Supporting Information for

Supercritical CO_2-Foamed Polystyrene Composites Containing Wood-Derived BC for Sustainable Thermal Insulation

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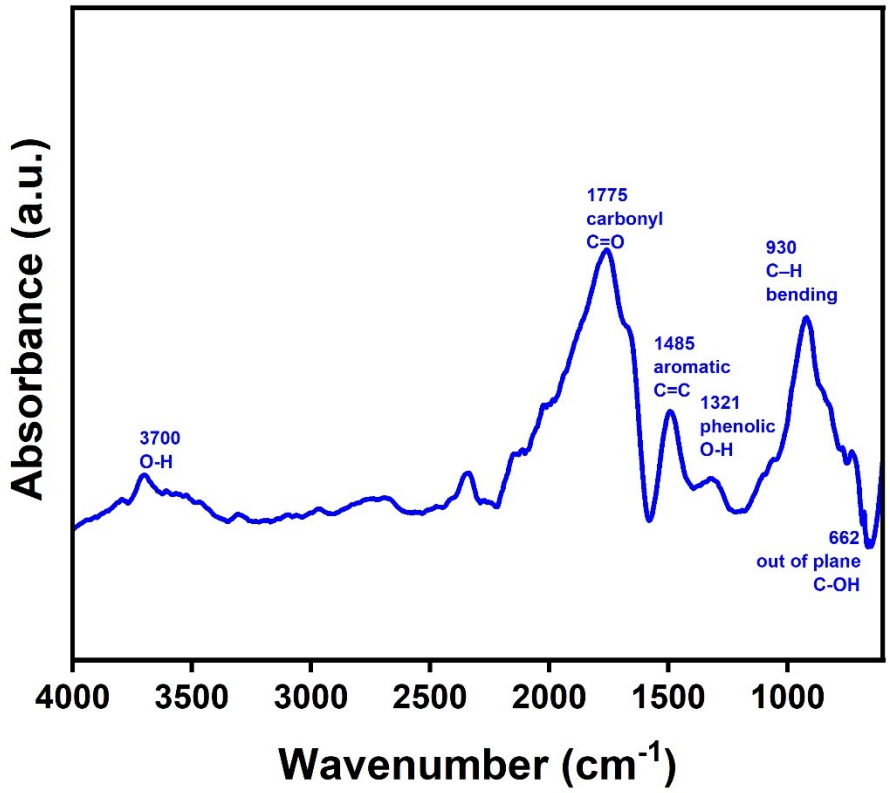

Fig. S1. FTIR spectra of oak and maple wood derived biochar

Table S1.

Surface properties and elemental composition of biochar

SSA (m^2/g)	PS (nm)	PV (cm^3/g)	Elemental composition (EDX)				
			C (%)	O (%)	Mg (%)	K (%)	Ca (%)
33	3.7	0.031	84.6	10.9	0.1	1.5	2.7

(Note: C; Carbon, O: Oxygen, Mg: Magnesium, K: Potassium, Ca: Calcium, SSA: specific surface area, PS: pore size, PV: pore volume)

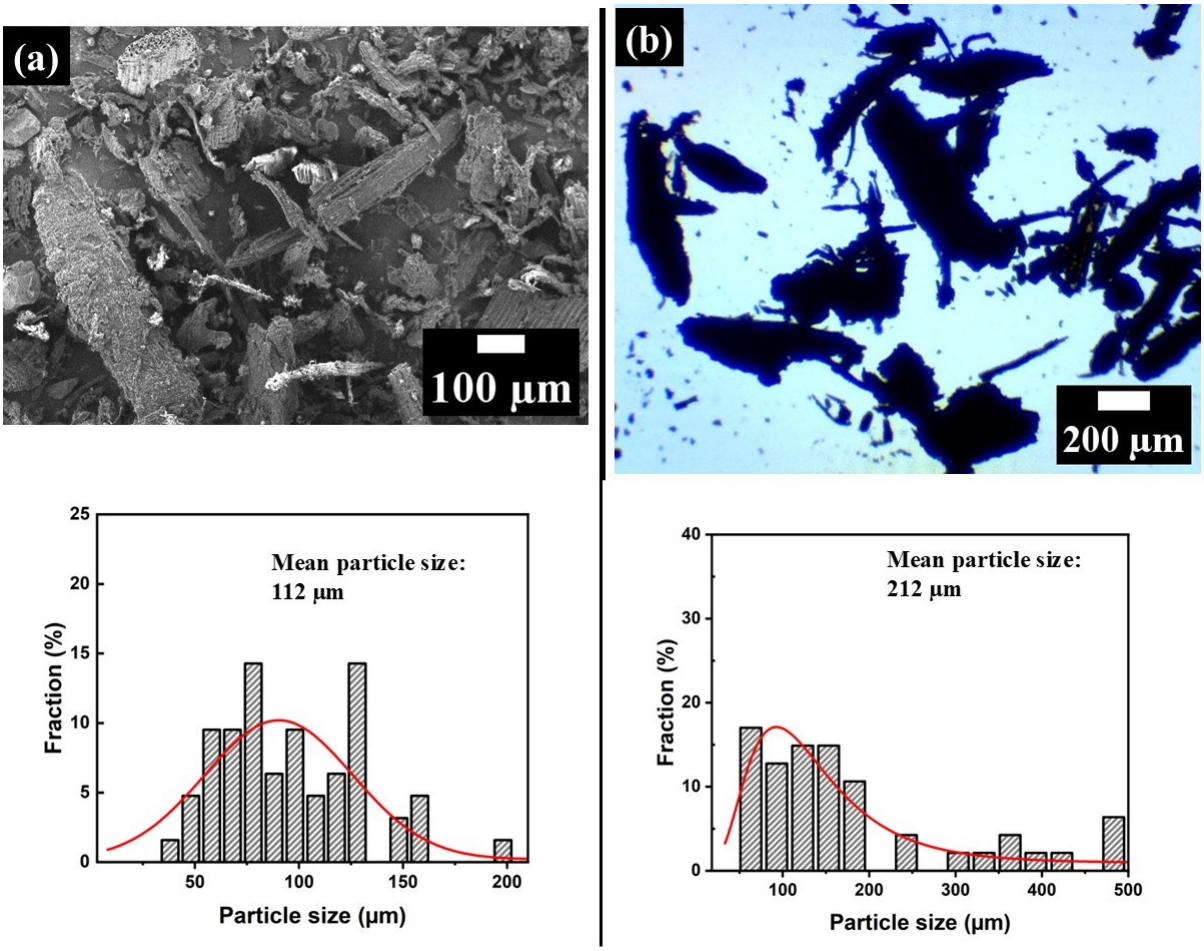

Fig. S2. Particle size analysis of wood derived biochar (a) SEM image and corresponding particle size distribution, (b) optical microscopy image and particle size distribution of ethanol-dispersed biochar.

Calculation of Global Warming Potential (GWP) of Foam Materials

GWP Calculation Formulae

$$\mathrm{GWP}_{\mathrm{total}} = \sum_{i} (w_i \times \mathrm{GWP}_i) \tag{1}$$

$$\mathrm{GWP}_{\text{per R - value}} = \frac{\mathrm{GWP}_{\mathrm{total}}}{R}$$ where

- w_i: weight fraction of material i
- GWP_i: literature GWP (kg CO_2 eq kg^{-1})
- R: measured or reported R-value of the foam

Table S2: GWP Values for individual materials and references

Material	**GWP (kg CO_2 eq kg^{-1})**	**Source**
Virgin PS	2.92	[1]
CO_2	1.0	[2]
HFC-152a	124	[3]
HFO-1234ze	1	[4]
Flame retardant (brominated)	2.4	[5]
Talc	0.4	[6]
Graphite	9.6	[7]
Biochar (oak/maple)	-1.2	[8]
Stearic acid	9	[9]
Graphene	8.5	[10]
Carbon black	400	[11]

Table S3: Sample Composition Data and Total GWP Calculation

	This work	**Previous work** (ref)	**Commercial foams**[12]	**Other academic work**
Virgin PS			86 to 89	
Blowing agent (CO_2, HFC, HFO, etc)	4	4	5 to 6	
Flame retardant	0	0	3	
Biochar	2.5	0	0	As reported in the literature.[13,14]
Additives (Talc, colorants, stearic acid)	1	1	3	
Graphene		1	0.8 to 1	
Carbon black		0	1	
Graphite		1	2.5	

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