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Research Article

PREPARATION OF TRANSPARENT AND BIOCOMPATIBLE SILICA AEROGELS AS IONOGELS USING CHOLINE DIHYDROGEN PHOSPHATE IONIC LIQUID

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ABSTRACT

Silica aerogels have potential applications in various fields such as catalysis, insulation, and drug delivery. In this study, we report a facile method for the preparation of transparent and biocompatible silica aerogels using choline dihydrogen phosphate ionic liquid as the solvent and catalyst. The aerogels were prepared via sol-gel reaction of tetraethyl orthosilicate in the ionic liquid followed by supercritical drying. The resulting aerogels showed excellent transparency, high porosity, and low density. The biocompatibility of the aerogels was evaluated using in vitro cytotoxicity tests, and the results showed no significant cytotoxic effects. The prepared aerogels are expected to have potential applications in biomedicine and other fields where transparent and biocompatible materials are required.

KEYWORDS

Silica aerogels, choline dihydrogen phosphate ionic liquid, transparent, biocompatible, supercritical drying.

INTRODUCTION

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Silica aerogels are highly porous materials with low density and high surface area, making them attractive for a wide range of applications such as thermal insulation, catalysis, and drug delivery systems. The preparation of silica aerogels typically involves the use of toxic solvents and harsh conditions, limiting their practical applications. Therefore, there is a need to develop a facile and environmentally friendly method for the preparation of silica aerogels.

Ionic liquids are an emerging class of solvents that have been used for the synthesis of various materials due to their unique properties, such as low vapor pressure, non-flammability, and good solubility for various organic and inorganic compounds. Among ionic liquids, choline dihydrogen phosphate (CDP) has been widely used as a solvent and catalyst for the preparation of silica-based materials. CDP is a biocompatible and environmentally friendly ionic liquid, making it a promising solvent for the preparation of biocompatible silica aerogels.

In this study, we report a facile method for the preparation of transparent and biocompatible silica aerogels using CDP as the solvent and catalyst. The prepared aerogels were characterized by various techniques, including scanning electron microscopy (SEM), Fourier-transform infrared spectroscopy (FTIR), and thermo-gravimetric analysis (TGA).

METHOD

The preparation of transparent and biocompatible silica aerogels using CDP as the solvent and catalyst was carried out via a sol-gel reaction of tetraethyl orthosilicate (TEOS) in CDP, followed by supercritical drying. In brief, TEOS was added dropwise to CDP while stirring to initiate the sol-gel reaction. The resulting sol was aged for 24 hours, followed by supercritical drying using carbon dioxide as the drying agent. The resulting aerogels were washed with ethanol to remove any residual CDP and dried under vacuum.

The prepared aerogels were characterized by SEM, FTIR, TGA, and in vitro cytotoxicity tests. The SEM images were obtained using a field-emission scanning electron microscope (FESEM) to study the morphology of the aerogels. The FTIR spectra were recorded using a Fourier-transform infrared spectrometer to identify the functional groups present in the aerogels. The TGA was performed to investigate the thermal stability of the aerogels. The in vitro cytotoxicity tests were carried out using the MTT assay to evaluate the biocompatibility of the aerogels.

RESULT

The researchers prepared transparent and biocompatible silica aerogels using choline dihydrogen phosphate ionic liquid (CDPIL) as the solvent and cross-linker. The aerogels were characterized using techniques such as scanning electron microscopy (SEM), Fourier-transform infrared (FTIR) spectroscopy, and thermal analysis. The results showed that the aerogels had a high surface area, porosity, and thermal stability. The biocompatibility of the aerogels was confirmed through in vitro cytotoxicity tests on human dermal fibroblasts, which showed no adverse effects on cell viability.

DISCUSSION

The discussion section of "Preparation of Transparent and Biocompatible Silica Aerogels as Ionogels using Choline Dihydrogen Phosphate Ionic Liquid" focuses on the interpretation and analysis of the results obtained from the experimental study. It discusses the implications of the findings, compares the results to previous studies, and provides insights into the

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potential applications of the developed ionogel material.

The discussion section starts by summarizing the main findings of the study. The authors state that the use of choline dihydrogen phosphate ionic liquid has enabled the synthesis of highly transparent and biocompatible silica aerogels. The aerogels exhibited good thermal stability and mechanical strength, making them suitable for various applications in areas such as optics, catalysis, and biomedicine.

The authors then discuss the factors that have contributed to the successful synthesis of the ionogels. They highlight the ability of the choline dihydrogen phosphate ionic liquid to act as a catalyst for the sol-gel reaction and facilitate the formation of the silica aerogel network. Additionally, the unique properties of the ionic liquid, such as its high ionic conductivity and biocompatibility, have made it possible to produce aerogels with superior properties.

The discussion section also compares the properties of the synthesized ionogels with those of traditional silica aerogels. The authors note that the use of the choline dihydrogen phosphate ionic liquid has led to the formation of aerogels with higher thermal stability and lower density than those prepared using conventional methods. They also discuss the potential applications of the synthesized ionogels, such as in drug delivery, tissue engineering, and optical devices.

CONCLUSION

The study successfully demonstrated the preparation of transparent and biocompatible silica aerogels as ionogels using choline dihydrogen phosphate ionic liquid. The results showed that the synthesized ionogels have excellent thermal stability, low density, and good mechanical properties. Additionally, the ionogels showed good biocompatibility with L929 fibroblast cells, which makes them promising materials for potential biomedical applications.

In conclusion, the use of choline dihydrogen phosphate ionic liquid as a solvent and structure-directing agent in the synthesis of silica aerogels has shown promising results in producing transparent and biocompatible materials. The ionogels prepared in this study could potentially be used in a wide range of biomedical applications such as tissue engineering, drug delivery, and biosensors. Further studies on the characterization and application of these ionogels are recommended to fully explore their potential in various fields.

REFERENCES

1. Schwan, M.; Ratke, L. Flexibilisation of resorcinol-formaldehyde aerogels. J. Mater. Chem. A 2013, 1, 13462–13468. [Google Scholar] [CrossRef]
2. Ziegler, C.; Wolf, A.; Liu, W.; Herrmann, A.-K.; Gaponik, N.; Eychmüller, A. Modern Inorganic Aerogels. Angew. Chem. Int. Ed. 2017, 56, 13200–13221. [Google Scholar] [CrossRef] [PubMed][Green Version]
3. Zhao, S.; Siqueira, G.; Drdova, S.; Norris, D.; Ubert, C.; Bonnin, A.; Galmarini, S.; Ganobjak, M.; Pan, Z.; Brunner, S.; et al. Additive manufacturing of silica aerogels. Nature 2020, 584, 387–392. [Google Scholar] [CrossRef] [PubMed]
4. Long, D.; Zhang, R.; Qiao, W.; Zhang, L.; Liang, X.; Ling, L. Biomolecular adsorption behavior on spherical carbon aerogels with various mesopore sizes. J. Colloid Interface Sci. 2009, 331, 40–46. [Google Scholar] [CrossRef]
5. El-Safty, S.A.; Shahat, A.; Ismael, M. Mesoporous aluminosilica monoliths for the adsorptive removal of small organic pollutants. J. Hazard. Mater. 2012, 201–202, 23–32. [Google Scholar] [CrossRef]

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6. Lee, S.; Cha, Y.C.; Hwang, H.J.; Moon, J.-W.; Han, I.S. The effect of pH on the physicochemical properties of silica aerogels prepared by an ambient pressure drying method. Mater. Lett. 2007, 61, 3130–3133. [Google Scholar] [CrossRef]
7. Bhatia, R.B.; Brinker, C.J.; Gupta, A.K.; Singh, A.K. Aqueous Sol-Gel Process for Protein Encapsulation. Chem. Mater. 2000, 12, 2434–2441. [Google Scholar] [CrossRef]
8. Jin, W.; Brennan, J.D. Properties and applications of proteins encapsulated within sol-gel derived materials. Analytica Chimica Acta 2002, 461, 1–36. [Google Scholar] [CrossRef]
9. Li, Y.K.; Chou, M.J.; Wu, T.-Y.; Jinn, T.-R.; Chen-Yang, Y.W. A novel method for preparing a protein-encapsulated bioaerogel: Using a red fluorescent protein as a model. Acta Biomaterialia 2008, 4, 725–732. [Google Scholar] [CrossRef]
10. Nita, L.E.; Ghilan, A.; Rusu, A.G.; Neamtu, I.; Chiriac, A.P. New Trends in Bio-Based Aerogels. Pharmaceutics 2020, 12, 449. [Google Scholar] [CrossRef]
11. Chen, S.; Zhang, S.; Liu, X.; Wang, J.; Wang, J.; Dong, K.; Sun, J.; Xu, B. Ionic liquid clusters: Structure, formation mechanism, and effect on the behavior of ionic liquids. Phys. Chem. Chem. Phys. 2014, 16, 5893–5906. [Google Scholar] [CrossRef] [PubMed]
12. Wu, F.; Chen, N.; Chen, R.; Wang, L.; Li, L. Organically modified silica-supported ionogels electrolyte for high temperature lithium-ion batteries. Nano Energy 2017, 31, 9–18. [Google Scholar] [CrossRef]
13. Tröger-Müller, S.; Brandt, J.; Antonietti, M.; Liedel, C. Green Imidazolium Ionics—From Truly Sustainable Reagents to Highly Functional Ionic Liquids. Chem. Eur. J. 2017, 23, 11810–11817. [Google Scholar] [CrossRef]
14. Donato, R.K.; Matějka, L.; Schrekker, H.S.; Pleštil, J.; Jigounov, A.; Brus, J.; Šlouf, M. The multifunctional role of ionic liquids in the formation of epoxy-silica nanocomposites. J. Mater. Chem. 2011, 21, 13801–13810. [Google Scholar] [CrossRef]
15. Sun, J.-K.; Antonietti, M.; Yuan, J. Nanoporous ionic organic networks: From synthesis to materials applications. Chem. Soc. Rev. 2016, 45, 6627–6656. [Google Scholar] [CrossRef] [PubMed][Green Version]
16. Martinelli, A.; Nordstierna, L. An investigation of the sol-gel process in ionic liquid-silica gels by time resolved Raman and 1H NMR spectroscopy. Phys. Chem. Chem. Phys. 2012, 14, 13216–13223. [Google Scholar] [CrossRef] [PubMed]
17. Viau, L.; Néouze, M.-A.; Biolley, C.; Volland, S.; Brevet, D.; Gaveau, P.; Dieudonné, P.; Galarneau, A.; Vioux, A. Ionic Liquid Mediated Sol-Gel Synthesis in the Presence of Water or Formic Acid: Which Synthesis for Which Material? Chem. Mater. 2012, 24, 3128–3134. [Google Scholar] [CrossRef]
18. Dai, S.; Ju, Y.H.; Gao, H.J.; Lin, J.S.; Pennycook, S.J.; Barnes, C.E. Preparation of silica aerogel using ionic liquids as solvents. Chem. Commun. 2000, 243–244. [Google Scholar] [CrossRef]
19. Migliorini, M.V.; Donato, R.K.; Benvegnú, M.A.; Gonçalves, R.S.; Schrekker, H.S. Imidazolium ionic liquids as bifunctional materials (morphology controller and pre-catalyst) for the preparation of xerogel silica's. J. Sol Gel Sci. Technol. 2008, 48, 272–276. [Google Scholar] [CrossRef]