ISGC 2017
May 16rd - 19th

N°826 / FC
TOPIC(s) : Polymers / Renewable carbon / Biomass conversion / Valorization of waste

Influence of both transition metal cation and alginate nature on rheological properties of hydrogels

AUTHORS
Mike ROBITZER / INSTITUT CHARLES GERHARDT MONTPELLIER, UMR 5253 CNRS-UM-ENSCM, ENSCM, 8 RUE DE L ECOLE NORMALE, MONTPELLIER CEDEX 5
Jean-Pierre HABAS / INSTITUT CHARLES GERHARDT MONTPELLIER, UMR 5253, CNRS-UM-ENSCM, UM, PLACE E. BATAILLON, CC 1702, MONTPELLIER CEDEX 5

PURPOSE OF THE ABSTRACT
Alginates are a family of biocompatible, biodegradable, and non-toxic polysaccharides mainly extracted from brown algae.[1] Their block copolymer chain are composed of (1-4)-linked uronate residues. Beta-D-mannuronate and alpha-L-guluronate residues are present in varying proportions, sequence and molecular weight.[2] Divalent or multivalent cations M(n+) form with alginate ionotropic gels, M(n+)/alginate, which can be prepared in various shapes, such as beads, fibers, films, membranes or monoliths.[3]

Recently, we characterized alginate ionotropic gels according to a multi-scale approach from atomic to macroscopic, i.e. from Å to decimeter (Fig.1). We studied several hydrogels by Density Functional Theory (DFT),[4] small-angle X-ray scattering (SAXS),[5] Scanning Electron Microscopy (SEM), Specific Surface Area determination (BET) and spectromechanical analyses (rheometry). [6]

Using this multi-scale approach, we found interesting and reliable correlations between atomic interactions, primary and secondary structures, and rheological properties of our ionotropic alginate gels.

In this presentation we focus more particularly on the macroscopic behavior of the hydrogels. First results concern the rheological characterisation of the hydrogels depending on the concentration in aqueous solution and the ratio between guluronate and mannuronate. The same technique was retained for the second stage devoted to the rheological properties of sev-eral ionotropic alginate hydrogels formed a low concentration by the addition of a divalent cation. The effects produced by the cation nature and the guluronic fraction of the alginate were carefully studied. Several hydrogels were synthesized and studied by spectromechanical analyses. On one hand, some hydrogels behaved as viscoelastic solids: the elastic contribution was higher than the dissipative component in all the frequency range studied (G' > G"). No flow zone (G" > G') was detected even at very low values of the shearing frequency. On the other hand, others hydrogels presented a spectromechanical behavior that resembled that ob-served classically for entangled polymers. Indeed, at high frequency, these latter materials could be compared to a viscoelastic solid but at low frequency, the flow zone was described and the viscous character became prevalent with finite relaxation time. Significant discrepan-cies were also observed between the creep behaviors characteristic of the same hydrogels.

FIGURES

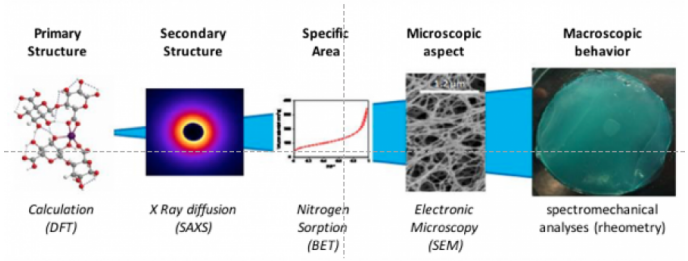

FIGURE 1

Schematic representation of the multi-scale approach.

From A to dm

FIGURE 2

KEYWORDS

Alginate | Assembling | Hydrogel | Rheology

BIBLIOGRAPHY

[1] McHugh, D.J. A guide to the seaweed industry, FAO, Rome 2003, p. 27

[2] (a) Barbotin J.N., Nava Saucedo J.E., in Polysaccharides, Dumitriu, S. (Ed.): New York: Marcel Dekker, 1998, 749; (b) Sime W.J., in Food Gels, Harris, P. Ed.: Elsevier: Amsterdam, 1990, 53. (c) Chen J. P., Hong L., Wu S., Wang L., Langmuir, 2002, 18, 9413.

[3] Quignard F., Di Renzo F., Guibal E., in Rauter A.P., Vogel P., Queneau Y. (Editors), Carbohydrates in Sustainable Development I: Renewable Resources for Chemistry and Biotechnology, Vol. 294, Springer-Verlag Berlin, Berlin, 2010, p. 165.

[4] Agulhon P., Robitzer M., David L., Quignard F., Biomacromol., 2012, 13, 215-220.

[5] Agulhon P., Markova V., Robitzer M., Quignard F., Mineva T., Biomacromol., 2012, 13, 1899?1907.

[6] Agulhon P., Robitzer M., Habas J-P., Quignard F., Carb. Pol., 2014, 112, 525-531