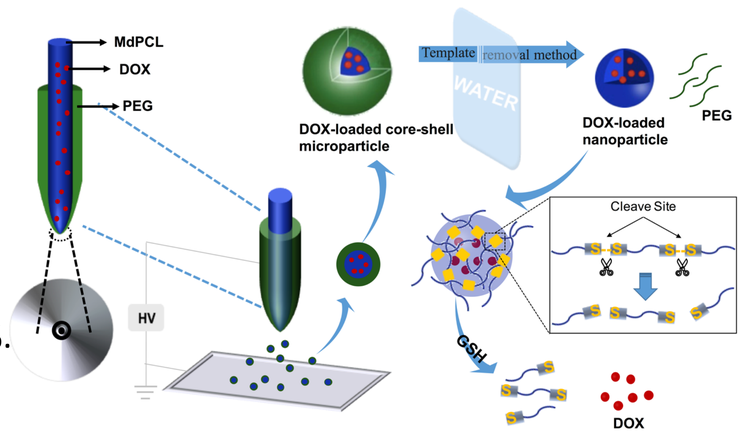
Preparation of Redox-respongsive Nanoparticles Using Coaxial Electrospray Template Removal Method

Huafeng Dai [a], Li-Qun Wang [a, *]

[a] *MOE Key Laboratory of Macromolecular Synthesis and Functionalization, Department of Polymer Science and Engineering, Zhejiang University, Hangzhou 310027, China*

Abstract:

In this work, the redox-responsive particles with core-shell structure were prepared by the coaxial electrospray technique. The PEG was regarded as the shell material. Polycaprolactone with the multiple-disulfide bonds included in the main chain (MDPCL) was synthesized and used as the core of particles. It was proved that the polymer can be degraded rapidly within 25mM dithiothreitol (DTT), suggesting that the particles could potentially be used as the drug controlled release carriers with redox-responsive property. It was estimated that the drug-loaded nanoparticles whose mean diameter was less than 100nm can be approached by coaxial electrospray template removal method , while the drug-loaded efficiency can be 100%. Meanwhile, under the condition of L-Glutathione (GSH), the content of the cumulative drug release could be up to 80% within 12h, given the temperature of 37 ℃.



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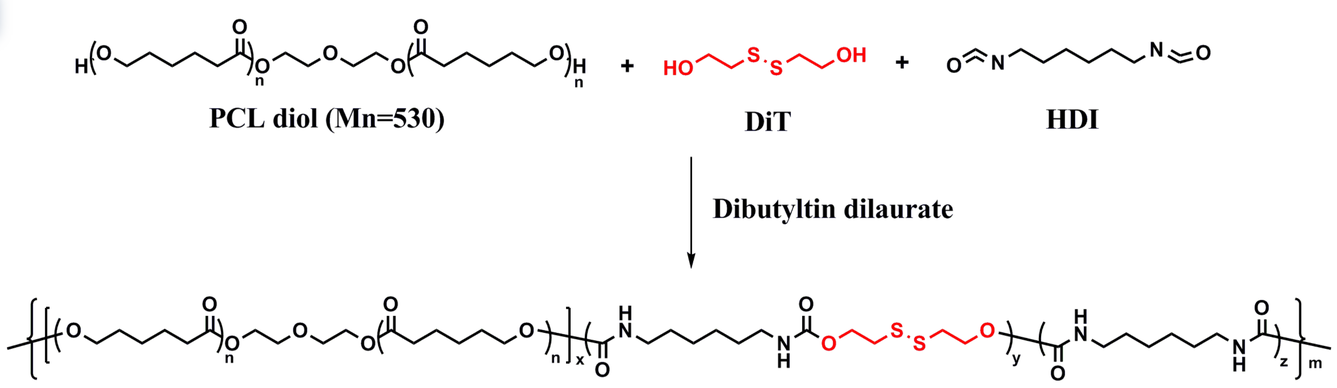

Scheme 1 Synthesis of multiple-disulfide bond polycaprolactone

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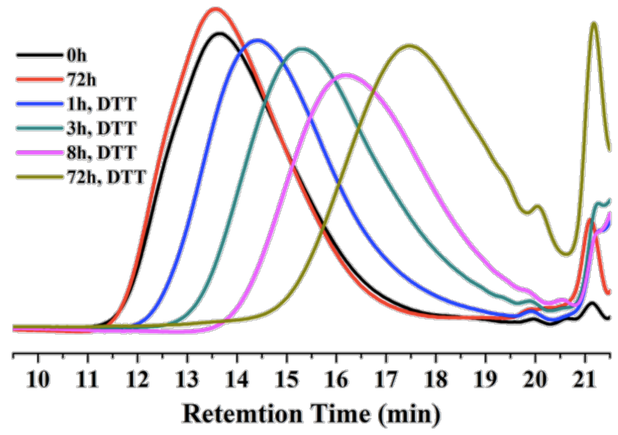

Fig.2The change of molecular weight of MdPCL in the presence of 25mM DTT

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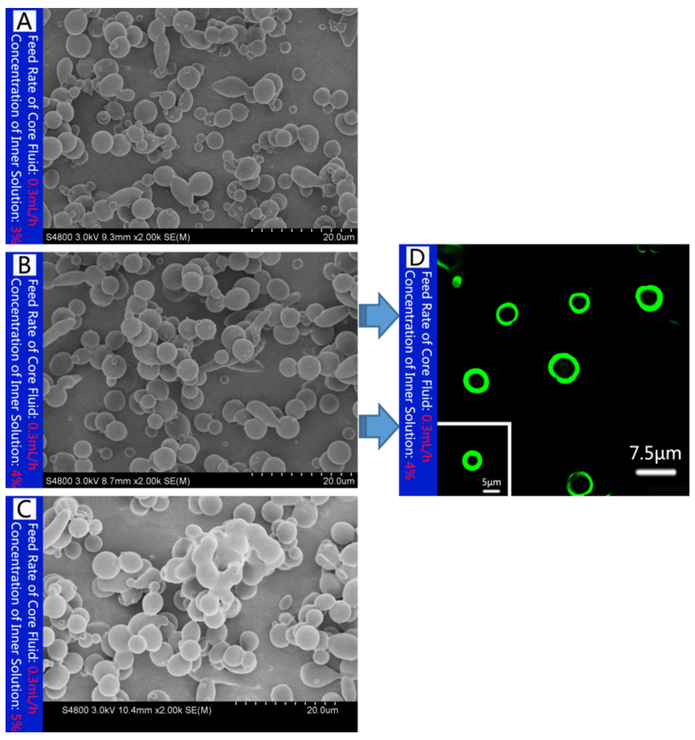

Fig. 3 SEM image of coaxial electrospray particles. The concentration of outer solution is 10%, the feed rate of shell fluid and core fluid is 1.0 mL/h and 0.3 mL/h respectively. The concentration of inner solution of A, B and C is 3%, 4% and 5% respectively. (D) LSCM image of Core-shell structure particles, when the feed rate of core fluid is 0.3mL/h and the concentration of inner solution is 4%.

	Feed rate of core fluid (mL/h)	Concentration of inner solution	Feed rate of shell fluid (mL/h)	Concentration of outer solution	Time (min)
M1	0.3	3%	1.0	10%	20
M1’	0.5	3%	1.0	10%	20
M2	0.3	4%	1.0	10%	20
M2’	0.5	4%	1.0	10%	20
M3	0.3	5%	1.0	10%	20
M3’	0.5	5%	1.0	10%	20

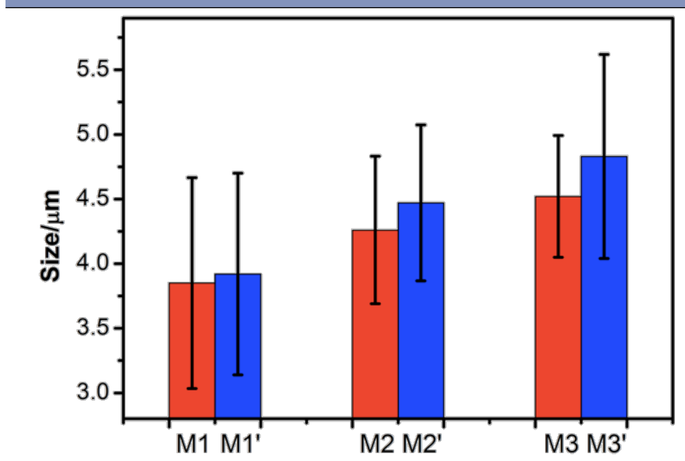

Fig. 4 The relationship between coaxial electrospray particle size and the concentration and feed rate of core fluid

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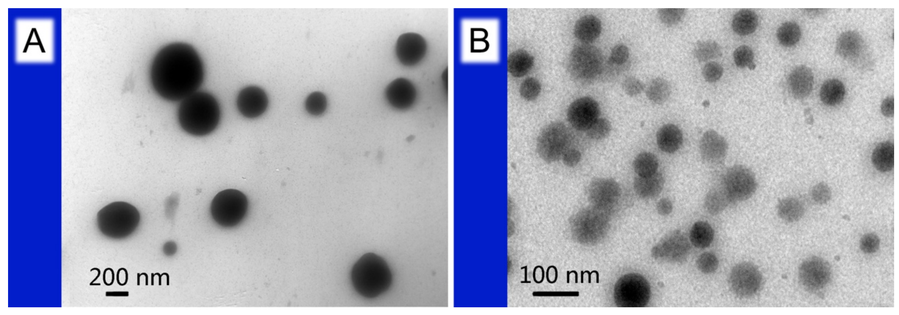

Fig. 5 (A) TEM image of particles which were stirred for 24h in deionized water to remove PEG template. (B) TEM image of particles which were stirred for 48h in deionized water to remove PEG template

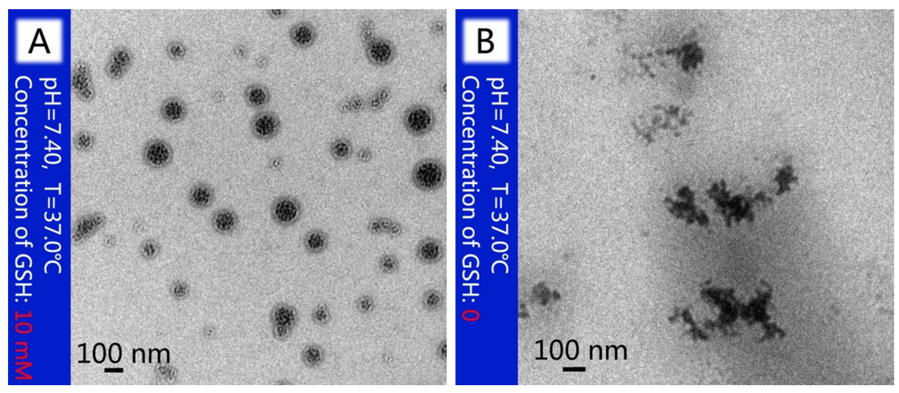

Fig. 6 At 37℃ in PBS with pH value of 7.4, (A) the concentration of GSH is 0, and (B) the concentration of GSH is 10mM

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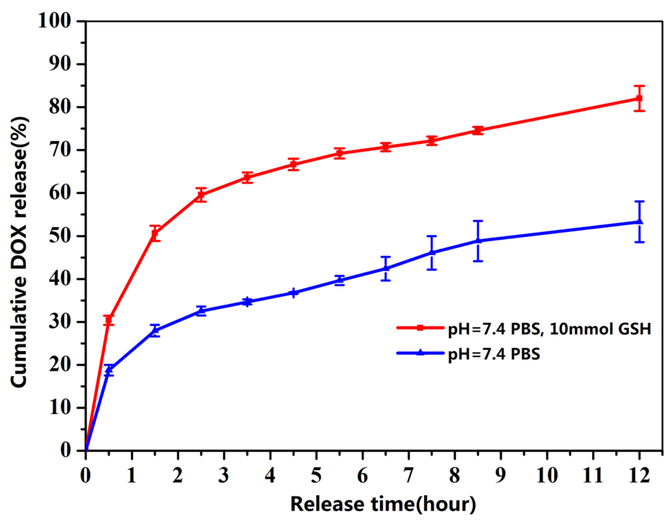

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Conclusions:

- The redox-responsive particles with core-shell structure were prepared by the coaxial electrospray technique.
- It was estimated that the drug-loaded nanoparticles whose mean diameter was less than 100nm can be approached by coaxial electrospray template removal method , while the drug-loaded efficiency can be 100%.
- Under the condition of GSH, the content of the cumulative drug release could be up to 80% within 12h, given the temperature of 37 ℃.

* Corresponding authors at: Department of Polymer Science and Engineering, Zhejiang University, Zheda Road No. 38, Hangzhou 310027, China