Supporting Information

Thermally reliable, recyclable and malleable solid-solid phase-change materials through classical Diels-alder reaction for sustainable thermal energy storage

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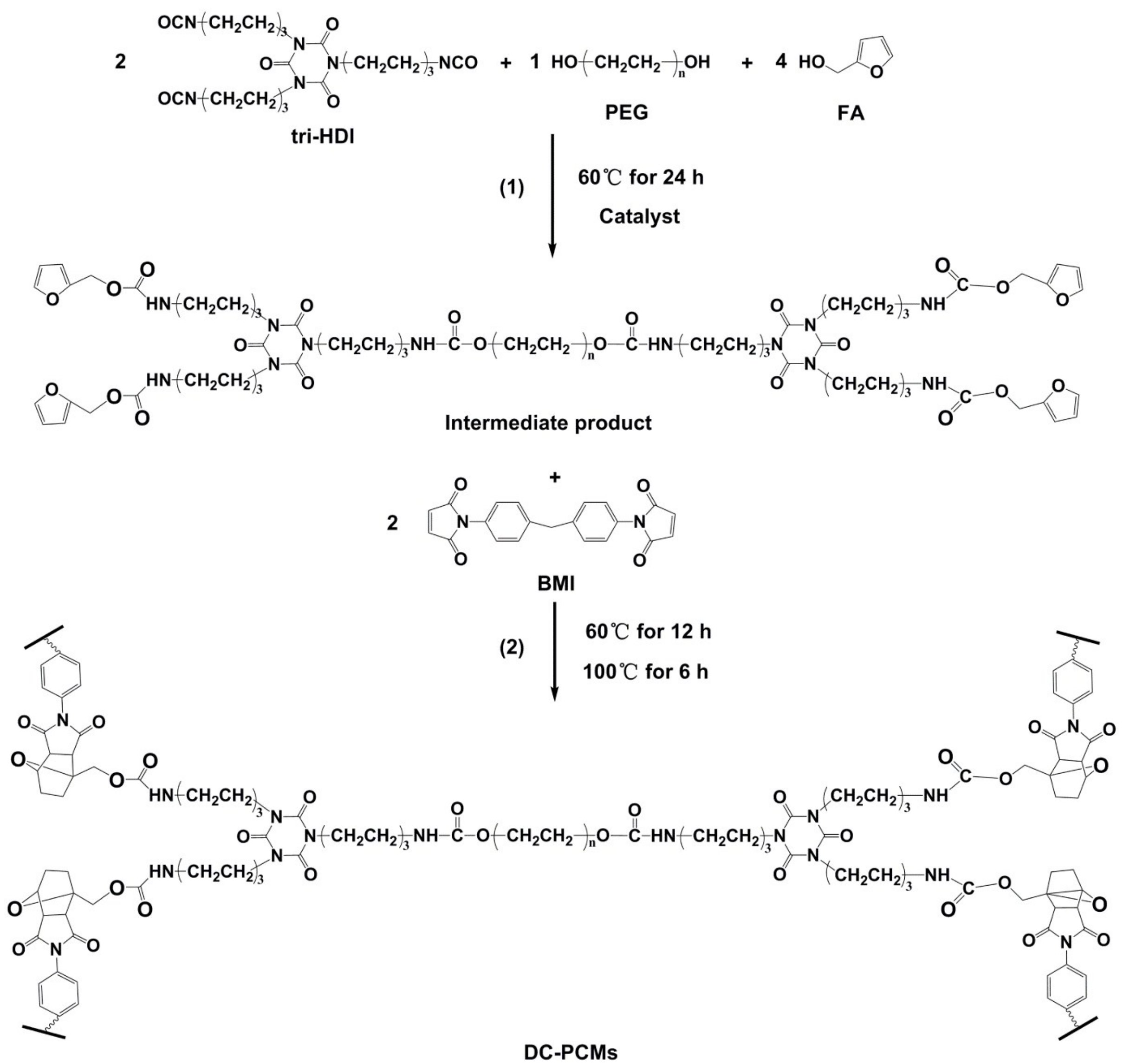
Table S1 Composition and gel fraction of SC-PCM4K, SC-PCM8K, SC-PCM20K and recyclable DC-PCM8K.

Samples	PEG	Furan alcohol	tri-HDI	Maleimide	Gel fraction
DC-PCM4K	PEG4K, 40 g	4 g	12 g	7 g	97.13%
DC-PCM8K	PEG8K, 80 g	4 g	12 g	7 g	97.42%
DC-PCM20K	PEG20K, 200g	4 g	12 g	7 g	87.13%



Scheme S1. Synthetic procedure to DC-PCMs by two-step polymerization via Diels-Alder reaction.

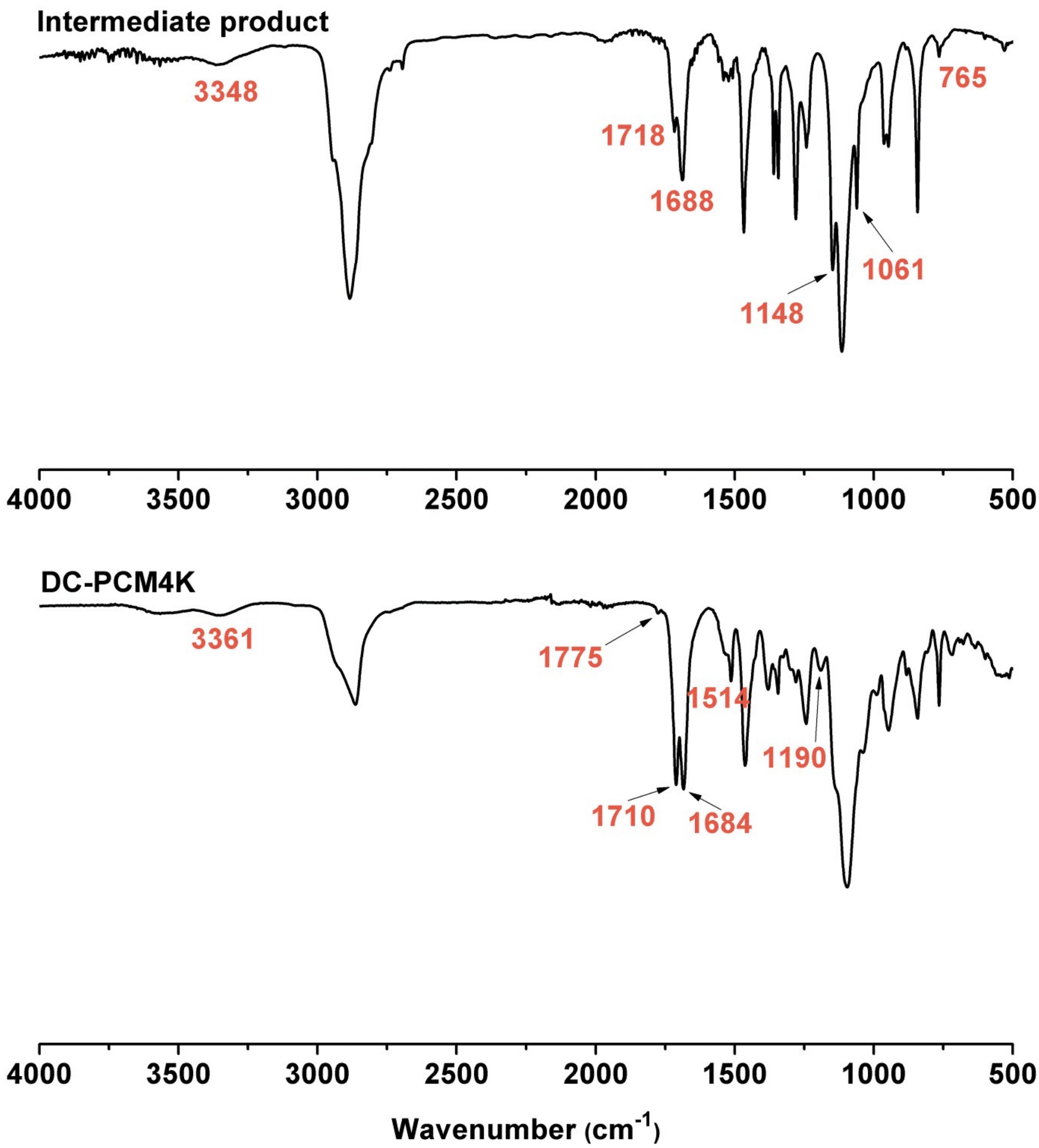


Fig. S1 FTIR diagrams of intermediate product and DC-PCM4K.

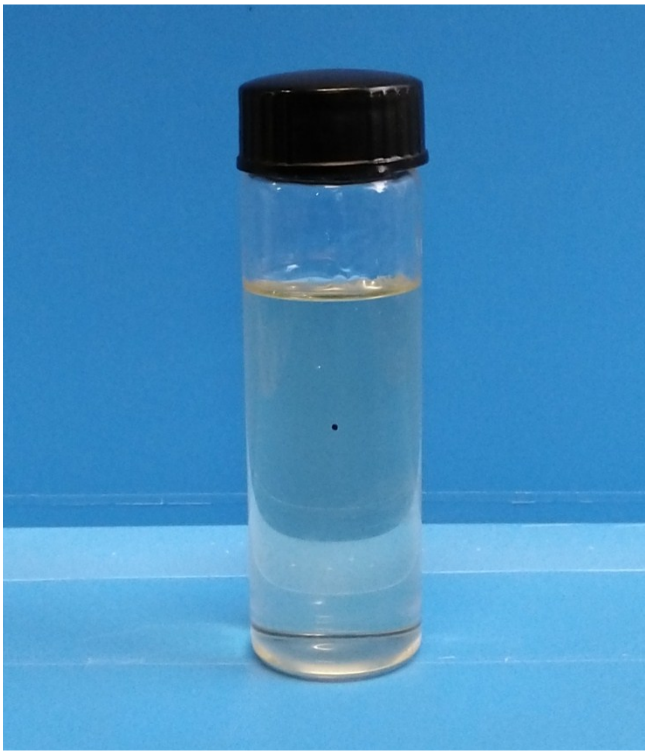


Fig. S2 Photographic images of intermediate product in chloroform. The obtained intermediate product after the first step is soluble in chloroform, indicating the absence of chemically cross-links.

Table S1 Comparison on thermal storage properties of DC-PCMs and some polymeric SSPCMs in the recent literatures.

Phase-change ingredients	Melting process		Freezing process		Ref.
	ΔH_m (J/g)	T_m (°C)	ΔH_f (J/g)	T_f (°C)	
1-octadecanethiol	70.5	36.5	65.1	25.1	1
PEG	98.2	49.9	102.0	38.4	2
PEG	106.1	48.5	104.3	43.6	3
PEG	117.7	51.4	109.0	42.3	4
PEG	107.5	59.7	102.9	44.0	5
PEG	40.8	46.4	-	-	6
MPEG	108.5	57.7	81.6	18.3	7
PEG	49.5	53.3	-	-	8
PEG	118.7	56.0	116.2	35.1	9
PEG	158.2	65.3	157.5	42.6	10
Hexadecanol	83.0	37.0	82.4	29.3	11
palmitic acid	39.8	19.2	39.2	18.7	12
PEG	87.8	71.0	107.2	39.2	Present work

ΔH_m and ΔH_f are the melting and freezing latent heat, respectively; Tm and Tf represent the melting and freezing temperatures, respectively.

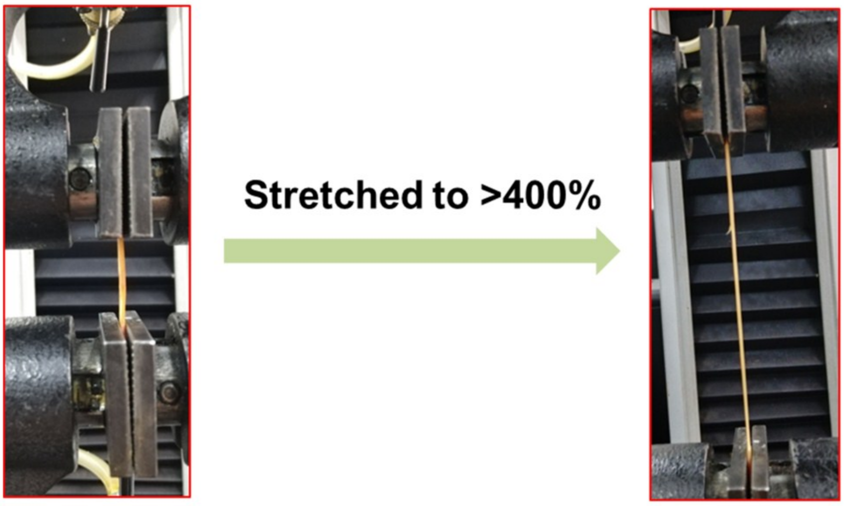


Fig. S3 Photographic images of a DC-PCM8K film before and after stretching.

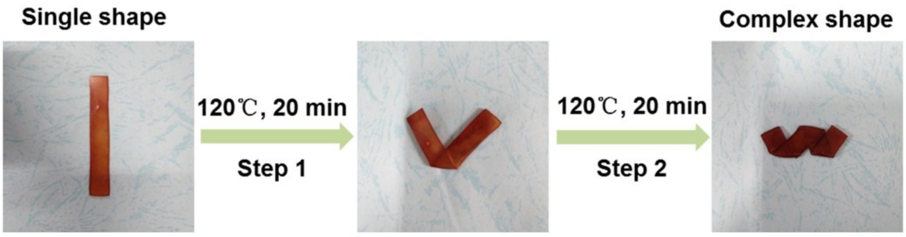


Fig. S4 The complex shape of DC-PCM8K can be achieved from single shape through two-step reshaping process, which indicates that the solid-state plasticity show a cumulative effect.

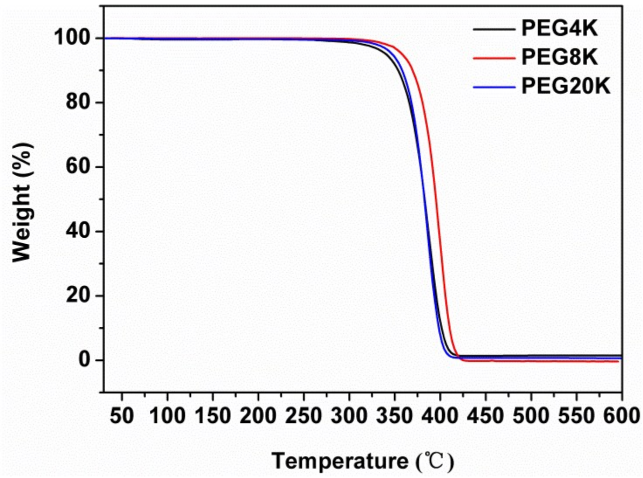


Fig. S5 TG diagrams of pure PEG4K, pure PEG8K and pure PG20K.

Table 3 Thermal stability properties of SA, PEG, PU and PU/SA composite PCMs

Sample	T_o (°C)	T_{max} (°C)	T_e (°C)	CR (%)
PEG4K	339.8	386.5	431.5	1.6
PEG8K	358.2	401.5	428.0	0.37
PEG20K	348.3	387.0	414.6	0.61
DC-PCM4K	282.6	408.7	471.8	10.5
DC-PCM8K	318.9	401.1	470.4	7.6
DC-PCM20K	355.4	394.8	462.7	4.3
Recycled DC-PCM8K	320.3	401.2	471.1	8.9

T_o is the initial decomposition temperature determined as the temperature of 5 wt% mass loss; T_{max} is the maximum decomposition temperature; T_e is the end decomposition temperature; CR is the mass ratio of char residue at 600°C.

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