

Supplementary materials

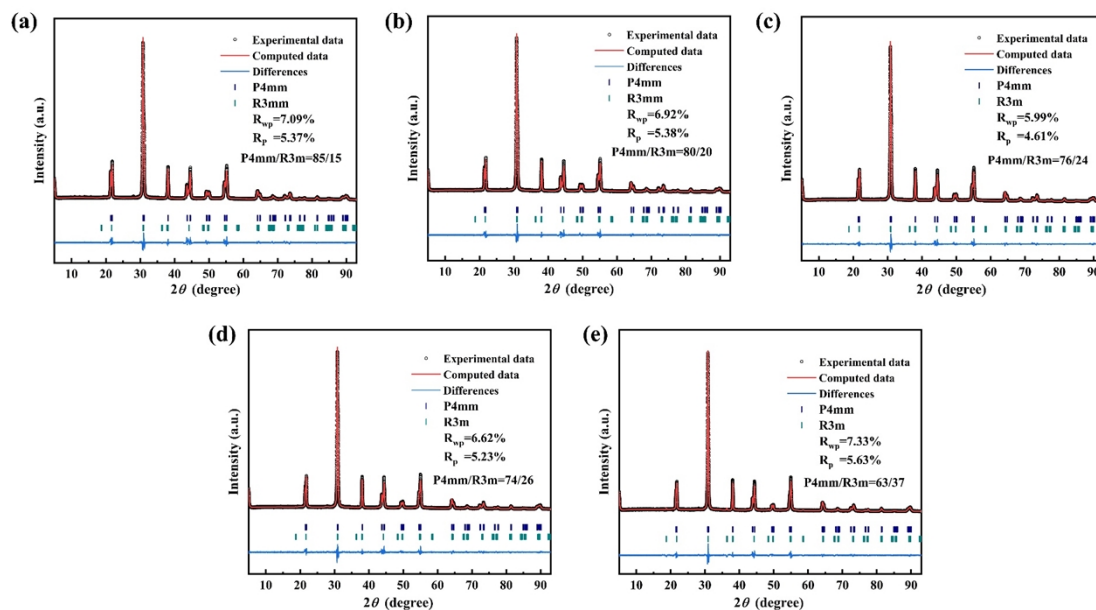
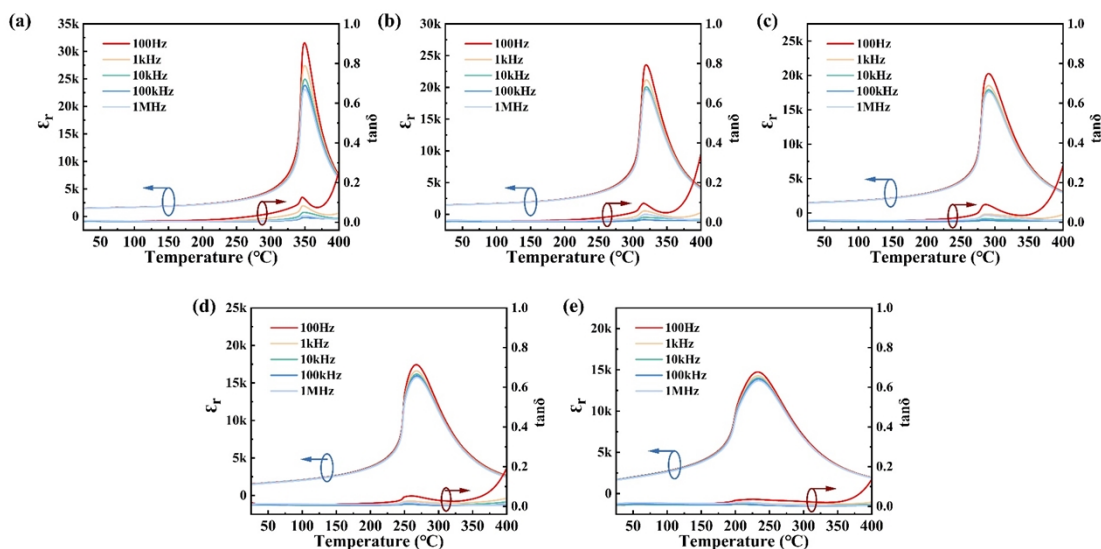
Well-Balanced Performance Achieved in PZT Piezoceramics via a Multiscale Regulation Strategy

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Table S1The various electromechanical properties for $\text{Pb}_{1-x}\text{Ba}_x\text{SNZT-Mn}$ ceramics.

x (mol%)	d_{33} (pC/N)	Q_m	k_p	$\tan\delta$	ϵ	T_c (°C)
0.00	423	582	0.64	0.0028	1733	350
0.04	449	658	0.67	0.0023	1928	320
0.08	474	679	0.68	0.0021	2126	291
0.12	502	726	0.69	0.0024	2405	267
0.16	507	546	0.67	0.0026	2691	235

Figure S1. Rietveld refinement of the $\text{Pb}_{1-x}\text{Ba}_x\text{SNZT-Mn}$ ceramics: (a) $x = 0.00$, (b) $x = 0.04$, (c) $x = 0.08$, (d) $x = 0.12$, and (e) $x = 0.16$.Figure S2. Temperature-dependent permittivity and dielectric loss of $\text{Pb}_{1-x}\text{Ba}_x\text{SNZT-Mn}$ ceramics: (a) $x = 0.00$, (b) $x = 0.04$, (c) $x = 0.08$, (d) $x = 0.12$, and (e) $x = 0.16$.

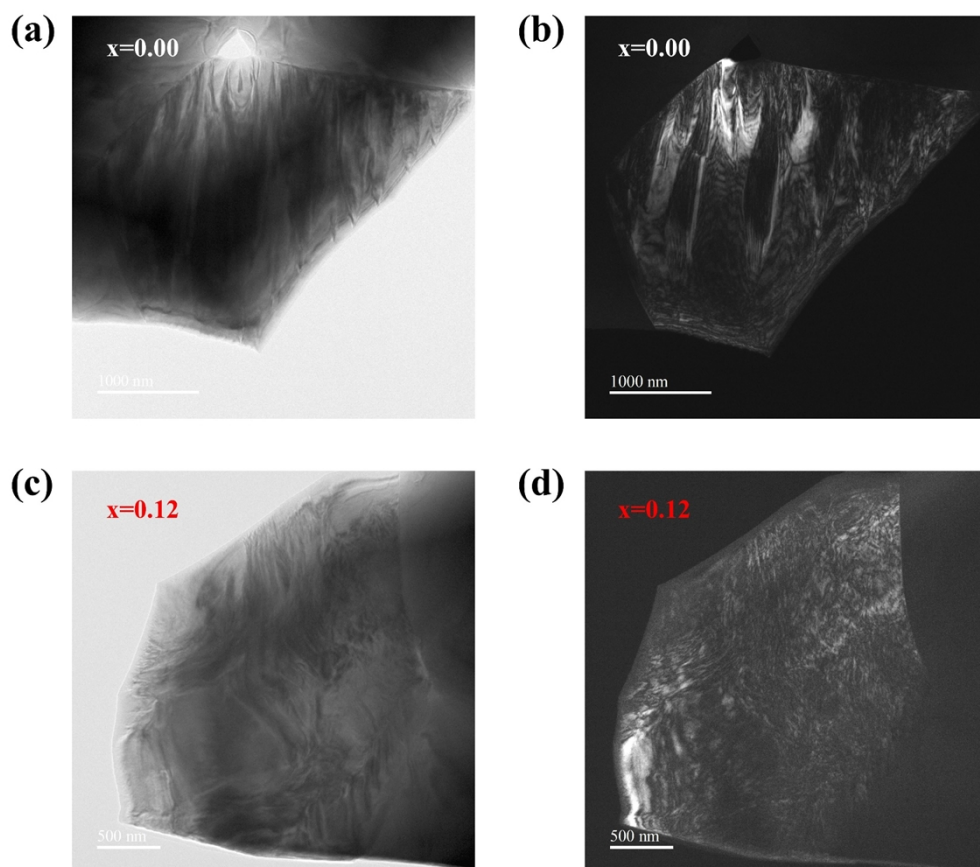


Figure S3. (a,c) Bright-field and (b,d) Dark-field TEM images showing the ferroelectric domains of the $x = 0.00$ and $x = 0.12$ ceramic samples, respectively.

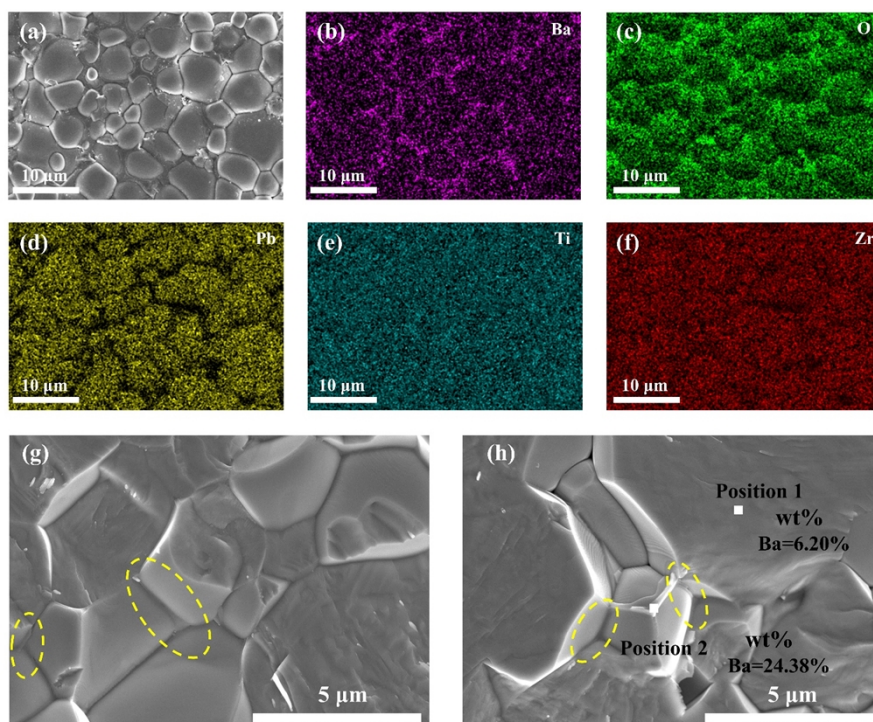


Figure S4. Microscopic morphology of $x = 0.12$ ceramic samples: (a) surface morphology, (b-f) element distributions, (g-h) cross-sectional morphology.

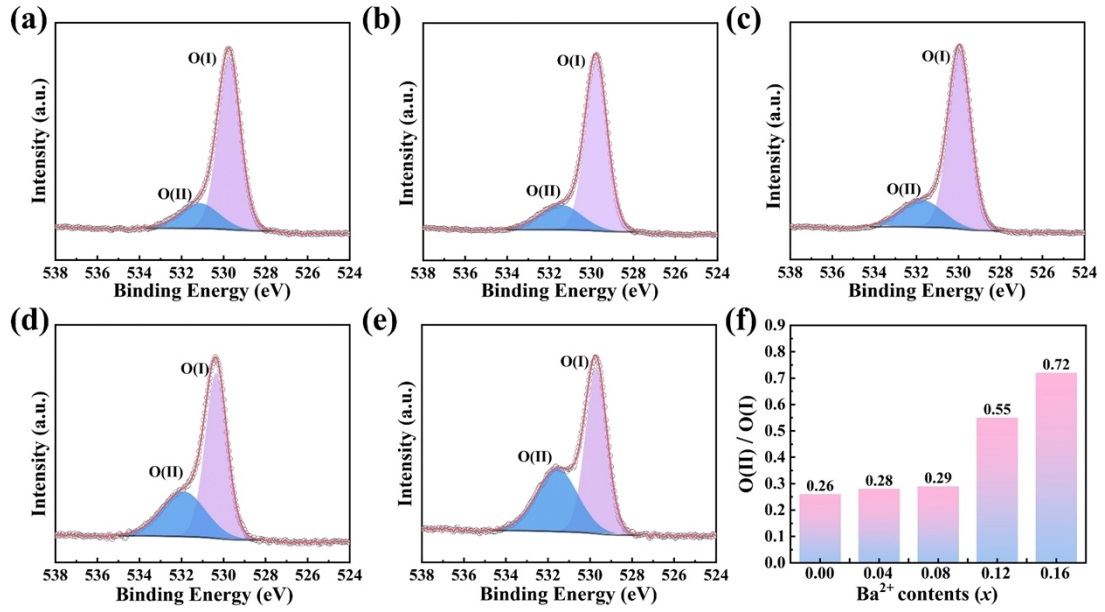


Figure S5. XPS spectrum of O 1s peak of $\text{Pb}_{1-x}\text{Ba}_x\text{SNZT-Mn}$ ceramics: (a) $x = 0.00$, (b) $x = 0.04$, (c) $x = 0.08$, (d) $x = 0.12$, and (e) $x = 0.16$. (f) The area ratios of the two sub-peaks in XPS O 1s spectra.