Preparation and thermal properties of polyethylene glycol/expanded graphite as novel form-stable phase change material for indoor energy saving

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Part 1

Background and Significance

Background and Significance

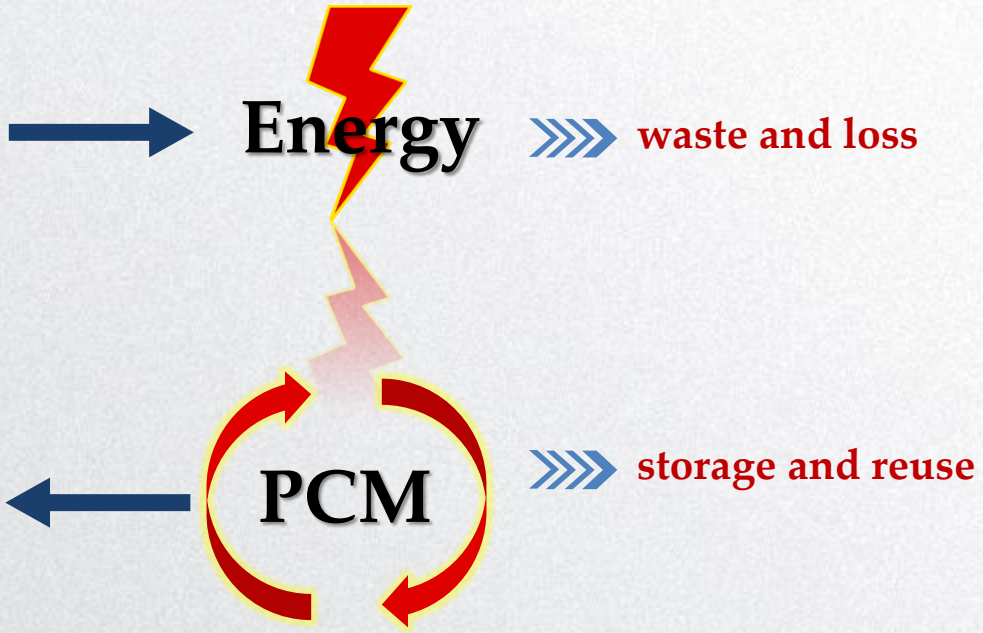
Thermal storage material, especially those using latent heat to store energy, has attracted unprecedented concern.



Energy crisis and climate change



Energy saving building materials



- higher thermal storage densities
- nearly isothermal process

Background and Significance

Advantages of PCMs

- Latent heat of phase transition
- High energy storage density
- Wide range of temperature
- Remarkable effect of heat storage

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Advantages of WPCs

- Green, low-carbon environmental
- Increasing the utilization of wood
- Renewable recycling
- Wide range of applications

✓ **Energy storage building materials**





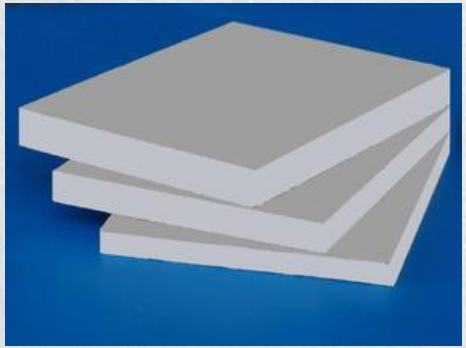
✓ **Energy storage furniture materials**





Background and Significance

The current application range:



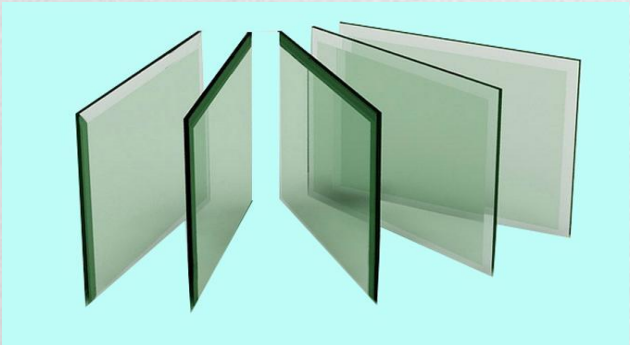
Phase change plasterboard



Phase change wood cement plate



Phase change concrete plate



Phase change glass



Energy saving floor board /geothermal floor board

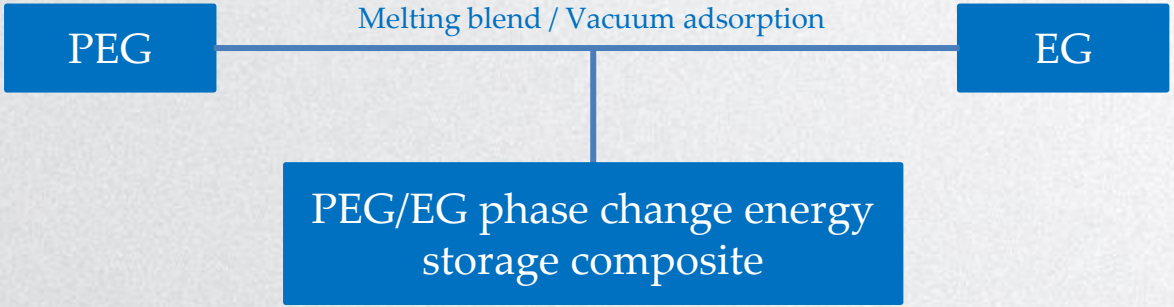


Part 2

Results and Discussion

Results and Discussion

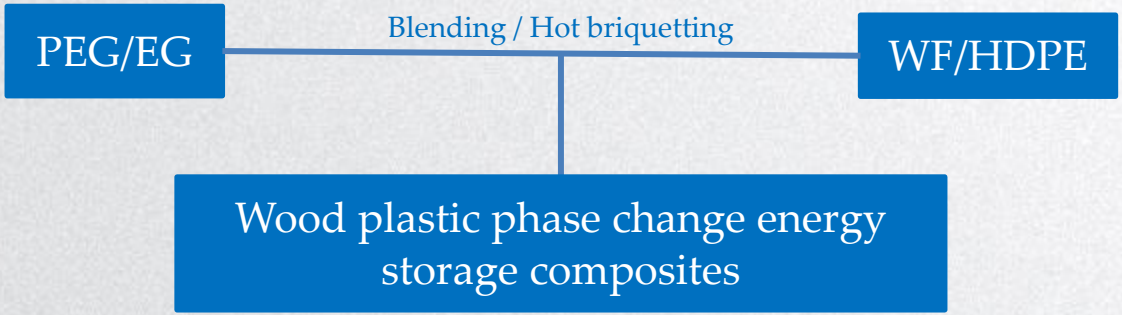
1.Preparation and characterization of polyethylene glycol / expanded graphite (PEG/EG) stabilized phase change energy storage material



- Composite materials used EG **as a fixed support material**.
- PEG/EG **interface structure and structure-activity relationship** were analyzed.
- **Stereotyped and efficient** phase change thermal storage system was **controlled and established**.

Results and Discussion

2.Preparation and properties of wood plastic composite phase change energy storage materials

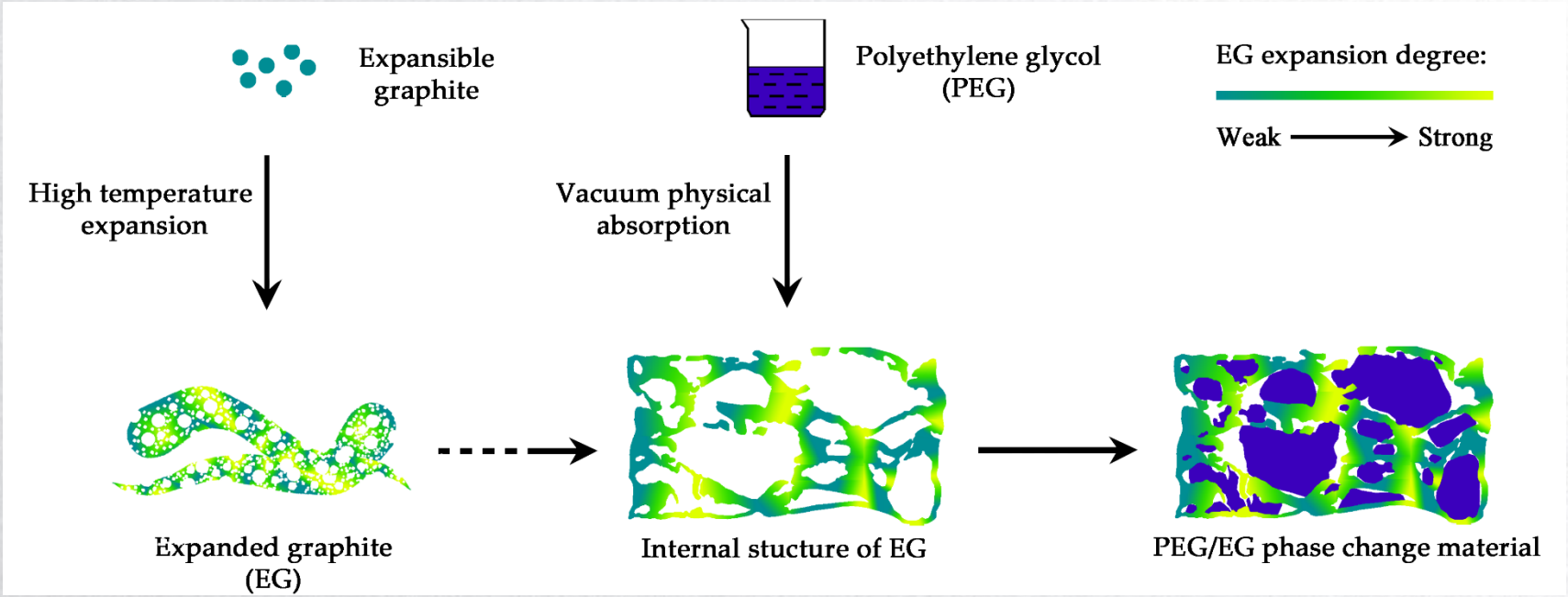


- Interface structure and optimization of **energy storage efficiency** of wood and phase change materials were regulated and controlled by pretreatment and processing technology.
- Micro structure and energy storage indexes of wood plastic phase change energy storage composites were characterized.
- The **energy storage mechanism** of wood composite phase change energy storage materials is analyzed.

Results and Discussion

Preparation process of PEG/EG phase change energy storage composites

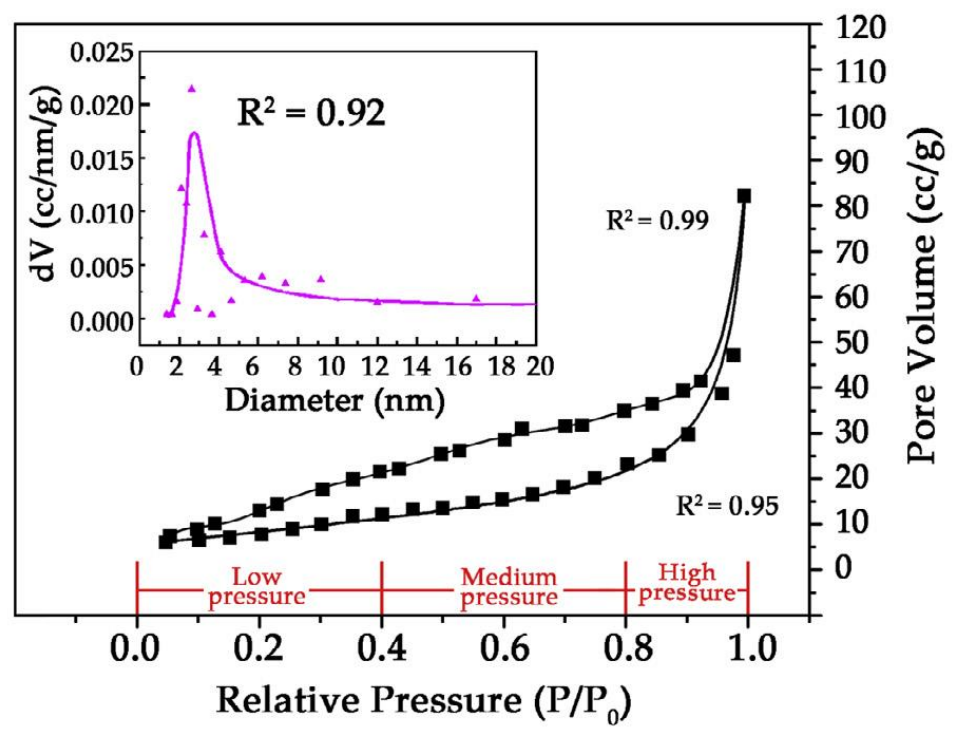
Methods: high-temperature expansion and vacuum adsorption



The synthetic route of PEG/EG PCM

Results and Discussion

Pore structure analysis of EG



The nitrogen adsorption/desorption isotherm and cumulative pore area versus and diameter curves of EG

- **EG possesses a wide meso-porous aperture distribution**

  (the aperture is concentrated in 1-10nm)

- **Large specific surface area**
- **Strong adsorption capacity**

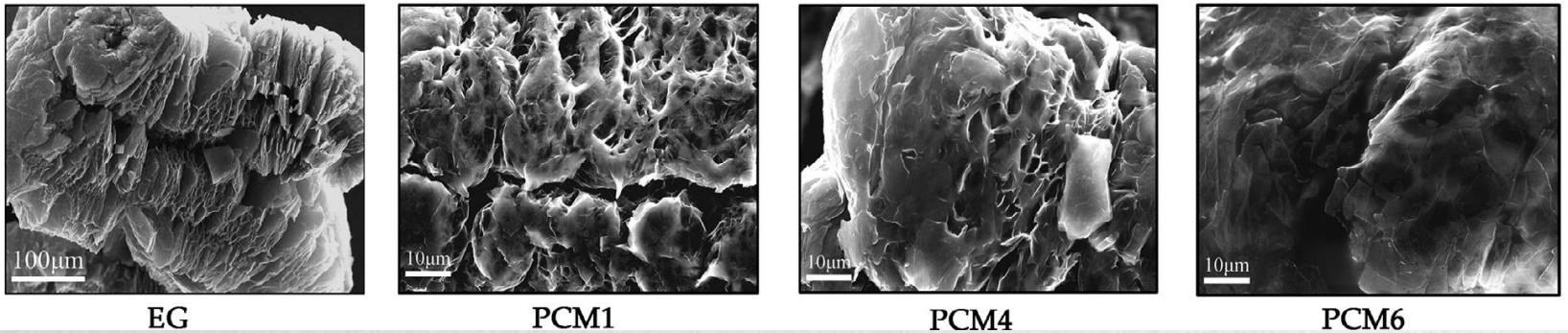
  (EG possessed powerful adsorption ability, which was advantageous for PEG to prepare phase change functional material)

Results and Discussion

Micromorphology characterization and leakage test of PEG/EG phase change energy storage composites

Sample	m_{PEG}: m_{EG}	Before treatment / g	After treatment / g	Mass loss rate / %
PCM1	6:1	0.5	0.4986	0.29
PCM2	7:1	0.5	0.4982	0.36
PCM3	8:1	0.5	0.4984	0.32
PCM4	9:1	0.5	0.4986	0.29
PCM5	10:1	0.5	0.4969	0.62
PCM6	11:1	0.5	0.4955	0.90

Comprehensive the economic material ratio and preferable permeability, **the relatively better ratio** of PEG and EG for PCM preparation was **9:1**

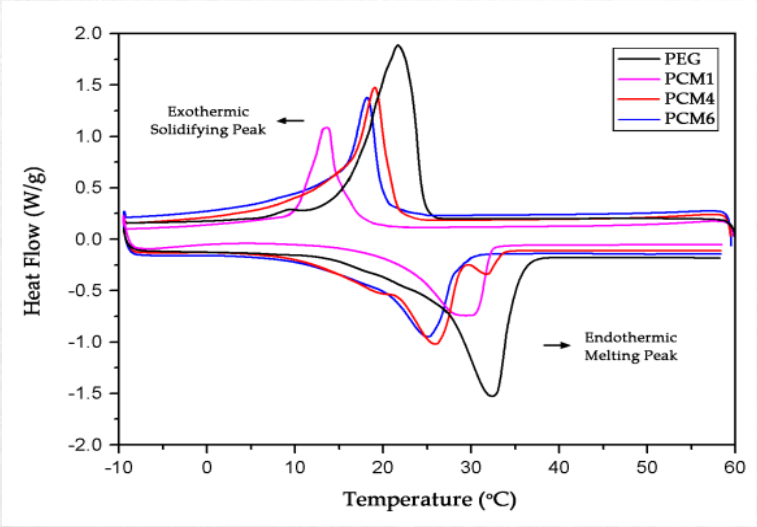


SEM images of EG, PCM1, PCM4 and PCM6

Results and Discussion

Thermal properties of PEG/EG phase change energy storage composites

Sample	Solidifying			Melting		
	Phase transition temperature/°C	Peak Temperature/°C	Latent Heat/J·g^{-1}	Phase transition temperature/°C	Peak Temperature/ °C	Latent Heat/J·g^{-1}
PEG	24.57	21.69	130.3	25.39	32.39	133.6
PCM1	13.35	12.55	81.5	21.65	30.06	78.06
PCM4	21.10	19.09	97.56	18.89	25.93	98.59
PCM6	20.18	18.74	95.03	17.14	25.81	98.28

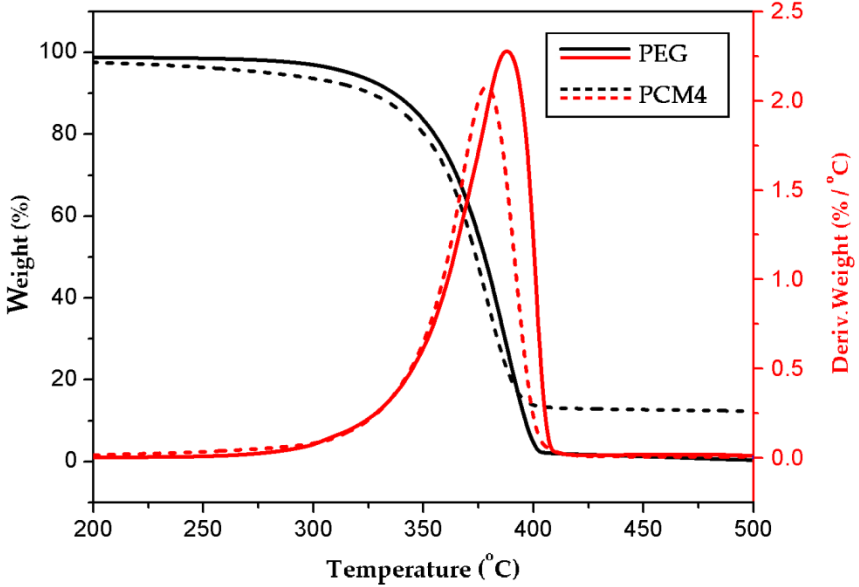


The PEG/EG PCM possessed favorable thermal properties and temperature range for indoor energy saving.

- EG had good thermal conductivity and this increased the speed of phase changing process.
- PEG/EG PCM owns the potential for indoor functional composites application.

Results and Discussion

Thermal Stability of PEG/EG phase change energy storage composites



TG and DTG curves of PEG and PEG/EG PCM samples

- **The superior thermal conductivity of EG**
- **"Pressure Cooker" action**

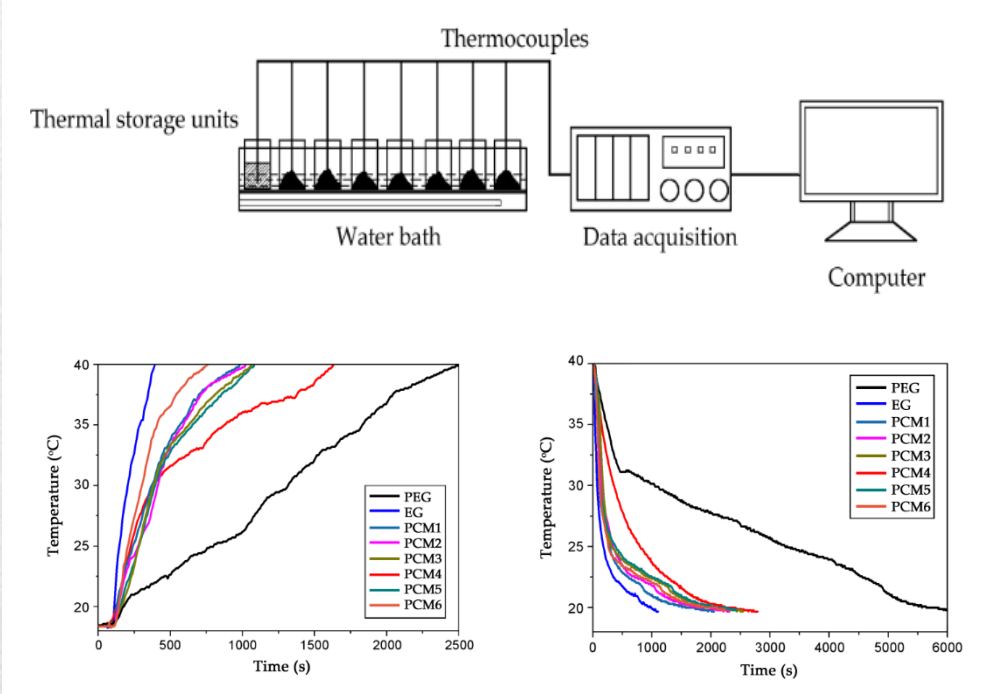
(the practical temperature in pores was higher than the apparent temperature.)

Results and Discussion

Thermal storage/release efficiency of PEG/EG phase change energy storage composites

- Time of PCM4 had been shortened 27.31% during thermal storage process, while time was saved 60.5% during thermal releasing process.

- **The preferable thermal conductivity of EG improved the thermal storage efficiency.**





Part 3

Conclusion and Prospection

Conclusion and Prospection

Conclusion

- EG possessed mesoporous structure made PCM obtained excellent sealing performance.
- The PEG/EG PCM possessed favorable thermal properties and a suitable temperature range for indoor energy saving.
- it performed great thermal stability and the addition of EG improved the thermal storage efficiency.

- **Consequently the PEG/EG PCM prepared in this work will be an excellent energy-storing material and has a promising application for indoor use in the future.**

Prospection

- **Combination of phase change energy storage materials and wood composites**

It not only meets building energy saving, but can adapt to the prevailing trend of wooden materials for furniture and interior decoration.

- **Reduce ambient temperature fluctuations**
- **Improve the comfort of the thermal environment**

It is a new type of material with great potential for development.

THANKS

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