Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary Information

Double-layer core/shell-structured nanoparticles in polyarylene ether nitriles based nanocomposites as flexible dielectric materials

Yong You, Weihua Han, Ling Tu, Yajie Wang Renbo Wei* and Xiaobo Liu*

Research Branch of Advanced Functional Materials, School of Microelectronics and Solid-State Electronics, High Temperature Resistant Polymer and Composites Key Laboratory of Sichuan Province, University of Electronic Science and Technology of China, Chengdu, 610054, China.

Corresponding author. Tel: +86-28-83207326; Fax: +86-28-83207326; E-mail address: weirb10@uestc.edu.cn
Corresponding author. Tel: +86-28-83207326; Fax: +86-28-83207326; E-mail address: liuxb@uestc.edu.cn

Synthesis of PEN: 50 mL toluene and 150 mL NMP were added into a 500 mL three-necked round-bottom flask equipped with a Dean-Stark trap and a mechanical stirrer. Then, biphenyl (BP, 0.20 mol) and 2, 6-dichlorobenzonitrile (DCBN, 0.20 mol) were sequentially added into the solvent companied with mechanical stirring. Subsequently, K_2CO_3 (0.25 mol) acting as a catalyst, was added into three-necked round-bottom flask in several times. After that, the round-bottom flask was heated by a heating jacket and kept stirring. After the water-toluene azeotrope distilled off, the reaction mixture was heated to 150, 160, 170, and 180 ^oC for 1 h, respectively. After cooling the system to room temperature, the mixture was poured into 1000 mL of diluted HCl solution in order to remove the excess K_2CO_3, and then rinsed by acetone and alcohol till the solvent and monomers were washed out completely. After filtration, the white solid product was dried at 100 °C for 12 h.

Synthesis of CPEN: The synthetic process of CPEN is exactly the same as PEN except using Phenolphthalin (PPL, 0.20mol) to replace biphenyl (BP, 0.20 mol).

Synthesis of NH_2-CuPc: The 4-nitrophthalonitrile (0.2 mol), $Cu(AC)_2 \cdot H2O$ (0.06 mmol) and 100 ml DMAC were added into a 250 mL three-necked round-bottom flask. Then, the mixture was refluxed and reacted at 160 ^oC for 4 h with the magnetic stirrer under the protection of nitrogen. After that, the solution was poured into 500 mL of deionized water for precipitation, and then the solid product (NO_2-CuPc) by washing them three times each with acetone, ethanol and deionized water. After filtration, the deep blue solid product was dried at 80 °C for 12 h. Furthermore, the obtained NO_2-CuPc was reduced to NH_2-CuPc by further treating with $Na_2S \cdot 9H_2O$ in DMF at 65 ^oC for 6 h.

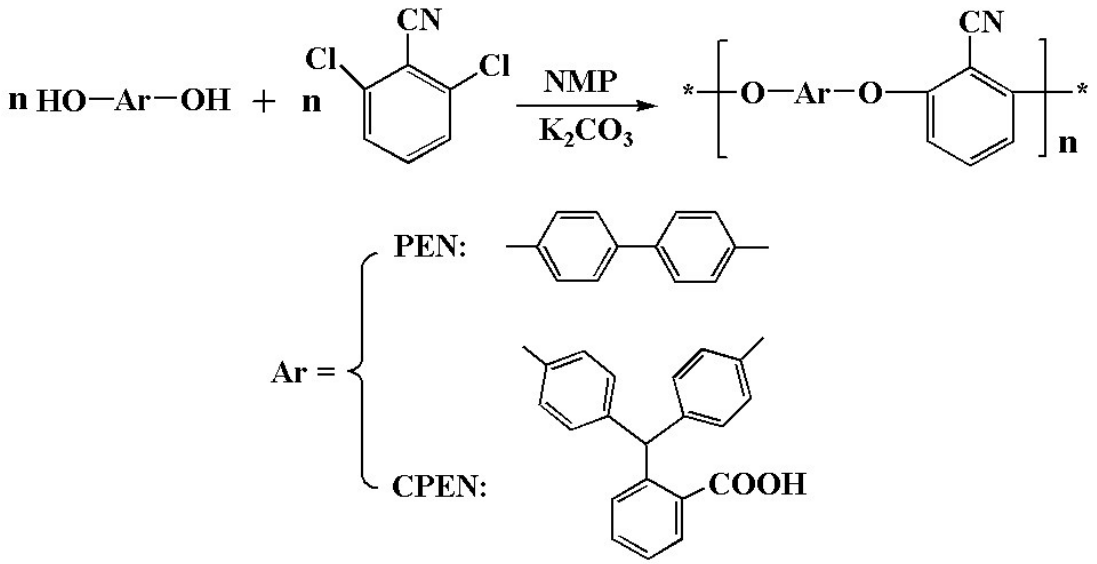

Fig. S1 Synthetic route to the PEN and CPEN.

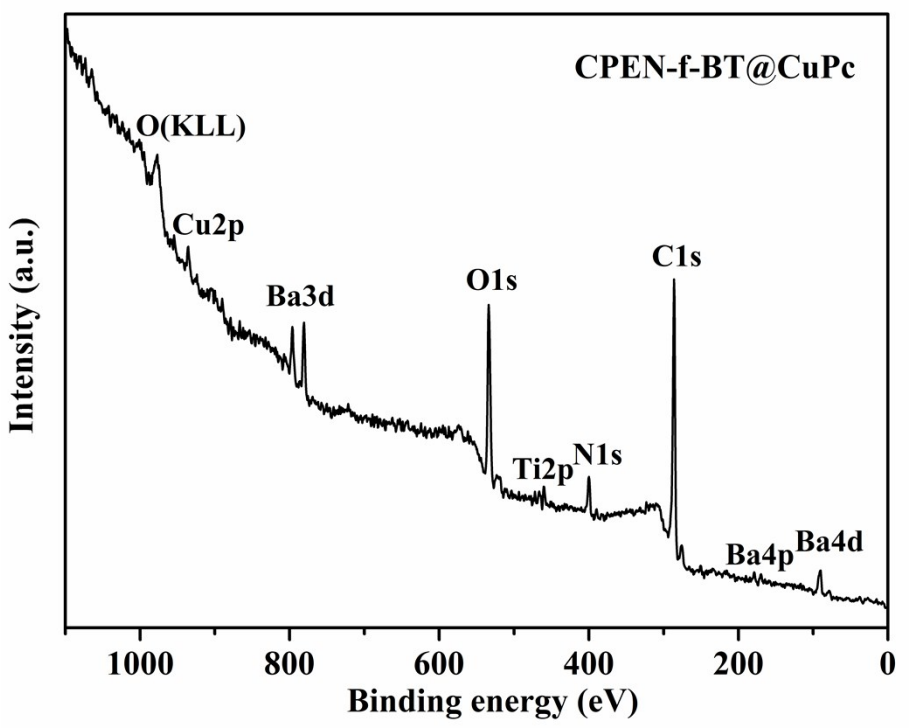

Fig. S2 XPS survey spectrum of the CPEN-f-BT@CuPc.

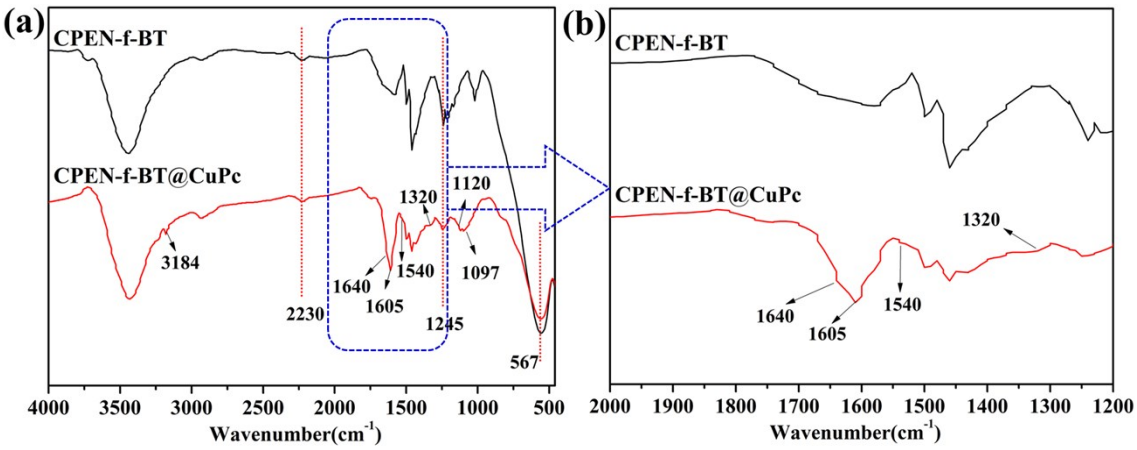

Fig. S3 FTIR spectrum of CPEN-f-BT@CuPc (a) and the enlarged FTIR spectrum of CPEN-f-BT@CuPc (b).

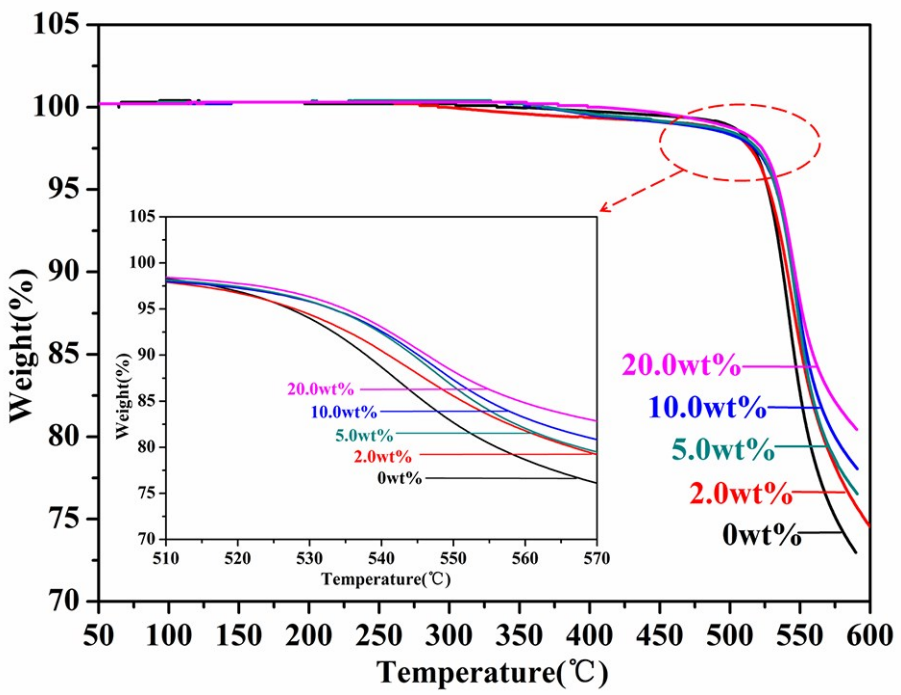

Fig. S4 The TGA curves of the CPEN-f-BT@CuPc/PEN composite films.

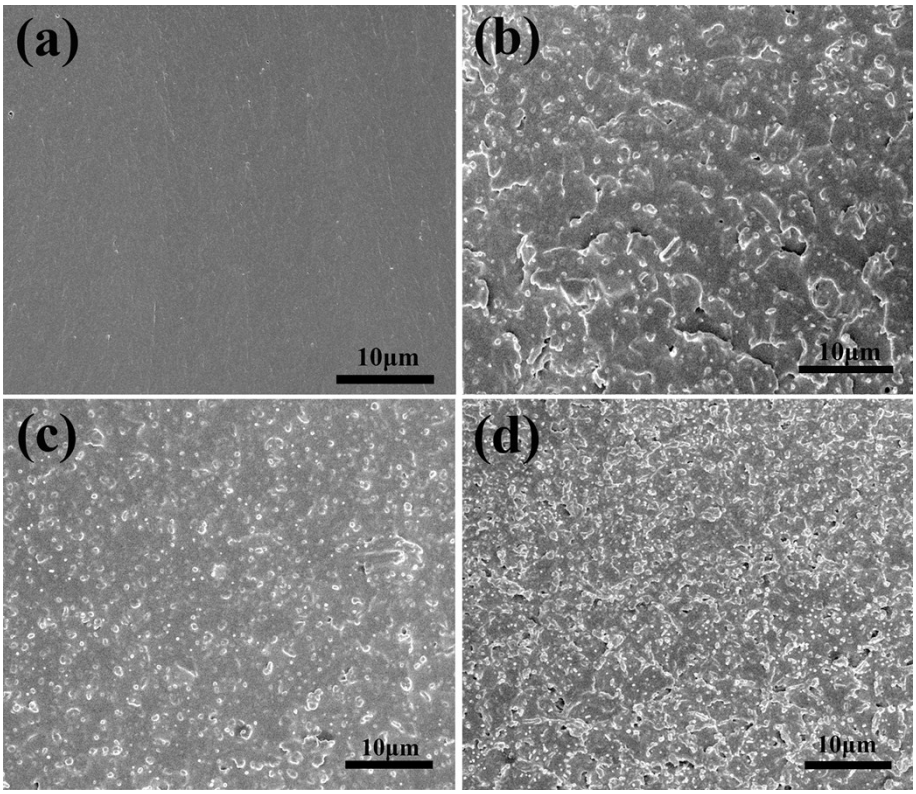

Fig. S5 SEM micrographs of the cross-section of the samples with different content of CPEN-f-BT@CuPc. (a) 0%, (b) 2.0 wt%, (c) 10.0 wt%, (d) 20.0 wt%.

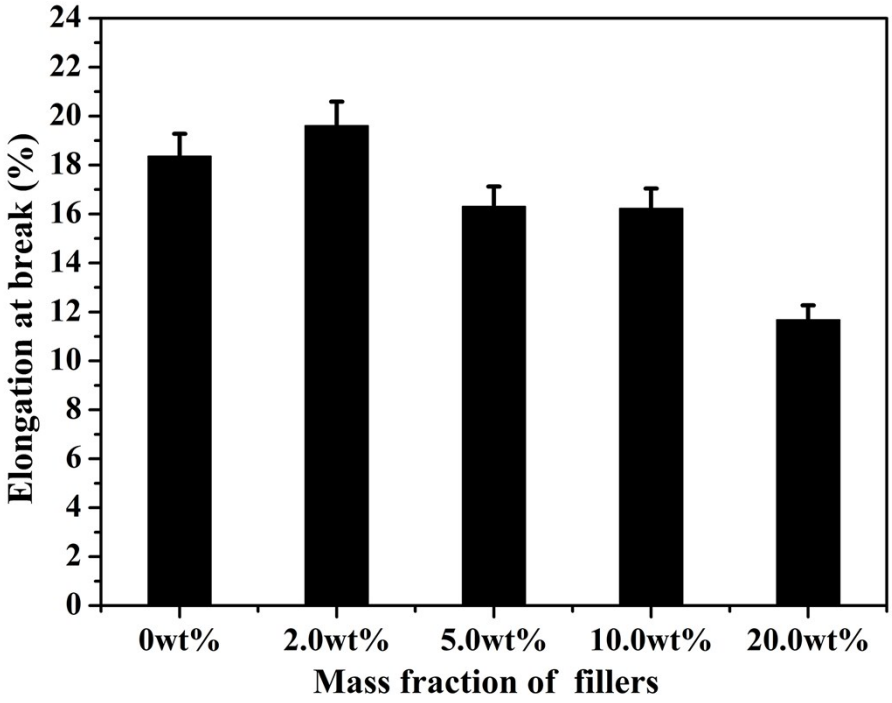

Fig. S6 The elongation at break of CPEN-f-BT@CuPc/PEN composite films.