Electronic Supplementary Information

Temperature-humidity dual regulation of a single-core-double-shell microcapsule fabricated by electrostatic-assembly and chemical precipitation

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Fig.S1. Digital photos of the prepared microcapsules

All of the prepared microcapsules were powder and the color became darker as the amount of GO increased, indicating the successful introduction of GO into microcapsules.

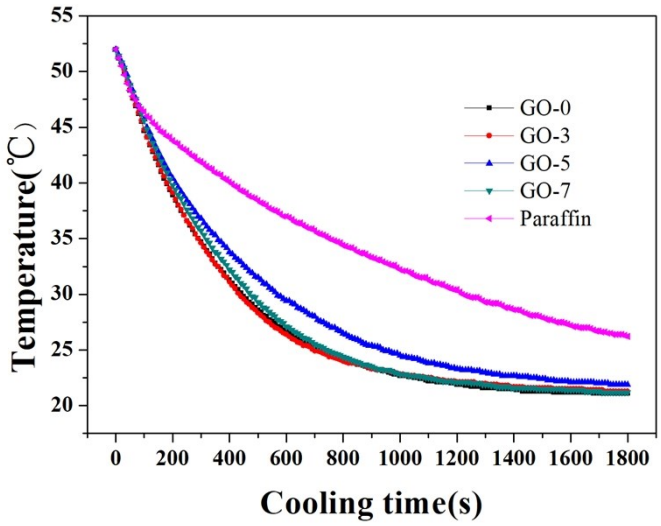

Fig. S2. Cooling curve of paraffin and the prepared microcapsules

A test tube containing 1g of microcapsules was placed in water bath and heated to 52 ° C. Then temperature of sample fell to room temperature and was recorded every 20 s to obtain a temperature-dependent cooling curve.

For all the samples, the temperature dropped rapidly from 52 to 47 ℃ before 60 s and the curves were similar. In this stage, there was no phase change and the temperature changed according to the environment condition. After 60 s, the cooling curve of paraffin appeared slower platform stage, this phenomenon may be ascribed to the composition of paraffin containing liquid paraffin and solid paraffin, and the mixed paraffin began to melt around 47 ℃. However, compared with paraffin, temperature of the microcapsules with different GO the decreased faster. The cooling rate of GO-5 was close to that of paraffin. The cooling curves of GO-0, GO-3 and GO-7 were were not significantly different. This may be explained by the fact that the lower content of paraffin in microcapsules would lead to an unobvious phase change process. Such result was consistent with the data of DSC and showed that microcapsule had the property of phase change temperature regulation.

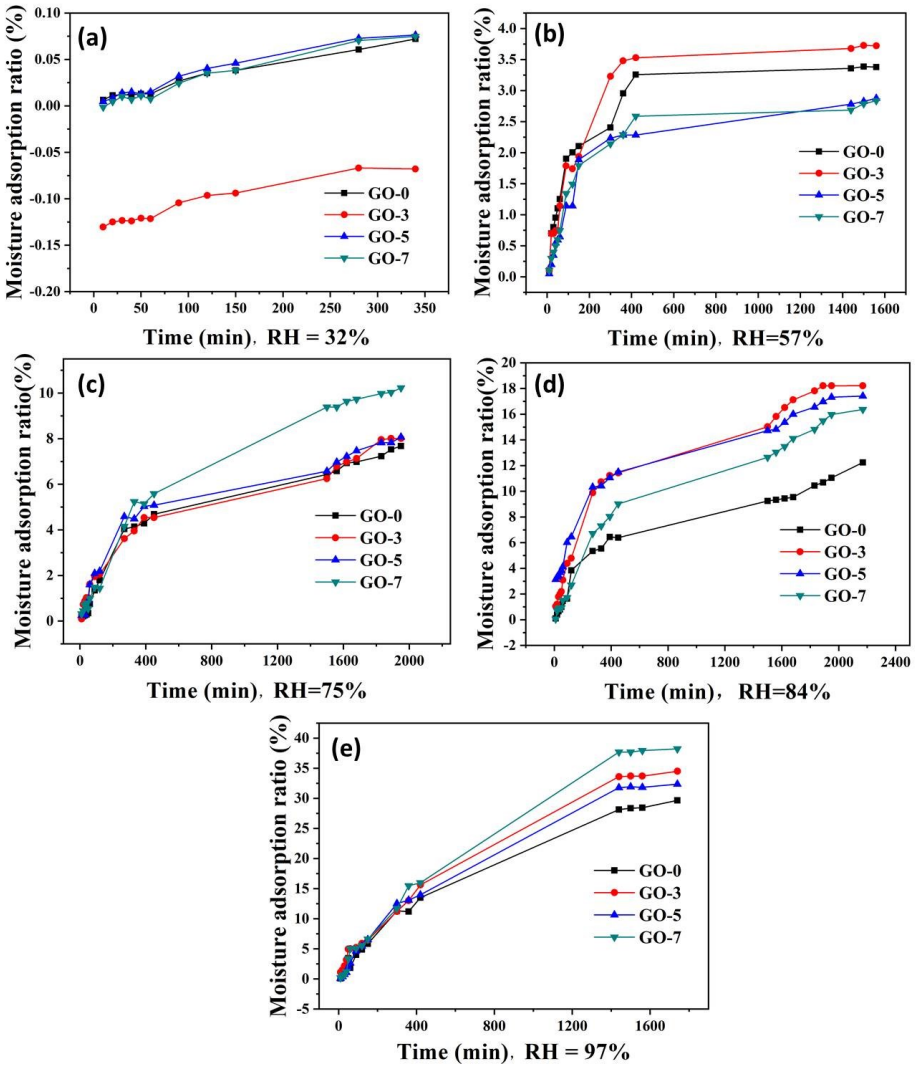

Fig. S3. Moisture adsorption ratio of the prepared microcapsules at different relative humidity

The moisture adsorption rate of microcapsules under different relative humidity was shown in Figure S3a-e. The moisture adsorption ratio and equilibration time of microcapsules increased with the increase of relative humidity. Under the condition of lower relative humidity (RH = 32%, 57%), the moisture adsorption ratio of microcapsule was small and reached the equilibrium soon. Under the higher relative humidity condition (RH = 75%, 84%, 97%), the moisture adsorption contents increase faster, while the adsorption rates of the microcapsules with GO were more than that of GO-0. The results indicated that the as-prepared microcapsules had the ability to adsorb moisture under different humidity conditions.

Performance comparison of the as-prepared microcapsules with its raw materials and the literature was shown in Table S1.

Table S1. Comparison of temperature/humidity regulation properties of different referred materials

Referred materials	Moisture adsorption content at RH=75% (mg/g)	Phase change properties
our microcapsule (GO-5)	80	yes
chitosan	16.18	no
SiO_2	28.8	no
paraffin	8.73	yes
Paraffin@SiO_2 microcapsule [1]	no	yes

[1] R.L. Luo, S.F. Wang, T.Y. Wang, C.Y. Zhu, T. Nomura, T. Akiyama, *Energ. Build.,* 2015, **108**, 373–380.

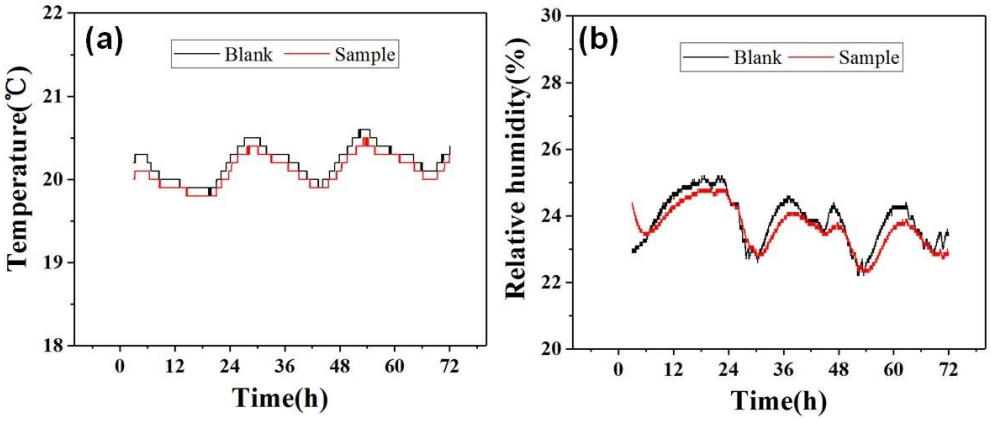

Fig. S4. The temperature and humidity regulation of GO-5 at the real laboratory environment with a relative constant temperature and a low humidity.

The temperature and humidity regulation in simulated environment was carried out as following. Sample GO-5 was placed in a tiny container as a real environment and the blank without sample was performed under the same conditions. The probes of the temperature and humidity recorder were inserted into the container to detect temperature and humidity changes. The experiment was carried out in at the real laboratory condition. The results are shown in Fig. S4. Both the temperature and humidity difference between the blank and sample were not significant.

This is because the laboratory temperature has not reached the phase change temperature of the paraffin in the core of microcapsule. There is no phase transition of paraffin at this temperature. The similar phenomenon occurred to humidity regulation due to no adsorption of moisture at the low relative humidity of environment.