Research Square

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Procedure for preparation of high-water-content hydrogels using clay and a dendritic molecular binder

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Method Article

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Abstract

Introduction

This protocol describes a facile, quick and reproducible preparation of hydrogels. The protocol requires four components: water, clay nanosheets \(Clay-NS), a dendritic macromolecule \(_Gn_-binder; _n_ = generation number) and sodium polyacrylate \(ASAP). Upon mixing with ASAP in water, Clay-NS, which are heavily entangled with one another, are exfoliated and dispersed homogenously because of a possible site-specific wrapping of their positive-charged edge parts with anionic ASAP. Meanwhile, _Gn_-binder possesses two dendron units, which are decorated with multiple guanidinium ion pendants on their periphery. A previous paper[1] reports that a mono-dendron version of _Gn_-binder interacts strongly with the oxyanionic surface groups of proteins. Upon addition of _Gn_-binder to the aqueous solution of Clay-NS with ASAP, exfoliated nanosheets of clay are crosslinked kinetically through multivalent salt-bridge formation between the guanidinium ion pendants of _Gn_-binder and oxyanionic groups on the nanosheet surface. Consequently, the hydrogelation takes place.

Reagents

Clay-NS \(Laponite XLG) was purchased from Rockwood Ltd. ASAP \(sodium polyacrylate) was purchased from Wako Pure Chemical Industries, Ltd. _Gn_-binder was synthesized through an adapted synthetic protocol of previous literatures.[1,2] For details, see Supplementary Information of the related article in Nature. Ultrapure-grade water was used for hydrogelation.

Equipment

Magnetic stirrer Teflon-coated magnetic stirrer bar Plastic vial Water purification system \(Milli-Q, Nihon Millipore K.K.)

Procedure

A typical example of the hydrogelation with Clay-NS, ASAP, and _Gn_-binder is given below: 1. Dissolve 3.0 mg of sodium polyacrylate \(ASAP) in 1.0 mL of water. 2. Dissolve 7.5 mg of _G3_-binder in 0.25 mL of water. 3. Suspend 100 mg of Clay-NS to 3.75 mL of water. 4. Stir the suspension of Clay-NS at room temperature such as 20 ^{o}C. 5. Add 1.0 mL of the aqueous solution of ASAP to the stirred suspension of Clay-NS at room temperature such as 20 ^{o}C. 6. Stir the ASAP-containing Clay-NS suspension for 10 minutes at room temperature such as 20 ^{o}C and confirm that it turns into a clear viscous solution. 7. Dropwise add 0.25 mL of the aqueous solution of _G3_-binder to the vigorously stirred Clay-NS/ASAP solution. 8. Let the resultant solution stand for 3 minutes and obtain a transparent, self-standing gel.

Timing

Approximately 13 minutes Magnetic stirring of an aqueous suspension of Clay-NS after addition of ASAP \(dispersion of Clay-NS); approximately 10 minutes, Magnetic stirring of the resulting dispersion after addition of _G3_-binder; approximately 1 minute, Standing of the resulting mixture \(hydrogelation); approximately 2 minutes.

Troubleshooting

_Gn_-binder is highly adhesive to glass: a) Leave _Gn_-binder protected until ready for hydrogelation. b) Use plastic vials and containers when performing hydrogelation. c) Powerful and efficient stirring is helpful for accelerating the exfoliation of Clay-NS and hydrogelation. However, air-bubbles occasionally form in the resulting hydrogel.

References

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