

Compressive stiffness of PhotoAlginate-INK

BIONOVA X | PhotoAlginate-INK

Summary

This study characterizes the compressive stiffness of PhotoAlginate-INK photoink printed with BIONOVA X using multiple printing approaches and exposure conditions, demonstrating the strategical options to generate a range of soft material constructs.

- PhotoAlginate-INK produced consistently soft hydrogel constructs with compressive moduli ranging within approximately 0.4-1.7 kPa.
- Similar stiffness values were achieved using layer-by-layer (1 layer of 1 mm or 10 layers of 100 μ m), and continuous print modes by adjusting exposure parameters.
- The ability to obtain comparable mechanical properties across print modes provides flexibility in selecting a printing strategy based on model geometry or workflow requirements.

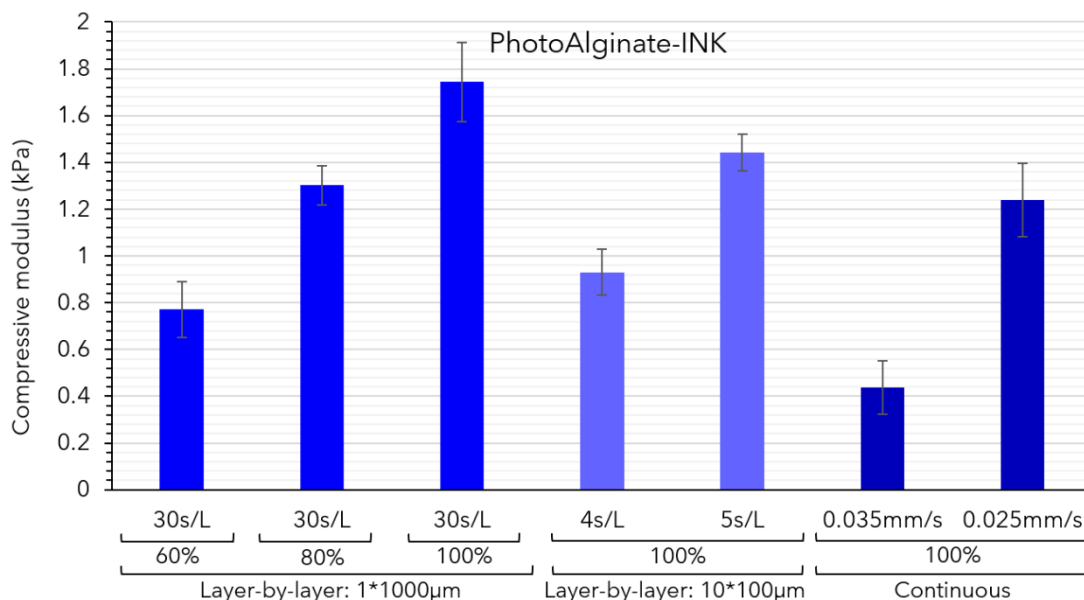


Figure 1. Compressive modulus of PhotoAlginate-INK discs (5 mm diameter, 1 mm height) printed with BIONOVA X using layer-by-layer (1*1000 μ m or 10*100 μ m layers) and continuous print modes with varying intensities (%), exposure times (seconds per layer = s/L) and speeds (mm/s).

Results and conclusions

Constructs were fabricated using CELLINK's BIONOVA X DLP bioprinter under controlled and reproducible printing conditions. The compressive stiffness of PhotoAlginate-INK constructs was evaluated across different print modes and exposure settings to assess the impact of processing parameters on final mechanical properties.

Representative images of printed PhotoAlginate-INK constructs after overnight incubation in PBS are shown in **Figure 2**, demonstrating good structural integrity prior to mechanical testing.



Figure 2. Representative images of constructs (5 mm diameter, 1 mm height) printed using layer-by-layer mode with 1 layer of 1 mm exposed for 30 s with 80% intensity (A), 10 * 100 μm layers with 5s/L at 100% (B) and continuous mode with 0.025 mm/s at 100% (C) after overnight PBS incubation.

Compression testing showed that PhotoAlginate-INK consistently produced soft hydrogel constructs across all evaluated print modes, with compressive moduli ranging from approximately **0.4 to 1.7 kPa (Figure 1)**. Similar compressive moduli could be achieved using layer-by-layer printing mode (with 1 or 10 layers) and continuous printing mode by adjusting the corresponding exposure parameters, providing flexibility in print strategy without substantially altering mechanical properties.

Overall, the results demonstrate that PhotoAlginate-INK can be printed reproducibly using the BIONOVA X while maintaining the soft mechanical characteristics expected for alginate-based hydrogels.

Methods

Bioink preparation

PhotoAlginate-INK was used as ready-to-print photoink at 2% (w/v) polymer concentration. The material was homogenized by gently inverting the tube 5 times before loading into the [BIONOVA X 24-well plates](#) using a positive displacement pipet.

Bioprinting with BIONOVA X

Printing of discs (5 mm diameter, 1 mm height) in 3 replicates per condition was performed following the [PhotoAlginate-INK bioprinting protocol](#), using layer-by-layer (1 layer of 1 mm or 10 layers of 100 μm each) and continuous print modes with exposure times, intensities, and print speeds specified in **Table 1**. Cell viability performance for PhotoAlginate-INK photoink has been evaluated separately and is reported in [Supporting cell viability Data](#).

Table 1. Print exposure parameters for PhotoAlginate-INK on BIONOVA X using continuous and layer-by-layer print modes. 100% intensity corresponds to $\approx 16 \text{ mW/cm}^2$ irradiance.

Print mode	Layer height	Parameter settings	
		Exposure time	Intensity
Layer-by-layer	1 layer of 1000 μm	30 s/layer	60% 80% 100%
	10 layers of 100 μm	4 s/layer 5 s/layer	100%
Continuous	N/A	0.025 mm/s 0.035 mm/s	100%

Compression testing

Compressive modulus was measured using the HR10 rheometer (TA Instruments) and 20 mm plate geometry, at 25°C. Geometry gap was decreased until a positive axial force was detected. Unconfined compression testing was performed with 1% strain/s until 60% strain, and the compressive modulus calculated from the linear region of the stress-strain curves between 5-10% strain.



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