Supporting information

Research on High Thermal Conductivity PPENK/PVP modified BN Electrospinning Hot-pressed Multifunctional Nanocomposite Films

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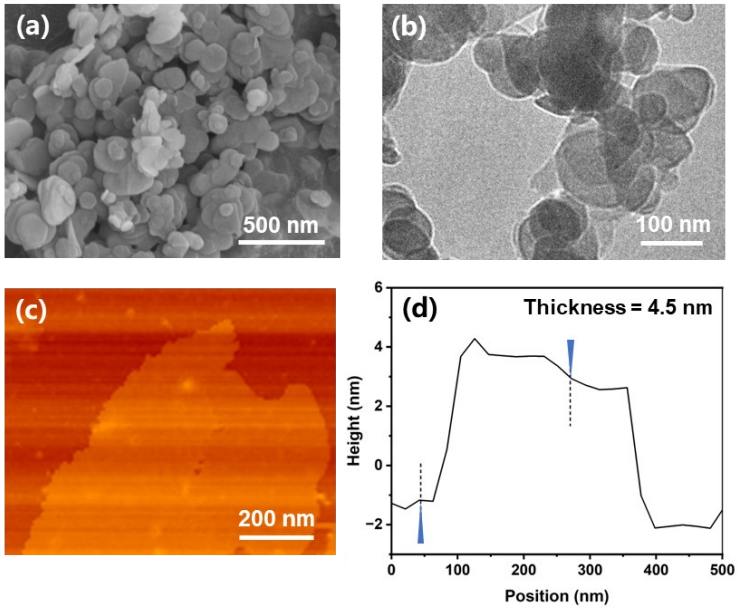

Fig. S1 (a) SEM, (b)TEM, (c) AFM images of BN and (d) the height-curve of BN corresponding to (c).

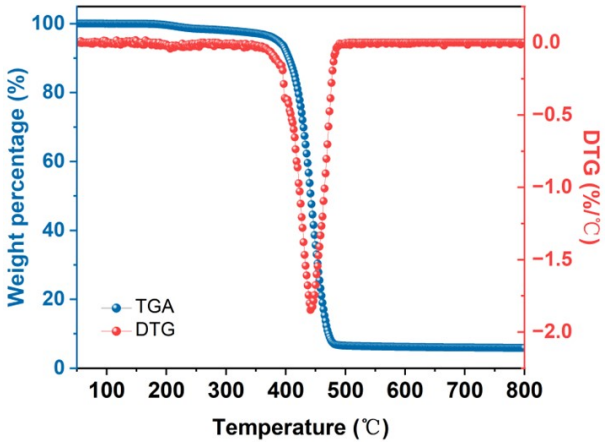

Fig. S2 TGA and DTG curves of PVP

Table S1. XPS peak proportions of BN before and after PVP modification

Samples	C (at.%)	N (at.%)	O (at.%)	B (at.%)
BN	13.24	35.45	3.82	47.48
PVP-BN	20.52	32.54	4.21	42.73

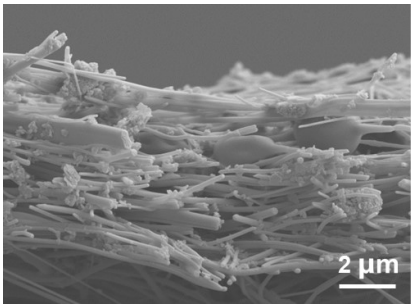

Fig. S3 SEM cross-section images of the PPENK/MBN-12 single fiber film.

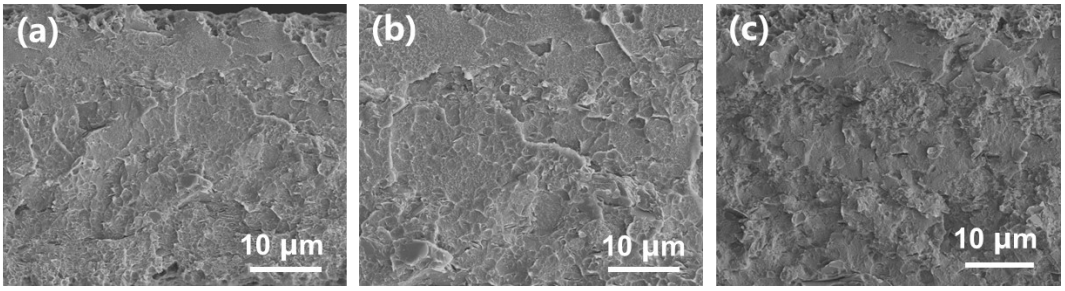

Fig. S4 SEM cross-section images of the PPENK/MBN-3(a), PPENK/MBN-6(b), PPENK/MBN-9(c) composite films.

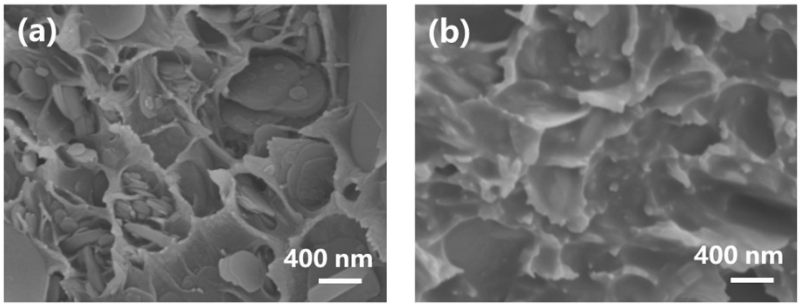

Fig. S5 SEM cross section images of PPENK/BN (a) and PPENK/MBN (b).

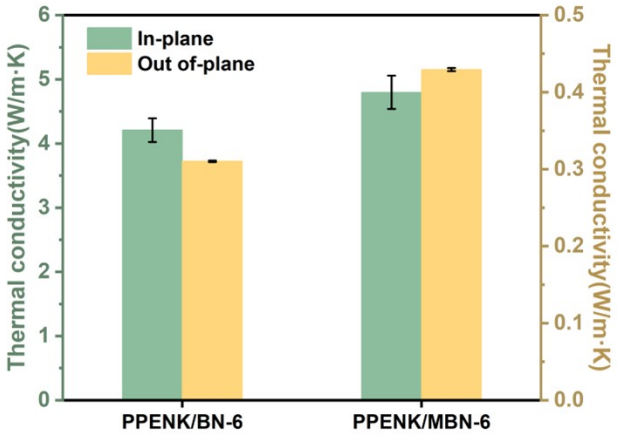

Fig. S6 In-plane and Out-of-plane thermal conductivity of PPENK/BN-6 and PPENK/MBN-6 composite films

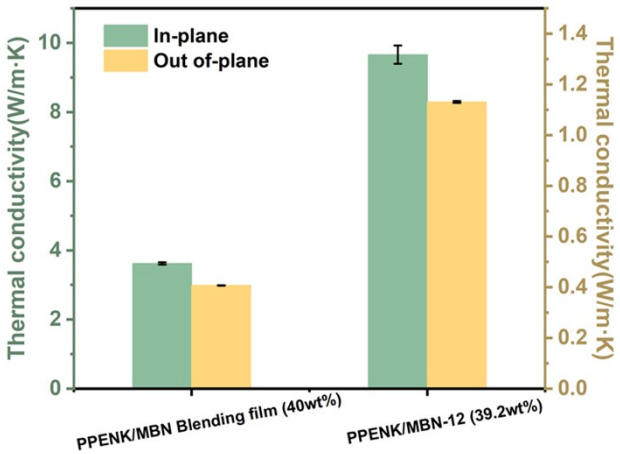

Fig. S7 In-plane and Out-of-plane thermal conductivities of PPENK/MBN Blending film(40wt%) and PPENK/MBN-12 (39.2wt%) composite films

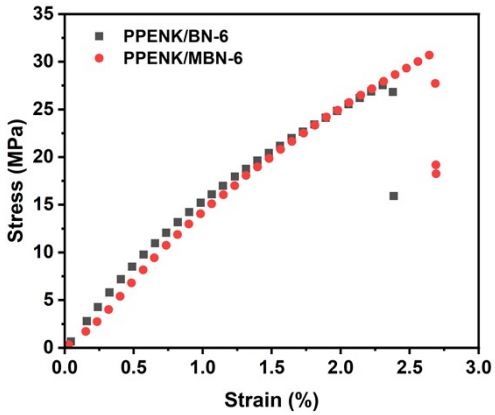

Fig. S8 Stress-strain curves of PPENK/BN-6 and PPENK/MBN-6 composite films.

Table S2. The Composition and content of PVP-BN/PPENK composite films.

Materials	BN (wt%)	PVP-BN (wt%)	PPENK (wt%)
PPENK	-	-	100
PPENK/MBN-3	9.3	9.5	90.5
PPENK/MBN-6	16.4	16.7	83.3
PPENK/MBN-9	29.1	29.7	70.3
PPENK/MBN-12	38.4	39.2	60.8

Table S3. Comparison of specific Thermal Conductivity (in-plane and out of-plane) between our sample with BN/polymer composites films reported in the literature.

Composites	Filler Content (wt%)	In-plane thermal conductivity ($W \cdot m^{-1} \cdot K^{-1}$)	Out of-plane thermal conductivity ($W \cdot m^{-1} \cdot K^{-1}$)	Reference
PPENK/MBN-12	39.2	9.96	1.13	-
EP/BNNS@IL	45	8.3	0.8	[1]
PVA/BTx	30	8.54	-	[2]
PI/BNNS@PAA	10	2.11	0.371	[3]
TPU/MWCNT@BNNS	41.7	9.99	1.17	[4]
PA6/mBN/mSiC	20	1.31	0.35	[5]
AgNWs@BNNS/ANF	50	10.36	0.93	[6]
EP/BNNS@AgNPs	20	1.13	-	[7]
BNNS@Al_2O_3/SR	30	2.78	0.84	[8]

PPENK: poly(phthalazinone ether nitrile ketone); MBN: modified boron nitride; BNNS: boron nitride nanosheets; EP: epoxy; IL: ionic liquid; PVA: poly(vinyl alcohol); BT_x: boron nitride nanosheets/$Ti_3C_2T_x$ MXene; PI: polyimide; PAA: polyamide acid; TPU: Thermoplastic polyurethane; MWCNT: multi-walled carbon nanotubes; PA6: Polyamide; mBN: modified boron nitride; mSiC: modified silicon carbide; AgNWs: silver nanowires; AgNPs: silver nanoparticles;

Al_2O_3: alumina oxide; SR: silicone rubber.

References

[1] Han, G.; Zhang, D.; Kong, C.; et al. Flexible, thermostable and flame-resistant epoxy-based thermally conductive layered films with aligned ionic liquid-wrapped boron nitride nanosheets via cyclic layer-by-layer blade-casting [J]. Chemical Engineering Journal, 2022, 437, 135482.

[2] Sun H, Bao Q, Chen G, et al. Highly thermal conductive and flame retardant poly(vinyl alcohol) film with synergistic alignments of boron nitride nanosheets/$Ti_3C_2T_x$ MXene for thermal interface materials [J]. Polymer, 2023, 283, 126277.

[3] Li, C-Y.; Gu, T.; Sun, D-X.; et al. High performances of polyimide/boron nitride nanosheets composites via integrative interfacial decoration strategy [J]. Composites Science and Technology, 2022, 229, 109681.

[4] Zhang, Y.; Zhao, Z.; Chen, M.; Wu, H.; Guo, S.; Qiu, J. Constructing interconnected network of MWCNT and BNNS in electrospun TPU films: Achieving excellent thermal conduction yet electrical insulation properties. Carbon, 2024, 218, 118691.

[5] Chen, J.; Zhu, J.; Pan, Y.; et al. Fabrication of wear-resistant PA6 composites with superior thermal conductivity and mechanical properties via constructing highly oriented hybrid network of SiC-packed BN platelets [J]. Journal of Materials Science & Technology, 2023, 146: 200-210.

[6] Han, Y.; Ruan, K.; He, X.; Tang, Y.; Guo, H.; Guo, Y.; Qiu, H.; Gu, J. Highly Thermally Conductive Aramid Nanofiber Composite Films with Synchronous Visible/Infrared Camouflages and Information Encryption. Angew Chem Int Ed Engl, 2024, 63 (17), e202401538.

[7] Liu, D.; Chi, H.; Ma, C.; Song, M.; Zhang, P.; Dai, P. Improving in-plane and out-of-plane thermal conductivity of polyimide/boron nitride film with reduced graphene oxide by a moving magnetic field induction. Composites Science and Technology, 2022, 220, 109292.

[8] Ruan, K.; Yan, H.; Zhang, S.; Shi, X.; Guo, Y.; Gu, J. In-situ fabrication of hetero-structured fillers to significantly enhance thermal conductivities of silicone rubber composite films. Composites Science and Technology, 2021, 210, 108799.