NOVATEUR PUBLICATIONS
JournalNX- A Multidisciplinary Peer Reviewed Journal
ISSN No: 2581 - 4230
VOLUME 7, ISSUE 10, Oct. -2021

DURABLE CELLULOSE AEROGELS FOR HIGH SEPARATION OF OIL AND WATER

Gafurov Adkhamjon,
Namangan Engineering and Technology Institute, Namangan, Uzbekistan

Abdujabborov Muslimbek Zohidjon ugli,
Namangan Engineering and Technology Institute, Namangan, Uzbekistan

Abdulhafizov Bilolxon Vohid ugli
Namangan Engineering and Technology Institute, Namangan, Uzbekistan

ABSTRACT:

This article presents a simple and environmentally friendly method for the production of flexible, ultra-lightweight and hydrophobic cellulose aerogels (CA), based on a process of chemical crosslinking, lyophilization of a cellulose solution and subsequent hydrophobic modification with methyl trichlorosilane (MTCS) (heat treatment). chemical vapor deposition CVD). The resulting cellulose aerogels are bonded to each other and have a very large porous structure characterized by different pore sizes due to different concentrations of the initial solution. In addition, the cellulose aerogels were extremely light (only 0.027 g/cm^3), but they showed improved mechanical properties when the compressive strength was 1.10-3.85 MPa. After silanization, the MTCS modified cellulose aerogels exhibited constant hydrophobicity with an average contact angle of 1410 with water and retained 1310 even after 5 days.

1. INTRODUCTION:

Due to the rapid development of industry and social economy, oil spills into water, pollution of organic solvents by oil paints and heavy metal ions with industrial waste are becoming more serious, causing serious damage to the environment, ecology, resources and human health [1-5]. Various approaches have been proposed to solve this water treatment problem, including petroleum water separation, photo catalytic degradation (decomposition), and adsorption [6-8]. Among these methods for the rapid removal of oil from the water surface, the approach of using three-dimensional porous (poristyx) absorbents with a hydrophobic surface due to the high degree of oil-water selectivity is very promising.

Recently, inorganic sorbents have emerged, including carbon sponges oil aerogels, [8-10] graphene sponges oil aerogels, [11] and synthetic polymers, including polyurethane sponges [12] poly (alkoxylane) organogels, [13] poly (m-phenylenediamine) aerogel [14] and polypyrrole.

In recent years, a large number of advanced cellulose-based materials have been developed as highly effective fat-absorbing substances due to their large hydroxyl groups, which provide reactivity for stability, biological degradation, excellent mechanical properties, and hydrophobic modification.

These modified cellulose-based materials have been shown to have increased adsorption and selectivity ability from water to oils or organic solvents.

In particular, hydrophobic cellulose aerogels accumulate fats and organic solvents quickly and efficiently above and below water levels and demonstrate excellent adsorption properties as well as recyclability.

2. EXPERIMENTAL PART:

2.1. Materials:

Cotton wool with more than 95% α-cellulose Heze Sanmu Health Materials Co. Ltd. (Shandong, China). NaON, urea, N, N-methylene nebisacrylamide (MBA) and methyltrichlorosilane (MTCS) Sinopharm Chemical Co. Ltd. (Shanghai, China). All chemical reagents are analytical and can be used without additional purification.

1. Production of cellulose aerogels:

Cellulose aerogels (CA) are based on the chemical cross-linking of N, N-methylenebisacrylamide (MBA). in short, the desired cellulose was dispersed in 100 g of aqueous solution until a clear urea solution with a concentration of 7% NaON / 12% cellulose was 2%, 2.5%, 3% and 4%. According to our previous reports [15]. 0.6 g of crosslinkers were then added directly to the cellulose solutions at MBA room temperature and mixed for 40 min to obtain a homogeneous solution. The mixture was then held for 4 h to transfer to cellulose hydrogels. To remove the residue, the cellulose hydrogels are washed with deionized water, and finally frozen to form cellulose aerogels.

2.4. Description:

2.4.1. Analysis of structure and morphology:

Rheological measurements of a mixed solution consisting of cellulose and MBA were performed at 25 °C in a RM-200C rheometer (Hapro electric technology Co. Ltd, China) at a constant shear frequency of 1 Gts. An elastic viscosity modulus (G) and an adhesive loss modulus (G") were recorded to monitor gel formation and movement and mechanical properties.

1.4.2. Estimation of density, porosity size and porosity:

The density of aerogels is calculated based on the ratio of its mass to volume. The porosity of aerogels was calculated based on the mass density (rb) and skeletal density (r = 1,528 g cm3) of cellulose aerogels using formula (1) [16].

$$Porosity(\%) = (1 - \frac{\rho_b}{\rho_s}) \quad (1)$$

The volume of porosity of aerogels (Vp, milliliter of holes (pores) in 1 g of aerogel) was calculated from the absorption of water by aerogels. Water is not a solvent for cellulose, it only enters the pores (pores) of the samples. Thus, Vp was calculated according to the following formula (2).

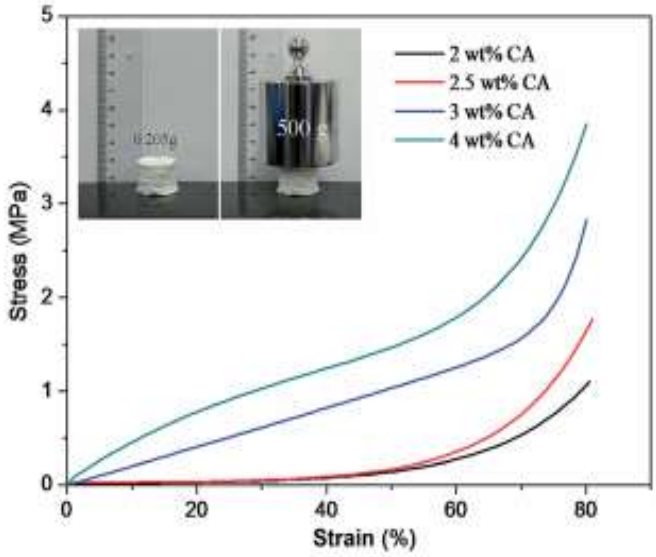
$$V_p = \frac{M_{wet} - M_{dry}}{\rho M_{dry}} \quad (2)$$

where Mwet is the mass of samples immersed in water until equilibrium swelling is reached. Mdry is the mass of dry samples, r is the density of water (0.995 g · ml-1, 30 °C). All samples were analyzed in triplicate, followed by mean values.

3.2. Morphology and hydrophobicity:

Chemically cross-linked cellulose aerogels were obtained successfully after a simple mixing and freezing process (as shown in Figure 1) without the need for additional initiators or chemicals. The morphology of aerogels obtained from different cellulose concentrations was observed using FESEM and is shown in Figure 3. Clearly, a structure was formed when clearly defined, cross-linked, three-dimensional cellulose chains were recovered from an aqueous solution of NaON / urea (urea) and chemically crossed. It has to do with the use of an MBA.

Interestingly, due to the difference in cellulose concentration, the four aerogels had different porous structures.



Picture. 1. Cellulose concentration 2; 2.5; Typical stress-strain curves for cellulose aerogels at 3 and 4 mas%. In the insert, it shows that the airgel is very flexible.

When the cellulose concentration was 2 mas%, the aerogel exhibited a hierarchical porous structure with a pore size of 0.05–4 mm, and its three-dimensional lattice structure was constructed from an elastic cellulose matrix (Fig. 2a). As the cellulose concentration increased, the size of the pores in the cellulose aerogels gradually increased, so that the pores had a regular (straight) and very thin wall. When the cellulose concentration increased to 3-4 mas%, the average porosity size of cellulose aerogels exceeded 200 mm and even more than 500 mm (Fig. 2c i d). This suggests that the semi-rigid molecular chain of cellulose played an important role in maintaining the porous wall [17]. To further study the effect of cellulose concentration on aerogel microstructure, density, porosity, and total pore volume (Vp), cellulose aerogels were evaluated and presented in Table 1. It was found that the density of aerogels obtained from a 2% cellulose solution could reach 0.027 g cm^{-3}, while the porosity and the total volume of the pores could reach 98.2% and 31.92 cm^3 g^{-1}, respectively.

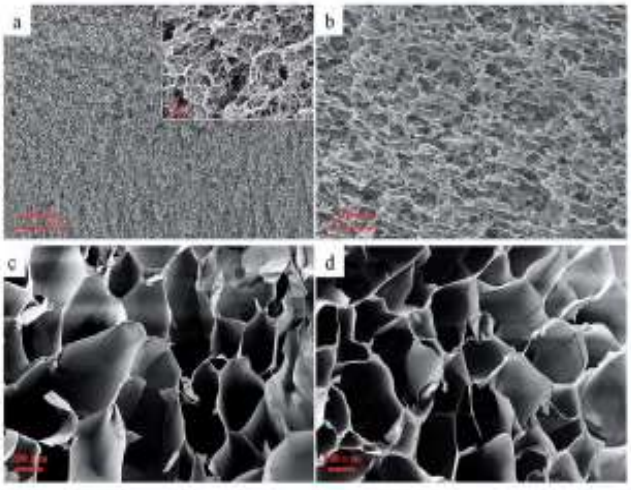


Figure.2. 2% (A), 2.5% (B), 3% (C) and 4% (D)) of different cellulose concentrations of cellulose aerogels. FE-SEM image obtained: Insertion (a) shows the porous structure of the aerogel.

With an increase in the cellulose concentration from 2 to 4 percent, the density of the aerogels gradually increased, the porosity and the total porosity decreased. However, cellulose aerogels also have very high porosity of more than 96%, which indicates that light and porous cellulose aerogels have been successfully prepared. It is worth noting that the prepared ultra-light aerogel can stand on the leaf without wobbling.

3.4. Adsorption capacity and recyclability:

Modified MTCS cellulose aerogels have great potential for easy removal of various oils and organic solvents from water due to their three-dimensional porous structure, low density, high porosity, hydrophobicity, oleophilicity and high stability. As shown in Figure 3, cellulose aerogels modified by MTCS can quickly remove floating oil and cyclohexane introduced and floated for contact with artificial organic contaminants (okrashennymi Sudanom krasnым III), as well as completely immersion of chloroform in 2 seconds.

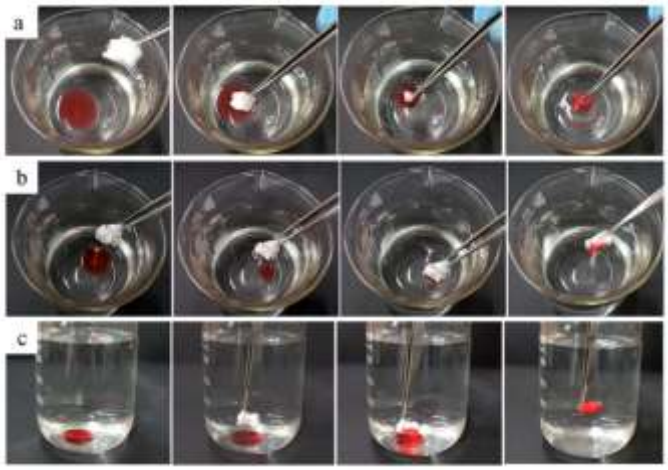


Figure 3. Cellulose aerogels modified by MTCS can quickly remove floating oil and cyclohexane introduced

4. CONCLUSIONS:

Flexible, ultra-light, and hydrophobic cellulose aerogels were prepared by simple chemical cross-linking, lyophilization, and subsequent hydrophobic modification with methyl chlorosilane (MTCS). The binding of silane cellulose to C – O – Si molecular chains resulted in high hydrophobicity of the surface and internal structure of the cellulose aerogel. Modified cellulose aerogels by MTCS have demonstrated that oils and organic solvents can quickly and efficiently collect water from both the surface and the bottom, and have good adsorption properties as well as recyclability. Thus, the clearly interconnected porous structure, high mechanical properties, and strong hydrophobic surface of cellulose aerogels resulted in their high removal of oil from water. Hence, hydrophobic cellulose aeroge is a very promising material for the purification of water from oily wastes containing oil.

REFERENCES:

1) K. He, H. Duan, G. Y. Chen, X. Y. Liu, W. Yang and D. Wang, ACS Nano, 2015, 9, 9188.
2) C. Zhang, P. C. Zhu, L. Tan, J. M. Liu, B. Tan, X. L. Yang and H. B. Xu, Macromolecules, 2015, 48, 8509.
3) J. Howarth, Y. Liu, J. T. Hupp and O. K. Farha, CrystEngComm, 2015, 17, 7245.
4) Rey, E. Mena, A. M. Ch´ avez, F. J. Beltr´ an and F. Medina, Chem. Eng. Sci., 2015, 126, 80.
5) J. Qu, Q. Zhang, Y. Xia, Q. Cong and C. Luo, Environ. Sci. Pollut. Res., 2015, 22, 1408.
6) X. Liu, L. Ge, W. Li, X. Wang and F. Li, ACS Appl. Mater. Interfaces, 2014, 7, 791.
7) W. Liu, J. Cai, Z. Ding and Z. Li, Appl. Catal., B, 2015, 174, 421.
8) X. Zhang, D. Liu, L. Yang, L. Zhou and T. You, J. Mater. Chem. A, 2015, 3, 10031.
9) Эркинов З.Э., Ғафуров А.Б., Эргашев М.М. Определение и анализ свойств крученой нити, выработанной из разноструктурной одиночной пряжи // Universum: Технические науки: электрон. научн. журн. 2018. № 6(51). URL: http://7universum.com/ru/tech/archive/item/6049
10) Sadikov M.R., Omonov M.T., Tojimirzaev S.T., Gofurov A.B. Analysis of changes in fiber properties in processes opening, cleaning and carding. ACADEMICIA: An International Multidisciplinary Research JournalYear : 2021, Volume : 11, Issue : 4. Article DOI : 10.5958/2249-7137.2021.01043.0
11) Korabayev Sh.A; Matismailov S.L; Salohiddinov J.Z (2018) "Investigation of the impact of the rotation frequency of the discretizing drum on the physical and mechanical properties of," *Central Asian Problems of Modern Science and Education*: Vol. 3 : Iss. 4, Article 9. Available at: https://uzjournals.edu.uz/capmse/vol3/iss4/9
12) Korabayev Sh.A; Mardonov B.M; Matismailov S.L; Meliboyev U.X "Determination of the Law of Motion of the Yarn in the Spin Intensifier", Engineering, 2019, 11, 300-306. Available at:

https://www.scirp.org/journal/paperinformation.aspx?paperid=92784

13) Korabayev Sh.A; Matismailov S.L; Yuldashev A.T., Atanbayev D.D. (2020) "Study Of Fiber Movement Outside The Crater Of Pnevmomechanical Spinning Machine", Solid State Technology. Vol. 63 : Iss. 6. Pages 3460-3466.Available at: http://www.solidstatetechnology.us/index.php/JSST/article/view/3473

14) Izatillayev, M.M; Korabayev, Sh.A (2020) "Experimental studies of shirt tissue structure", The American Journal of Applied sciences: Vol. 2 : Iss. 11. Available at: https://usajournalshub.com/index.php/tajas/article/view/1353

15) Yuldashev A.T., Matismailov S.L., Korabayev Sh.A., Aripova Sh.R., Matmuratova K.R. Investigation of Influence ofa New Twist Intensifier on the Properties of the Twisted Yarn. Turkish Journal of Computer and Mathematics Education Vol.12 No. 5 (2021), 1943-1949. https://doi.org/10.17762/turcomat.v12i5.2275

16) Korabayev Sh.A; Matismailov S.L; Miraxmedov A.G; Shaxobiddinova D.E (2021) Characteristics of yarn spinned on different spinning machines. section xvii. technologies de l'industrie légère et le travail du bois. 5 février 2021 • Paris, République française. Pages 37-39 . https://doi.org/10.36074/logos-05.02.2021.v3.10.