Supporting Information

Synthesis of tunable thickness-to-diameter ratio microcapsules via a diffusion-controlled process for temperature-responsive release

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Core Content of DB@PU. The content of DB in PU (α) is determined by elemental analyzer [1]. S element completely comes from the core material and their amount remains unchanged after combustion. So, the core content is calculated by the following formula:

$$\alpha = \frac{Mr(\mathrm{DB})}{2 \times Ar(S)} \times S_{\mathrm{EA}} \times 100\%$$

where Mr is the relative molecular mass, Ar is the relative atomic mass, and S_{EA} is the percentage of S element in elemental analyzer, respectively.

Table S1. Different preparation formulas of PU microcapsules and DB@PU

Sample	Ethyl acetate (mL)	Petroleum ether (mL)	DB (g)	Thickness (μm)	Diameter (μm)	T/D	T_g (℃)	Core content (%)
PU1	30.0	20.0	-	1.32	12.7	0.104	180	-
PU2	25.0	25.0	-	0.63	12.6	0.050	178	-
PU3	20.0	30.0	-	0.46	12.4	0.037	177	-
PU4	10.0	40.0	-	0.31	14.1	0.022	169	-
DB@PU	30.0	20.0	20.0	-	13.5	-	-	43.49

Table S2 Formulation of PVC composites.

Parameter	Score (phr)
PVC	100
Calcium-zinc Stabilizer	8.54
DB@PU	3
MgO	6

Measurement of Hydroquinone Standard Curve. 1 g of hydroquinone was added to 100 mL of ethyl acetate to make a solution, and then 0.01 mL-0.1 mL of the solution was taken sequentially with a gradient of 0.01 mL and diluted with 10 mL of ethyl acetate to make a standard curve in Fig. S1b.

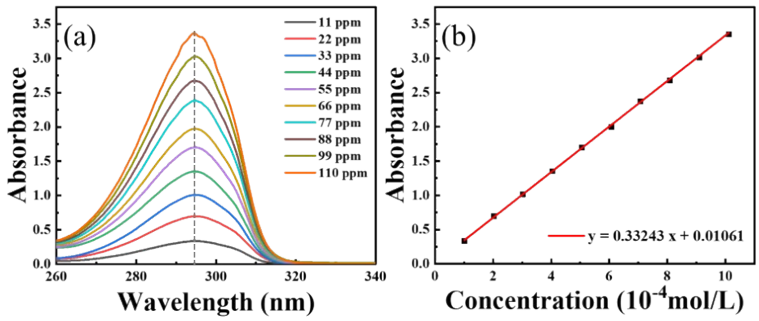

Fig. S1 Standard curve between the concentration of hydroquinone and absorbance.

The T_g of Microcapsules at Different Monomers. During the synthesis of this process, the monomers for the pre-polymerization reaction as well as the chain expansion reaction were changed, respectively. And the T_g of microcapsules was shown in Fig. S2. The results indicated that the T_g of microcapsules increased with the increase in monomer rigidity and was in the range of 155-189°C.

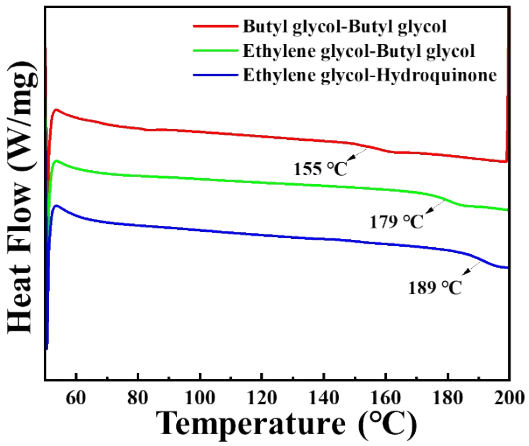

Fig. S2 The T_g of microcapsules at different monomers.

When the pre-polymerization monomer is ethylene glycol and the chain expansion monomer is butyl glycol, ethylene glycol-butyl glycol is named.

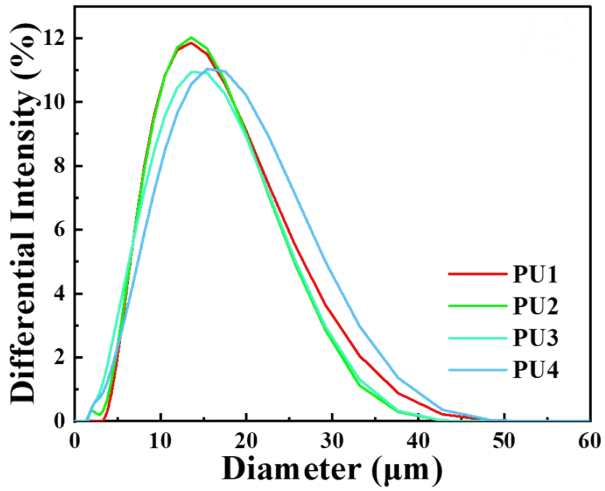

Fig. S3 Particle size distribution of synthesized microcapsules under the compounded solvents.

The thermal stability of DB@PU. The TGA results shown that the initial decomposition temperature of PU was about 250℃ in Fig. S4 indicating excellent thermal stability during PVC processing. Comparing the weight loss curves of crosslinking agents before and after encapsulated, crosslinking agents and PU had about 80% mass loss in the range of 200°C-400°C, while DB@PU had 50% mass loss in the same range. The results confirmed that PU and crosslinking agent demonstrated in poor thermal stability, and DB@PU had excellent thermal stability. From what is stated above, the thermal stability of crosslinking agents was improved by encapsulation, indicating that the dense PU layer had an inhibitory effect on decomposition.

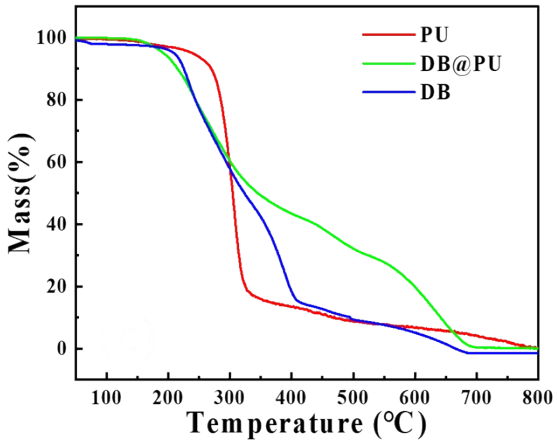

Fig. S4 Heat weight loss of PU, DB and DB@PU.

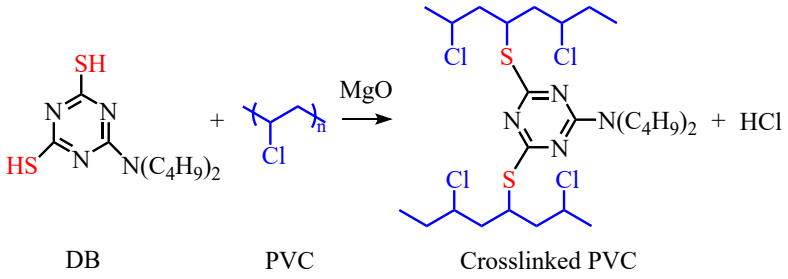

Fig. S5 The process of the PVC chemical crosslinking reaction.

Author contributions

Data curation, J.Z. and Chun Li; formal analysis, J.Z., Chun Li and J.S.; investigation, J.Z., J.S. and T.F.; conceptualization, Chun Li, X.C. and W.Z.; methodology, J.Z., Chonghui Li and H.X.; resources, W.Z.; software, Chonghui Li, L.L. and H.X.; writing—original draft, J.Z. and T.F.; writing—review and editing, J.Z., Chun Li, L.L., W.Z. and All authors have read and agreed to the published version of the manuscript.

Conflicts of interest

There are no conflicts to declare.

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References

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