DOI: 10.20396/revpibic2720192826



# Extrusion printing of Alginate/Laponite nanocomposite hydrogels scaffolds: Influence of rheological properties and printing parameters.

**Gabriel de S. Kurashima *, José Luis Dávila, Marcos A. d'Ávila**

**Abstract**

Hydrogels are polymeric materials extensively used in biomedical applications. One important application is as scaffolds for tissue engineering, due to their high biocompatibility and the capability to provide viable microenvironment for growth and proliferation of cells. Among the main techniques to obtain hydrogel scaffolds is three-dimensional printing. However, hydrogel extrusion printing is challenging, since the material must present suitable rheological properties in order to confer mechanical stability and adequate shape fidelity in the printed structure. In this work, nanocomposite hydrogels of the system alginate/Laponite in aqueous dispersion was studied aiming extrusion printing. An extrusion printing equipment was built and tested for hydrogel printing. Rheological behavior and printing parameters were studied in order to obtain scaffolds with adequate printing fidelity.

***Key words:*** *Hydrogels, extrusion printing, rheology*

## Introduction

Hydrogels are polymeric materials with hydrophilic groups, producing a porous and highly hydrated structure. These materials are promising for tissue engineering applications due to properties suitable for scaffolds manufacturing. Nanomaterials are often added within hydrogels networks to obtain desirable physical and chemical properties for scaffolds printing.

One of the major problems relative to extrusion based 3D printing is the availability of materials and high demands on its rheological properties such as high viscosity. During extrusion low viscosity is desirable while dispensing material and high viscosity is necessary to maintain its shape once printed, that is a high shear thinning behavior with fast recovery.

In this work, nanocomposite hydrogels made of Alginate /Laponite in phosphate buffered saline (PBS) was used to obtain a printable formulation for scaffold extrusion printing and define printing parameter such as print velocity, extrusion velocity and needle diameter, in order to obtain scaffolds with good shape fidelity.

## Results and Discussion

In order to assess the print parameters of samples, a 3D print machine was built, shown in Image 1. The material dispenser was adapted by connecting a screw based motor with a piston inside a syringe, making it possible to dispense soft materials, in this case nanocomposite hydrogels.

Samples with different concentration of alginate and Laponite in PBS solution were tested at rotational rheometer in order to obtain their rheological properties. Samples with less than 10 wt% of Laponite didn´t present significant shear thinning, which was attributed to the negative charges in PBS. Samples with 10 wt% of Laponite demonstrated high shear thinning, presented in Image 2. Results of printed scaffolds will be presented in Congress.

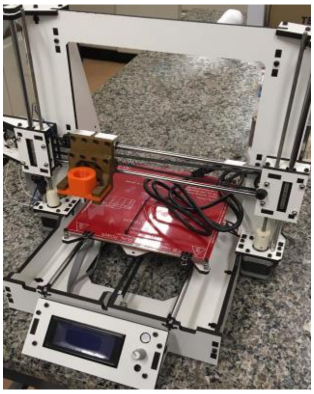

**Image 1.** Extrusion 3D printing machine after assembled.

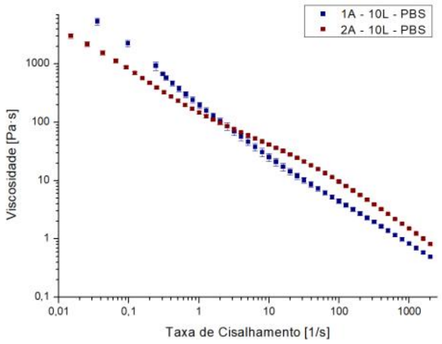


**Image 2.** Viscosity as a function of shear rate for 10 wt% of Laponite (L) with 1 and 2 wt% of Alginate (A).

## Conclusions

An extrusion printing system for hydrogels was built and rheological evaluation allowed identification of a promising alginate/Laponite system. Printed scaffolds by extrusion-based process of alginate/Laponite in PBS will be presented.

## Acknowledgement

To PIBIC and CNPQ for sponsoring the research.
To Prof. Dr. Marcos Akira and Dr. José Dávila for all the guidance and knowledge.