Dual network structures of PDMS based composite foam *via* anchoring liquid metal nanoparticles for improve thermal conductivity and electromagnetic interference shielding performances

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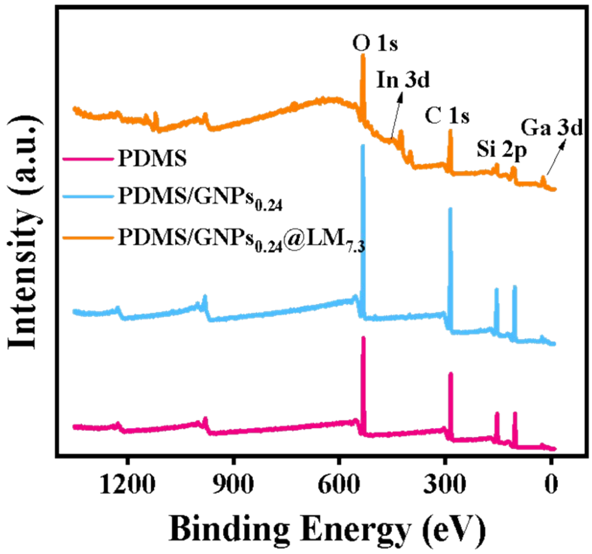

Fig. S1 XPS spectra of neat PDMS, PDMSGNPs$_{0.24}$, and PDMS/GNPs$_{0.24}$@LM$_{22.1}$ foam.

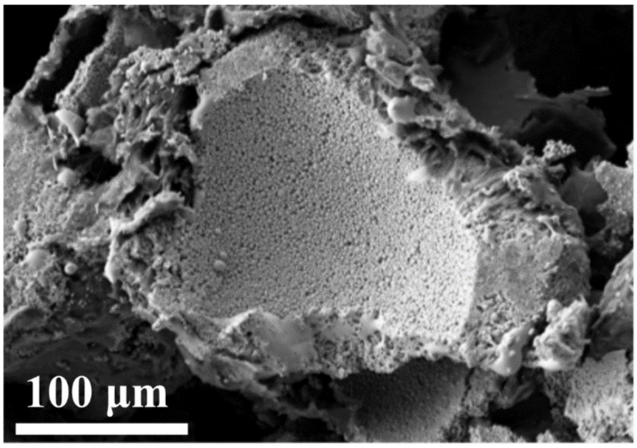

Fig. S2 SEM images of PDMS/GNPs$_{0.24}$@LM$_{22.1}$ foam.

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Table S1 The detailed information is listed of the thermal conductivity and corresponding thermal conductivity enhancement efficiency with a 3D network structure composite materials.

Sample	Filler content (vol%)	Thermal conductivity ($W/m^{-1}K^{-1}$)	φ	ref
EP/f-Al_2O_3	26.8	2.44	1184	15
3D-BN-C/EP	27.79	1.223	561	16
3D-OH-BN/EP	17.3	2.073	897	17
Ag-BNNS/AgNW/epoxy	27.08	0.804	136	18
3D-BN/PDMS	18.87	1.868	899	19
BN@UHMWPE	29.3	1.9	296	20
rGO@Al_2O_3/NR	18	0.514	206	21
EP/3D-BN	20.62	~0.55	206	22
h-BN/EP	23.78	~1.1	322	23
PDMS/GNPs@LM	22.34	0.74	1130	This work

Table S2 The detailed information is listed of the thermal conductivity and corresponding thermal conductivity enhancement efficiency with PDMS-based composite materials.

Sample	Filler content (vol%)	Thermal conductivity ($W/m^{-1}K^{-1}$)	φ	ref
m-BN@Al_2O_3/PDMS	60	2.23	1015	24
h-BN@(Ag/Cu)/PDMS	25	1.5645	682	25
BN@AgNWs/PDMS	20	0.914	480	26
MgO/PDMS	11.68	1.2	700	27
GO/MWCNT/PDMS	6	1.52	744	28
FPB/PDMS	3.8	0.7	367	29
MGF/GF/PDMS	2.7	1.08	440	30
Al_2O_3-ZnO/PDMS	40	1.185	577	31

3D-BN/PDMS	18.83	1.868	899	19
PDMS/GNPs@LM	22.34	0.74	1130	This work

Supplementary method-Finite Element Model

The heat transfer processes of the samples were modeled using COMSOL Multiphysics 5.6. Three types of composite foams, consisting of pure PDMS, PDMS/$GNPs_{0.24}$, and PDMS/$GNPs_{0.24}$@$LM_{22.1}$, were modeled with TC values set to 0.06, 0.3, and 0.74 W/$m^{-1}K^{-1}$, respectively. A transient-state finite element methodology was established, where the temperature at the bottom was fixed at 100°C, while all other external boundaries were fully insulated and had initial values set to room temperature (20°C). Based on experience, the convective heat flux was set to W/$m^{-1}K^{-1}$, and the ambient temperature and atmospheric pressure were set to 23°C and 1 atm, respectively. The rectangular model had dimensions of 31.2 cm × 21 cm.

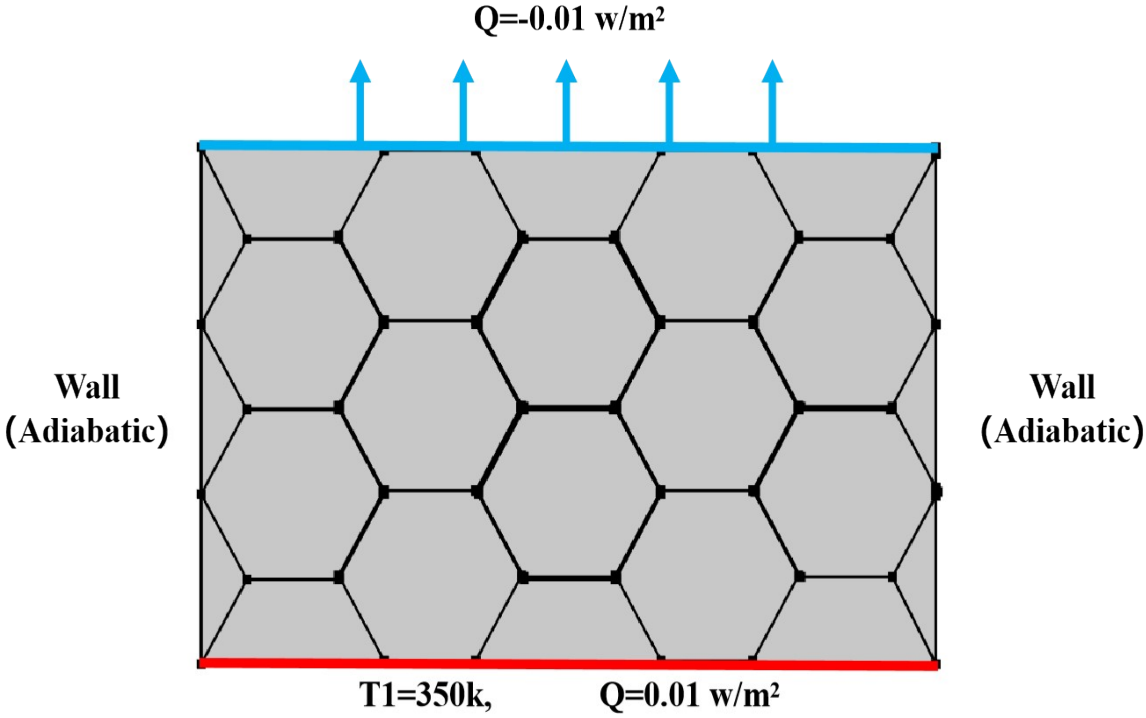

Fig. S3 Schematic of the boundary conditions for the simulation model.

Table S3 The detailed information is listed of the SE/t values with 3D structure composite materials.

Sample	Thickness (mm)	EMI SE (dB)	Normalized SE (dB mm^{-1})	ref
PF/Fe_3O_4@PPy	8	41.1	5.14	35
Epoxy/p-GA	2	35	17.50	36
PS/MWCNT	1.8	23.2	12.89	37
EHP/f-NCB/AgNS	3	49.7	16.57	38
MP@Ag/CW	4	47.1	11.78	39
AgFe-MF	5	69.61	13.92	40
LM/elastomer	10	70.5	7.05	14
Ni/rGO	4.5	53.11	11.80	21
CNT-Matrix/Cellulose	2.5	40	16.00	41
PDMS/GNPs@LM	2.16	40.81	18.89	this work