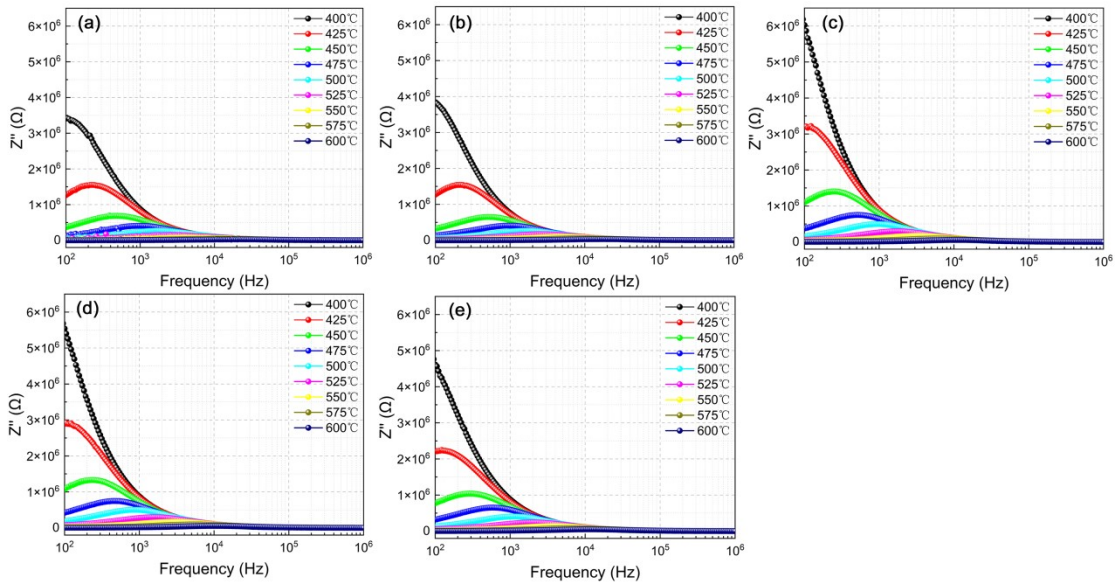

Fig. S5 The frequency-dependent Z″ spectra of NBT-NN-ST/$x$$HfO_2$ ceramic composites with various contents of HfO_2 at temperature range of 400~600 °C.