Allyl Cellulose (AC) as a sustainable feedstock for 3D (bio)printing

Rute Silva[a], Rafael Rebelo[a], **Carlos T.B. Paula[a,b]**, Patrícia Pereira[a,b], Ana C. Fonseca[a], Arménio C. Serra[a], Jorge F. J. Coelho[a,b]

[a] CEMMPRE, ARISE, Department of Chemical Engineering, University of Coimbra, Rua Sílvio Lima-Pólo II, 3030-790 Coimbra, Portugal

[b] IPN, Instituto Pedro Nunes, Associação para a Inovação e Desenvolvimento em Ciência e Tecnologia, Rua Pedro Nunes, 3030-199 Coimbra, Portugal

Introduction

The demand for sustainable and biocompatible materials in additive manufacturing has increased interest in renewable raw materials for 3D (bio)printing. **Cellulose stands out due to its abundance, biodegradability, and excellent thermal and mechanical properties. Allyl cellulose (AC),** a cellulose derivative with allyl groups, **is a promising candidate for renewable feedstocks due to its chemical tunability and mechanical properties.** In this work, the physicochemical properties of the photopolymerizable AC derivatives were investigated, **demonstrating compatibility with different 3D printing techniques**. These promising results point to new applications of cellulose hydrogels in additive manufacturing, impacting areas such as bioinks, drug delivery systems, tissue engineering and soft robotics.

Methods

Different cellulose sources (Avicel® and industrial cellulose pulp) were **dissolved in an aqueous alkali-urea** system and modified to obtain AC derivatives with controlled DS. (Fig. 1)

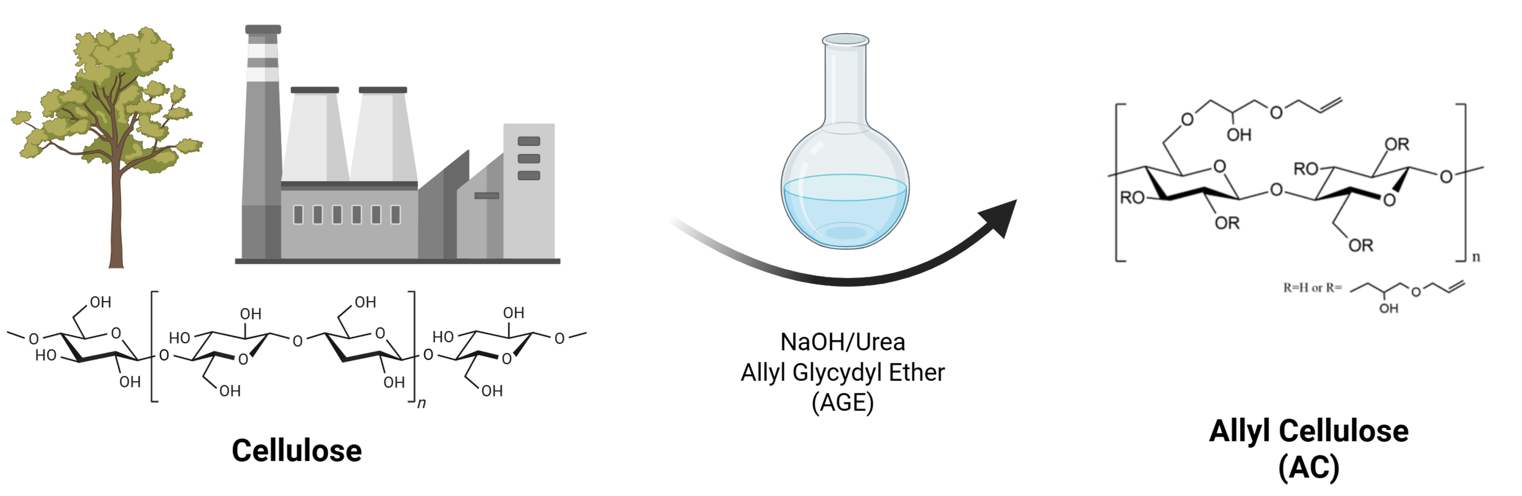

Fig. 1 . Cellulose dissolution and functionalization to obtain the photopolymerizable AC derivatives

All-cellulose hydrogels were fabricated via DLP 3D printing of resins with varying AC concentrations, degrees of substitution (DS), and cellulose sources. (Fig. 2)

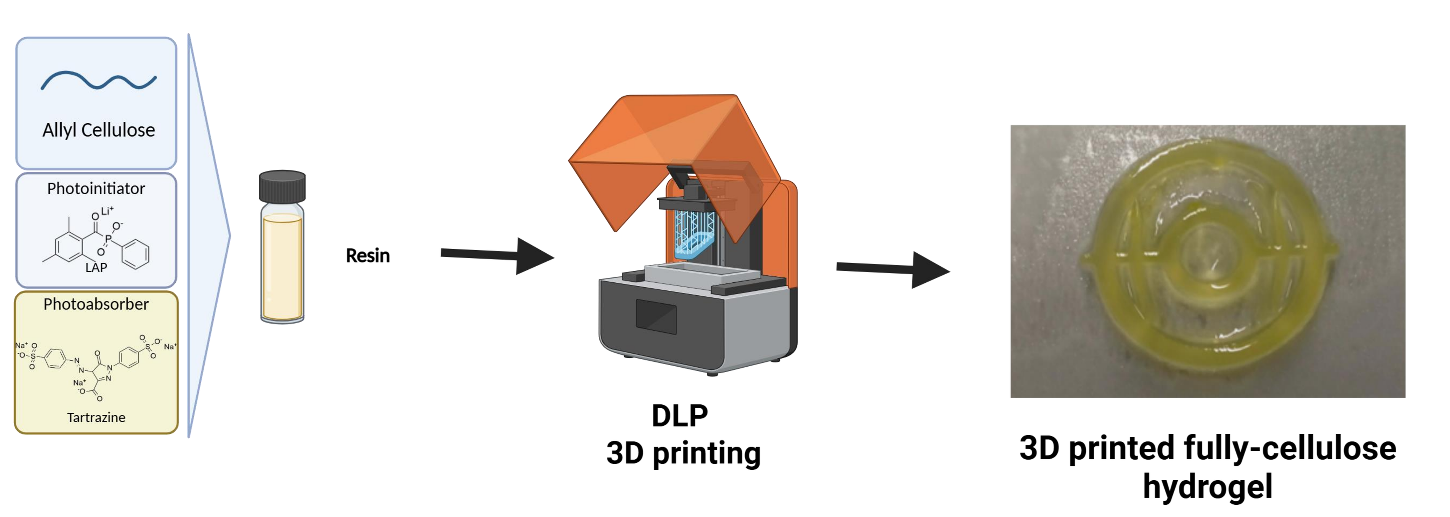

Fig. 2 . Additive manufacturing of all-cellulose hydrogels via DLP 3D printing

Results

Water-soluble AC derivatives with controlled DS were successfully prepared and used to **prepare single-component resins.** (Fig. 3)

Fig. 3. CAD model and 3D-printed all-cellulose hydrogel using a DLP process

The 3D-printed all-cellulose hydrogels showed:

- **High gel content (over 80%)**
- **Excellent swelling capacity (<350%)**
- **Good mechanical properties (σ ≈ 120 kPa)**

Additionally, high cell viability was observed when hydrogels were cultured with NHDF cells, **indicating their promise in biomedical applications.**

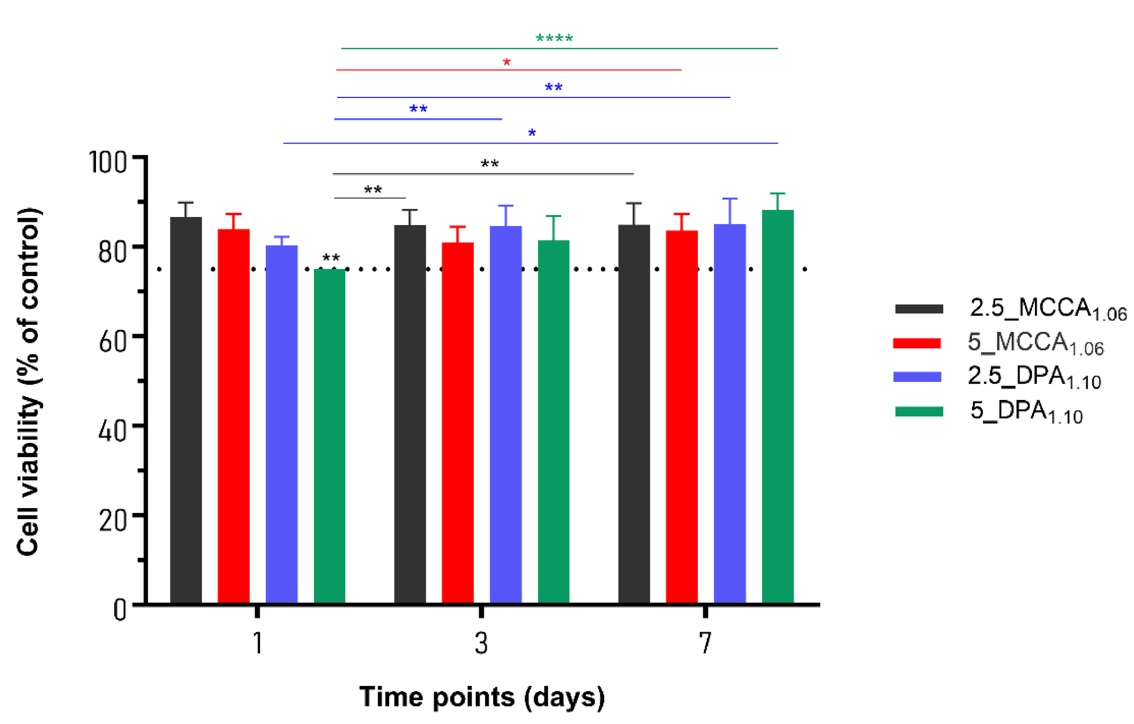

Fig. 4. Cell viability (%) of NHDFs exposed to hydrogels over periods of 1, 3, and 7 days (n = 5)

Conclusions

- **Single-component, fully cellulose resins** were developed for DLP 3D printing of hydrogels;
- The **AC photopolymers can be used to print hydrogels** with good resolution and improved shape fidelity, **opening opportunities for their application 3D (bio)printing.**

Refs: Hu et al., 2015. *Polym. Chem.*, 6(18): 3543–3548 ; Rashid et al., 2023. *Mater. T. Sus.*, 24: 100529 ; Silva et al., 2025. *Int. J. Biol. Macromol.*, 306: 141389

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