SUPPORTING INFORMATION

Effective Thermal Transport Highway Construction within Dielectric Polymer Composites via a Vacuum-assisted Infiltration Method

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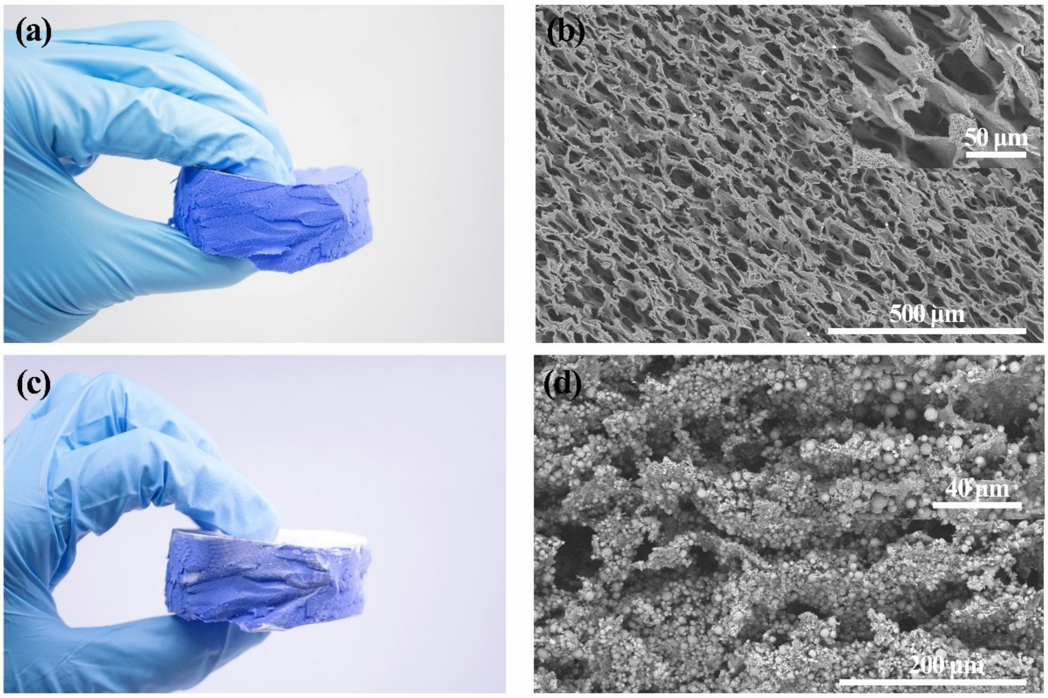

Fig. S1 (a) Photograph of raw PVA foam and (b) SEM images showing the microstructure of the raw foam. (c) Photograph of PVA foam after vacuum-assisted infiltration and before hot pressing and (d) SEM images showing the microstructure of the sample.

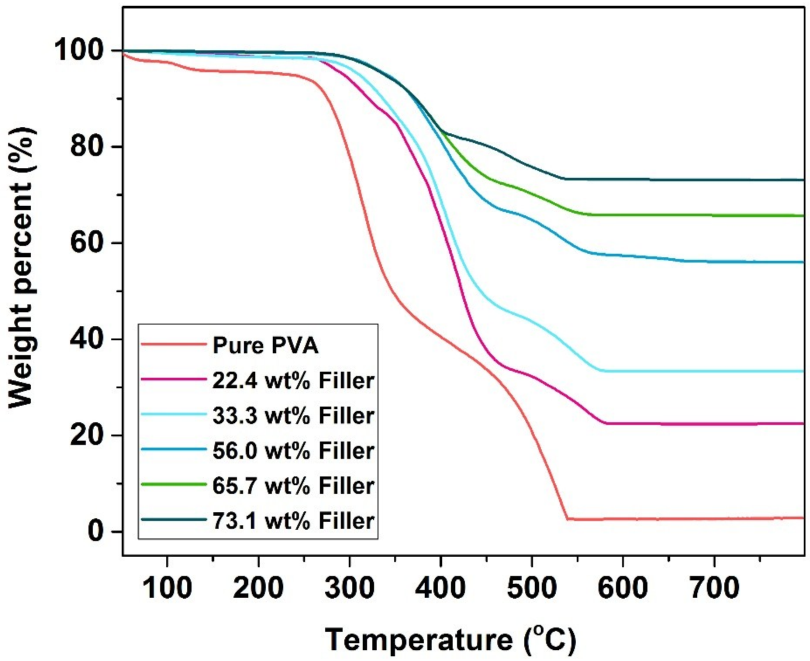

Figure S2. TGA curves of PVA and VIM composites

Table S1 Conversion of mass fraction into volume fraction and calculation method

	Al_2O_3 wt%	Al_2O_3 vol%
PVA	0	0
Composite 1	22.4	8.0
Composite 2	33.3	13.1
Composite 3	56.0	27.8
Composite 4	65.7	36.7
Composite 5	73.1	45.4

Calculation method:

Density at standard conditions: $\rho_1 = \rho_{Al2O3} = 3.97$ g/cm^3 $\rho_2 = \rho_{PVA} = 1.2$ g/cm^3

The volume fraction of Al_2O_3 filler is calculated through the equation:

$$Al_2O_3\ Vol\% = \frac{(wt\%)/\rho 1}{\frac{wt\%}{\rho 1} + (1 - wt\%)/\rho 2}$$

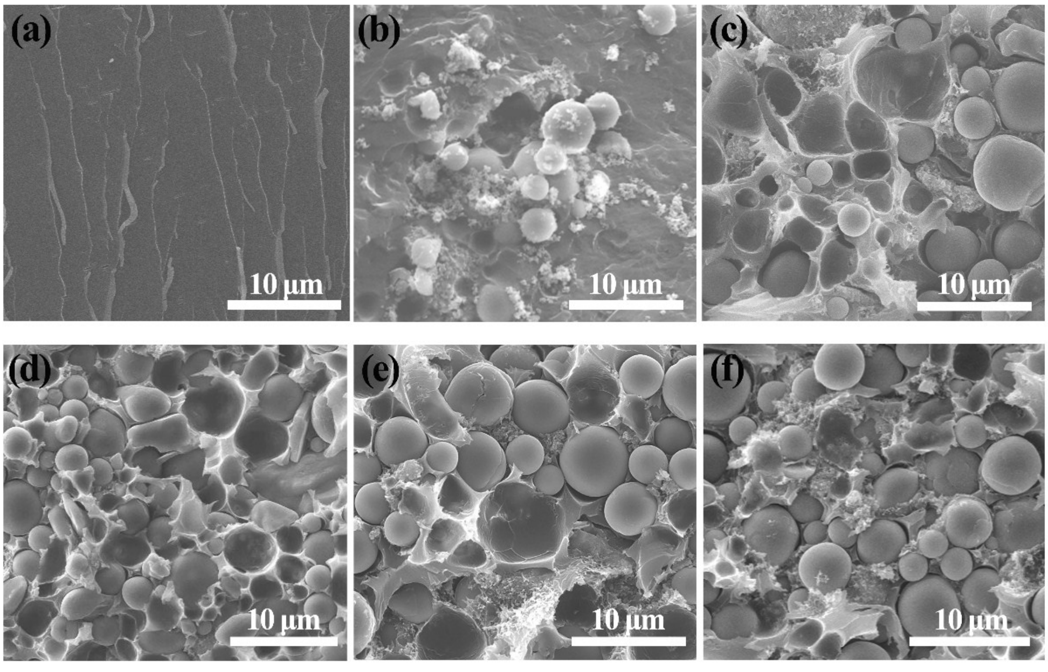

Fig. S3 Cross sectional SEM images of VIM composites with different Al_2O_3 content: (a) pure

PVA, (b) 8.0 vol%, (c) 13.1 vol%, (d) 27.8 vol%, (e) 36.7 vol%, (f) 45.4 vol%.

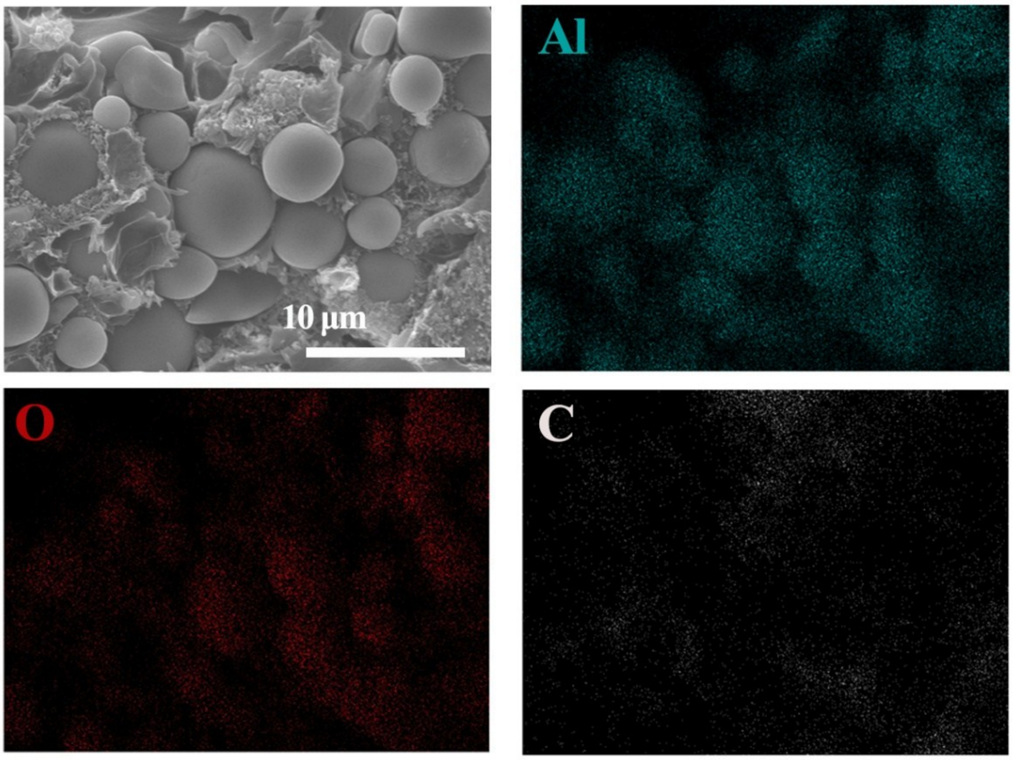

Fig. S4 EDX element mapping images of VIM composite for 45.4 vol% Al_2O_3 filler

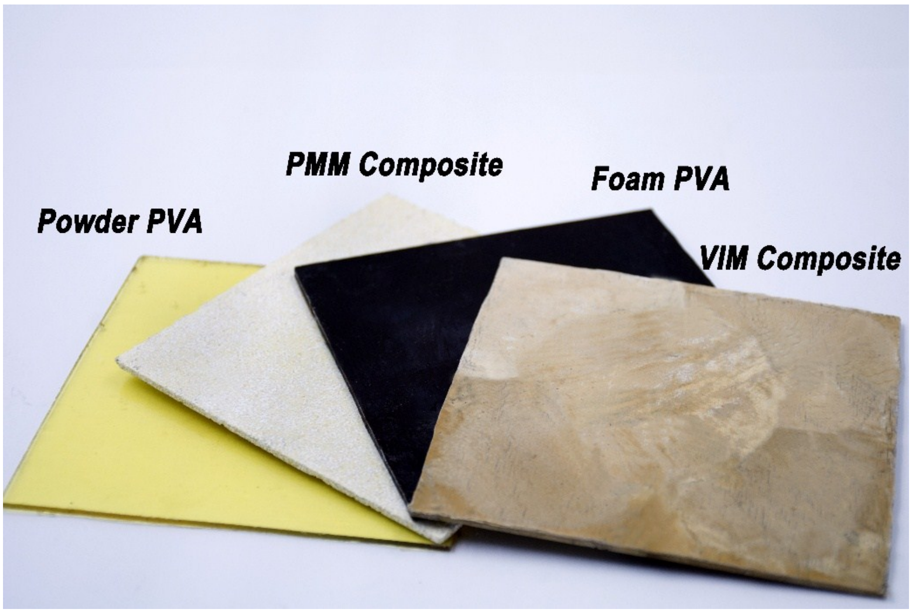

Fig. S5 Digital photography of samples prepared for insulation test

For meeting the sample size demand of dielectric breakdown strength and volume resistivity, foam PVA sheet (only hot pressing PVA foam), powder PVA sheet (only hot pressing PVA powder), PMM composite sheet (including 45.4 vol% Al_2O_3) and VIM composite sheet (including 45.4 vol% Al_2O_3) are prepared through hot pressing and the sizes of all the sheets are 10×10 cm^2. The reason why the foam PVA is not transparent as the powder PVA is that the dye within raw PVA foam is oxidized during hot pressing.

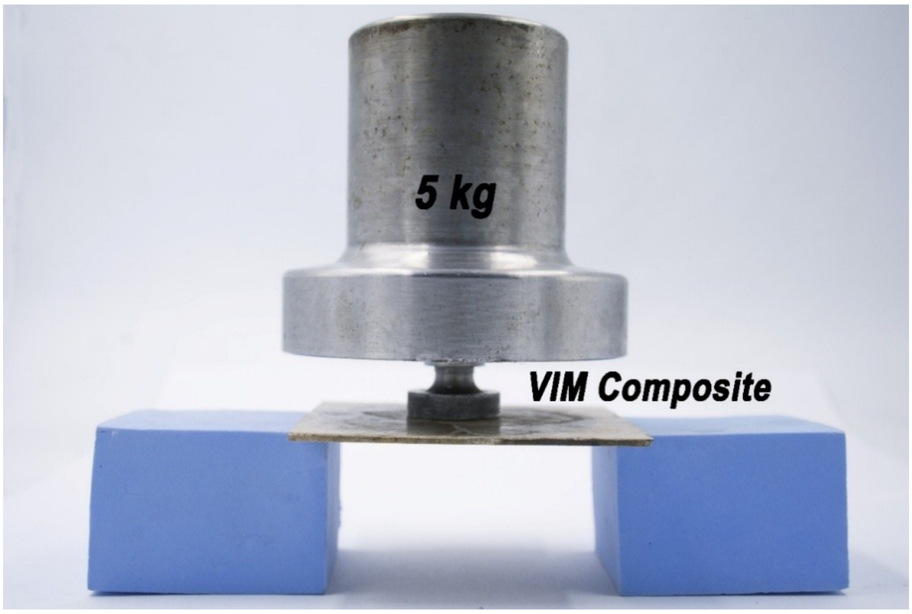

Fig. S6 Mechanic property of VIM composite sheet with 45.4 vol% Al_2O_3 content

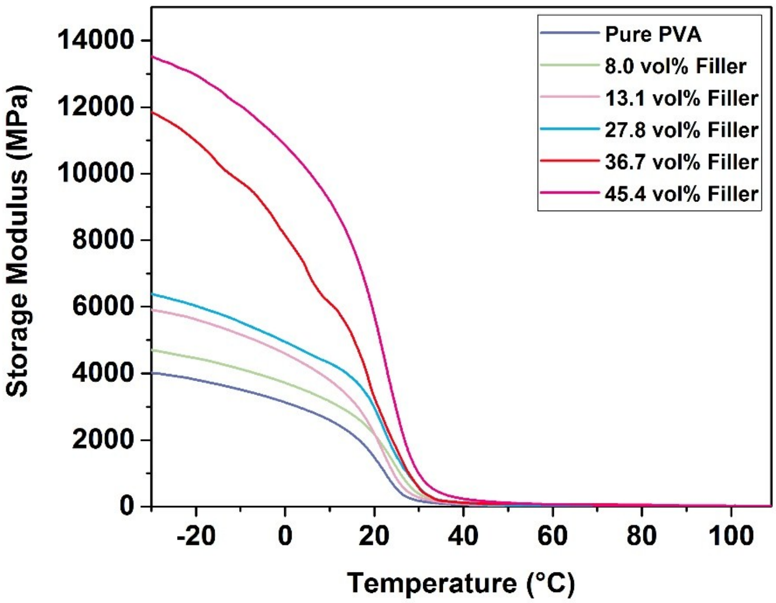

Fig. S7 Dynamic mechanical analysis of PVA and VIM composites

Dynamic mechanical analysis (DMA) measures the cyclic response of a material as a function of the temperature. The storage modulus represents the elastic modulus of plastic material and its recovery ability. The storage modulus of pure PVA and VIM composites from -30 ^oC to 100 ^oC are shown in Figure S6. It is displayed that the addition of Al_2O_3 results in an increase the storage modulus. The storage modulus of 45.4 vol% filler VIM composite is 13.5 GPa at -30 ^oC, while the value of pure PVA is 4.0 GPa. Therefore, the results indicate that Al_2O_3 filler can improve the stiffness of PVA matrix.