Electronic Supplementary Material (ESI) for Phys. Chem. Chem. Phys.

Influence of Dipole and Intermolecular Interaction on the Tuning Dielectric and Energy Storage Properties of Polystyrene-Based Polymers

Qizheng Li,[a] Shaobo Tan,[a] Honghong Gong,[a] Junyong Lu[b], Wenjing Zhang[c] Xiao Zhang*[b] and Zhicheng Zhang*[a]

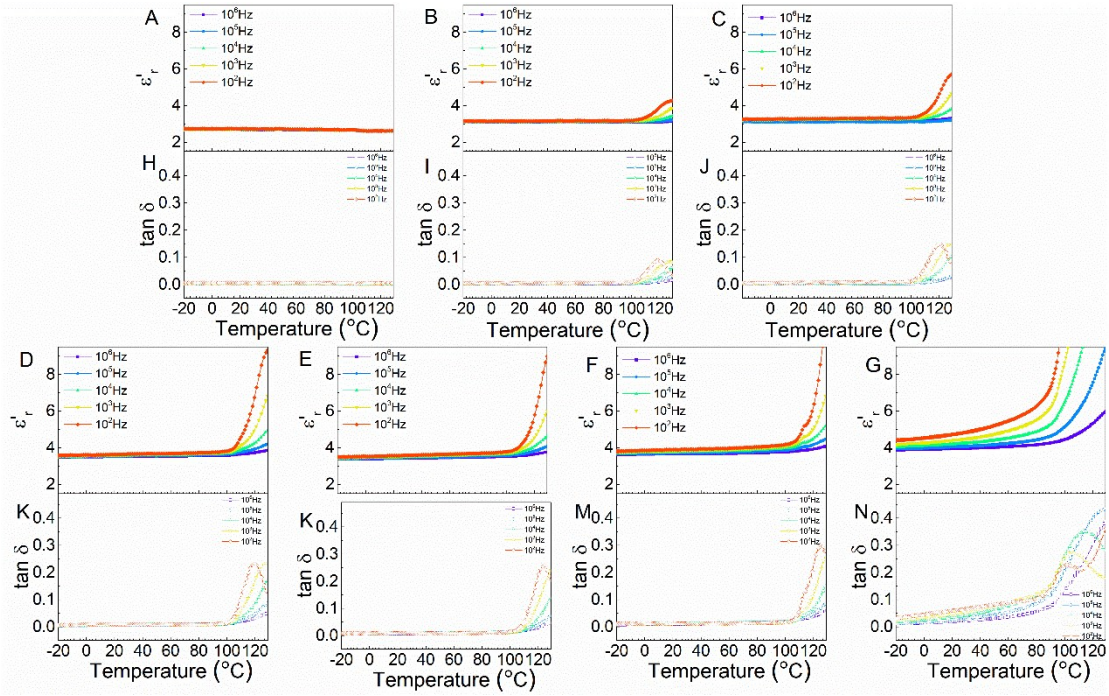

Fig. S1 Permittivity (A-G) and loss factor (H-N) as a function of temperature at different frequencies for polymers: PSt (A, H), AS-1 (B, I), AS-2 (C, J), AS-3 (D, K), AS-4 (E, L), AS-5 (F, M) and PAN (G, N).

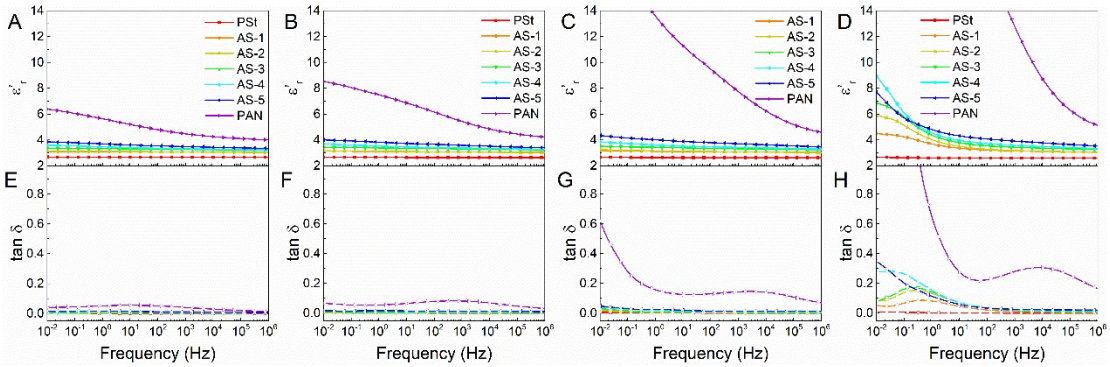

Fig. S2 Permittivity (A, B, C and D) and loss factor (E, F, G and H) of PSt, PAN and ASs, measured at 1 V bias and 20 °C (A, E), 60 °C (B, F), 90 °C (C, G), and 110 °C (D, H), respectively.

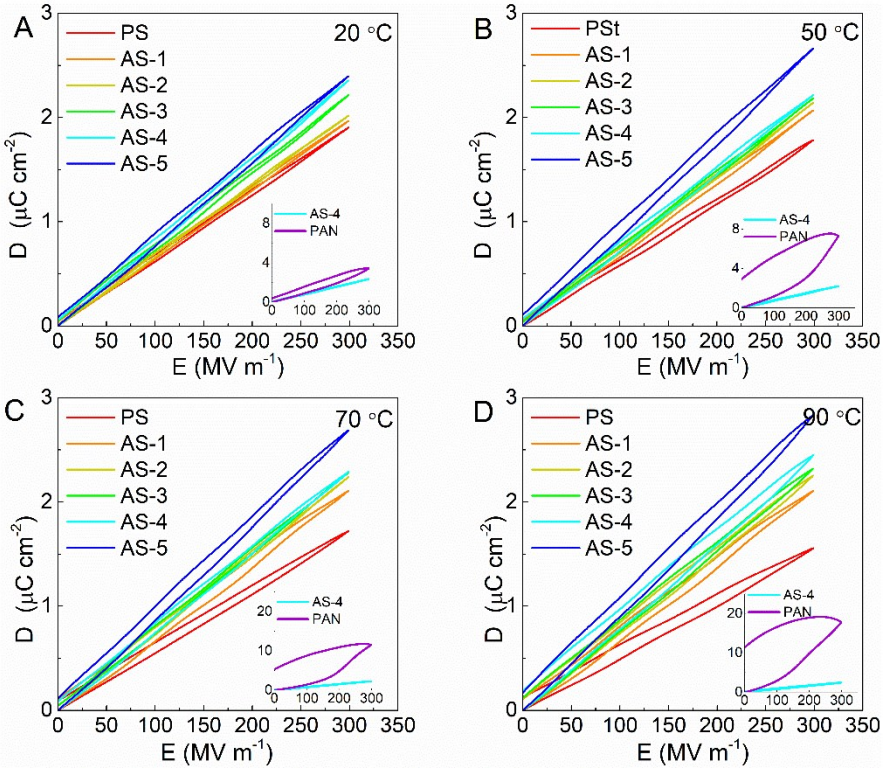

Fig. S3 Comparison of D-E loops of PSt, PAN and ASs measured at an electric field of 300 MV m^{-1} and different temperatures of 20 °C (A), 50 °C (B), 70 °C (C) and 90 °C (D).

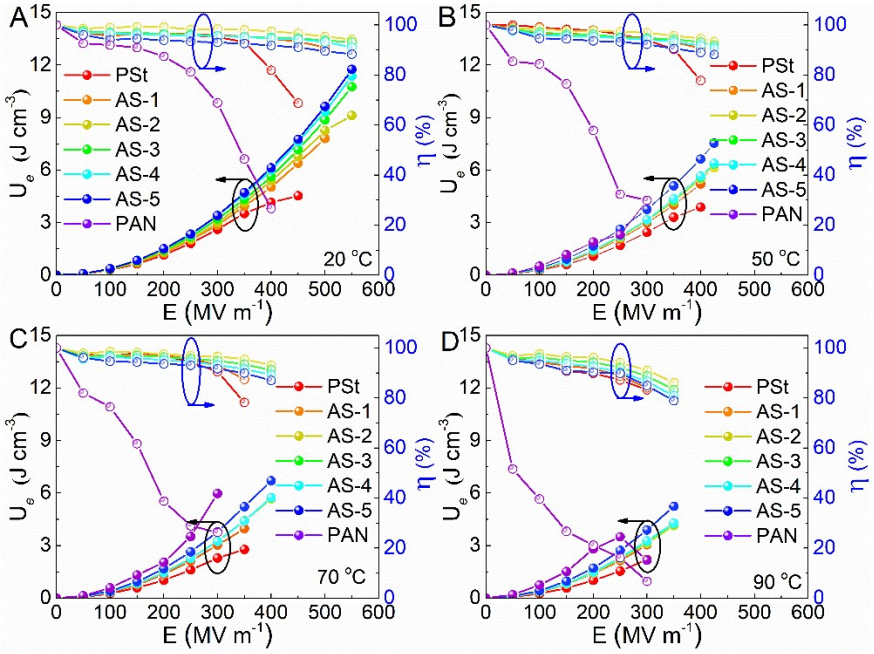

Fig. S4 Comparison of discharged energy density (U_e) and charge-discharge efficiency (η) of PSt, PAN and ASs at different electric fields and different temperatures of 20 °C (A), 50 °C (B), 70 °C (C) and 90 °C (D).

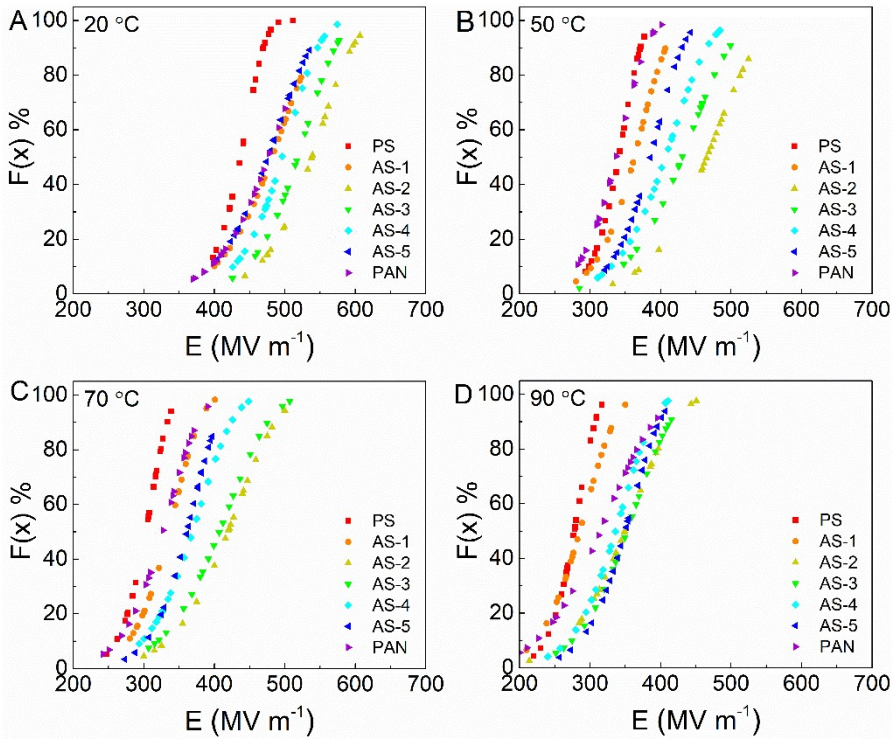

Fig. S5 Weibull distribution of the breakdown electric field of PSt, PAN and ASs with varied ratios of St/AN at 20 °C (A), 50 °C (B), 70 °C (C) and 90 °C (D).

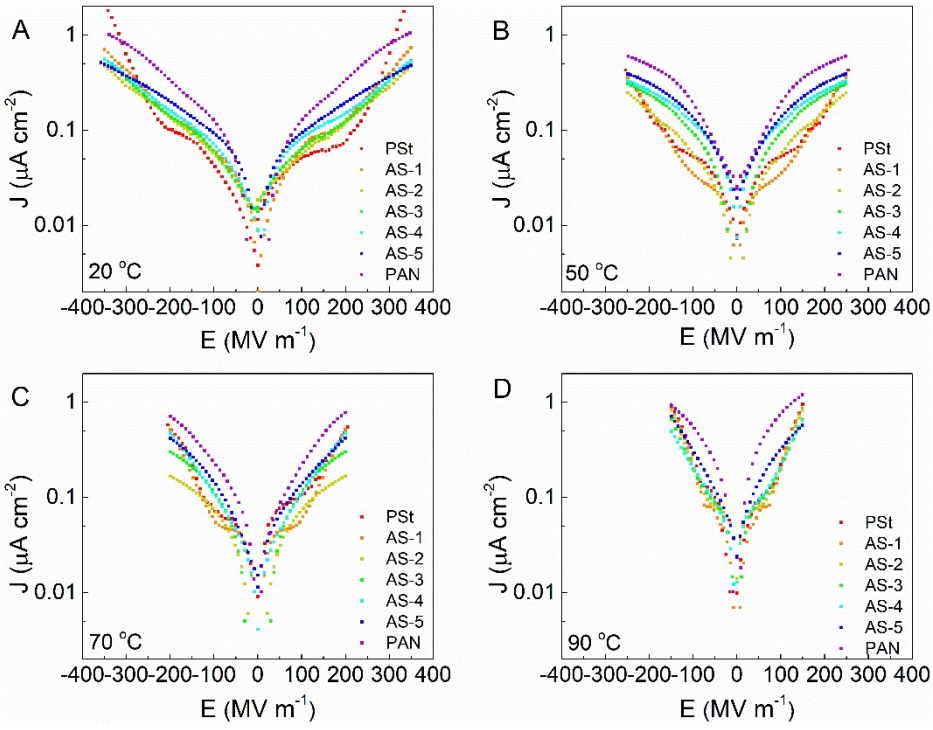

Fig. S6 Leakage current density@ 20 °C (A), 50 °C (B), 70 °C (C) and 90 °C (D) of the PSt, PAN and ASs films as a function of electric fields.

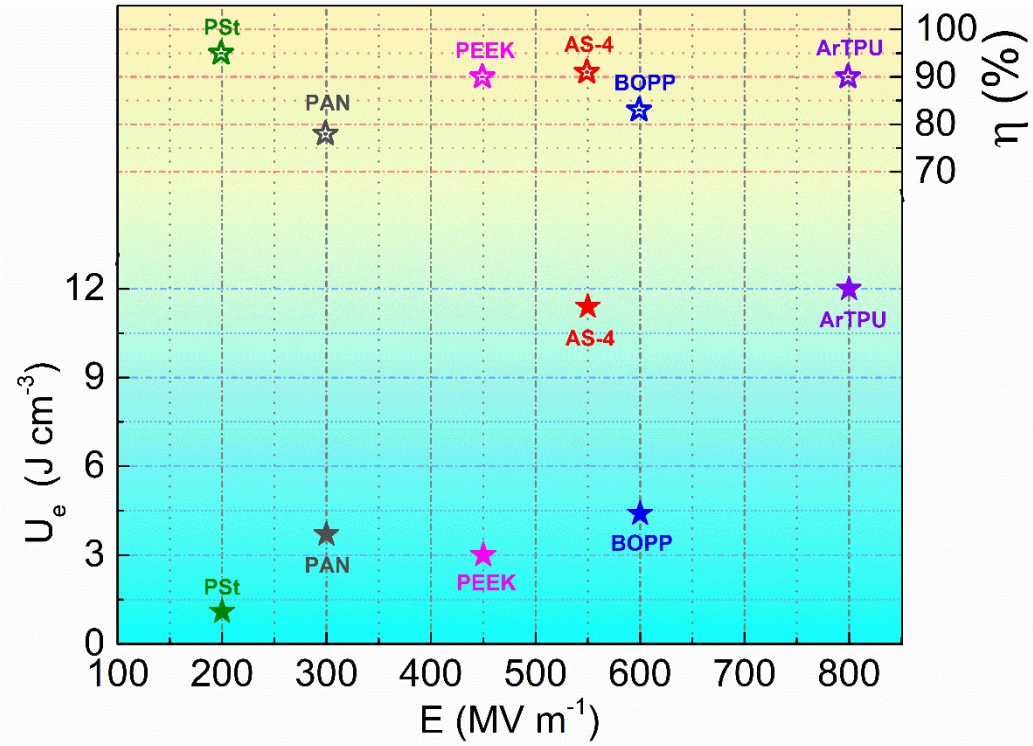

Fig. S7 The discharge energy density (U_e) and charge-discharge efficiency (η) of AS-4 compared to the-state-of-the-art dielectrics.

Polystyrene and polyacrylonitrile were commercial polymers purchased from the Innochem Company. U_e and η of PSt and PAN were measured in the same way as the AS-4 in section 3. Others come from the references.

polymers	U_{emax} (J cm^{-3})	η_{max} (%)	Ref
PP	4@600 MV m^{-1}	87	S1
BOPP	4.4@600 MV m^{-1}	83	S2
PP-OH	7@650 MV m^{-1}	-	S3
SO_2-PPO_S	24@805 MV m^{-1}	45	S4
ArPTU	12@800 MV m^{-1}-	90	S5
PTU	11@780 MV m^{-1}	90	S3
PEEK	3.0@450 MV m^{-1}	90	S6
PAN	3.7@300MV m^{-1}	78	
PSt	1.1@200MV m^{-1}	95	

Reference

S1. M. Rabuffi and G. Picci, *IEEE Transactions on Plasma Science*, 2002, **30**, 1939-1942.

S2. J. Wei, Z. Zhang, J.-K. Tseng, I. Treufeld, X. Liu, M. H. Litt and L. Zhu, *ACS Applied Materials & Interfaces*, 2015, **7**, 5248-5257.

S3. Z. Li, G. M. Treich, M. Tefferi, C. Wu, S. Nasreen, S. K. Scheirey, R. Ramprasad, G. A. Sotzing and Y. Cao, *Journal of Materials Chemistry A*, 2019, **7**, 15026-15030.

S4. Z. Zhang, D. H. Wang, M. H. Litt, L. S. Tan and L. Zhu, *Angewandte Chemie International Edition*, 2018, **57**, 1528-1531.

S5. Y. Wang, X. Zhou, M. Lin and Q. M. Zhang, *Applied Physics Letters*, 2009, **94**, 202905.

S6. J. Pan, K. Li, J. Li, T. Hsu and Q. Wang, *Applied Physics Letters*, 2009, **95**, 022902.