proceedings

MDPI

Abstract

Organizational Arrangements Associated with Partial Ion Exchange in Gelation Process †

Marius Ghiurea, Naomi Tritean, Ştefan-Ovidiu Dima and Florin Oancea *

Bioresources and Polymers Departments, National Institute for Research & Development in Chemistry and Petrochemistry—ICECHIM Bucharest, Spl. Independentei nr. 202, 6th District, 060021 Bucharest, Romania; marius.ghiurea@icechim.ro (M.G.); naomi.tritean@icechim.ro (N.T.); ovidiu.dima@icechim.ro (Ş.-O.D.)

* Correspondence: florin.oancea@icechim.ro

† Presented at the 19th International Symposium "Priorities of Chemistry for a Sustainable Development", Bucharest, Romania, 11–13 October 2023.

Keywords: alginic acid; dynamic modulus; pseudoplastic fluid; gel properties; sustainable bioeconomy

The intention of this work is to use various constituents obtained from bioeconomy side streams, such as brown algae or bacteria, to create a source of biodegradable and environmentally neutral materials for 3D printing.

Sodium alginate is a water-soluble co-polysaccharide that forms a gel when hydrated. It is generally known that sodium alginate has non-Newtonian, pseudoplastic behavior [1]. The challenges in using hydrated sodium alginate hydrogel in 3D printing are reflected in the circumstance that, depending on the degree of hydration, either the viscosity at 0 shear stress is too low and the printed layers cannot be preserved, or the viscosity at high-level shear stress is too high, and large forces are needed to flow the hydrogel through the extrusion nozzle once with the use of special materials (steels) in the manufacture of the extrusion device.

To stabilize the form obtained from the sodium hydrogel, it can be cross-linked by the ionic exchange between sodium ions and calcium ions, resulting in calcium alginate, a water-insoluble gel [2]. To obtain a uniform solution of calcium alginate, it is necessary to introduce a reaction retardant, such as sodium salt, a base, or an acid [3].

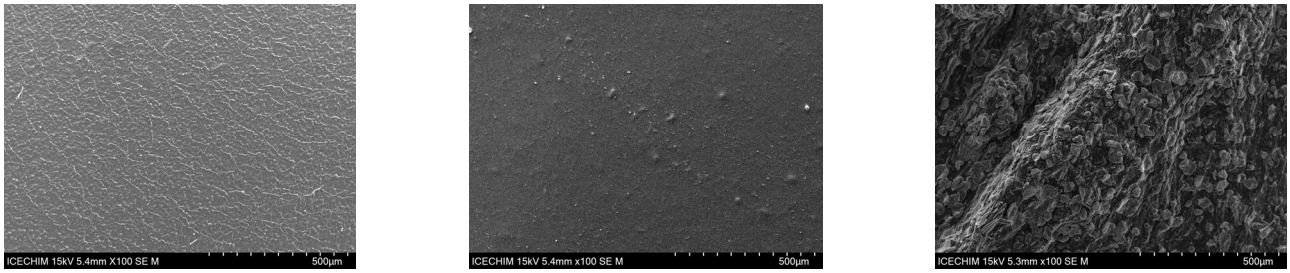
The rheology of the partial modified hydrogels and the stability of the compositions were studied (TA Instruments Discovery HR20). The structure of composite and the degree of ionic exchange in the hydrogel were demonstrated and calculated based on the Fourier-transform infrared spectroscopy spectra (Shimadzu IRTracer-100) and X-ray diffraction (Rigaku Smartlab). The morphological changes in the partially calcium ion-modified hydrogel and the mode of organization of the hydrophobic–hydrophilic regions were analyzed using the signals resulting from the interaction of accelerated electrons with the obtained composites (scanning electron microscopy analysis, TM4000plus II, Hitachi, Tokyo, Japan)—Figure 1.

check for updates

Citation: Ghiurea, M.; Tritean, N.; Dima, Ş.-O.; Oancea, F. Organizational Arrangements Associated with Partial Ion Exchange in Gelation Process. *Proceedings* **2023**, *90*, 40. https://doi.org/10.3390/proceedings2023090040

Academic Editors: Mihaela Doni and Radu Claudiu Fierăscu

Published: 20 December 2023



(**a**) (**b**) (**c**)

Figure 1. Film form secondary electron images of dehydrated sodium alginate (**a**) and partial modified dehydrated hydrogels at 5% (**b**) and 20% (**c**).

Author Contributions: Conceptualization, M.G. and N.T.; methodology, M.G.; investigation, M.G., N.T., Ş.-O.D.; project administration, M.G. and F.O; supervision, F.O.; validation Ş.-O.D. and F.O.; visualization, writing—original draft preparation, N.T.; writing—review and editing, M.G., Ş.-O.D. and F.O.; funding acquisition, F.O. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the project POC-A1-A1.2.3-G-2015-P_40_352-SECVENT, My_SMIS 105684, Sequential processes of closing the side streams from bioeconomy and innovative (bio)products resulting from it, subsidiary project 1488/2020 3D-4Fish. The SECVENT project was co-funded by European Regional Development Fund (ERDF), The Competitiveness Operational Program (POC), Axis 1.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data are within the paper.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Belalia, F.; Djelali, N.E. Rheological properties of sodium alginate solutions. *Rev. Roum. Chim.* **2014**, *59*, 135–145.
2. Iijima, M.; Hatakeyama, T.; Nakamura, K.; Hatakeyama, H. Thermomechanical analysis of calcium alginate hydrogels in water. *J. Therm. Anal. Calorim.* **2002**, *70*, 807–814. [CrossRef]
3. Wang, Q.Q.; Zhang, G.Q.; Zhang, L.; Zhu, P. Mechanical Properties and Water Absorption of Alginate/hydroxypropyl Methyl Cellulose Blend Membranes with Semi-interpenetrating Network. *Fibers Polym.* **2020**, *21*, 1403–1410. [CrossRef]