Biopolymer-based aerogels for tissue engineering applications

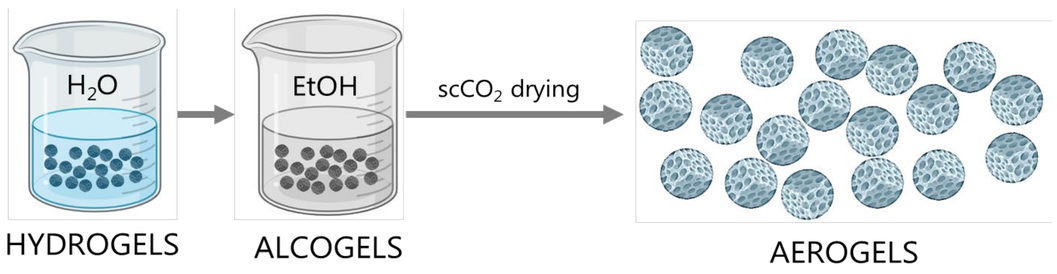
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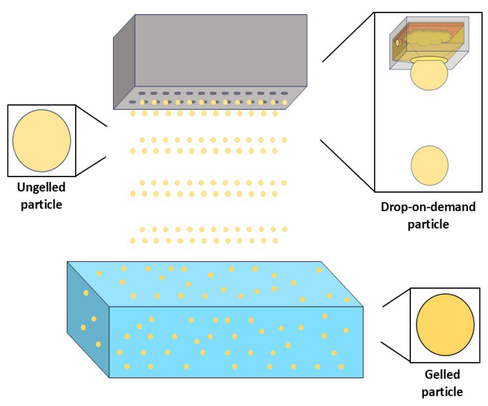
In the AerogelsLab, supercritical CO_2 ($scCO_2$) technology is extensively employed for the processing and sterilization of biomaterials[1], enabling the development of aerogels for tissue engineering scaffolds[2-3] and drug delivery systems[4-6].

AEROGELS FABRICATION

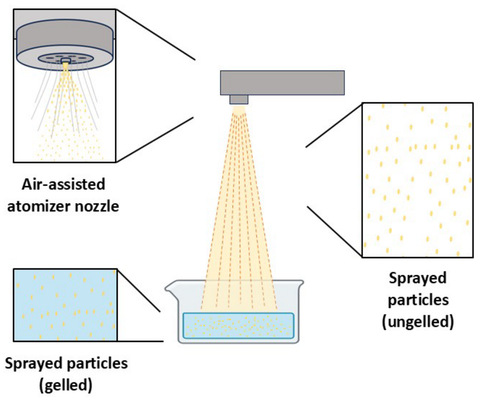


TUNING BIOAEROGELS

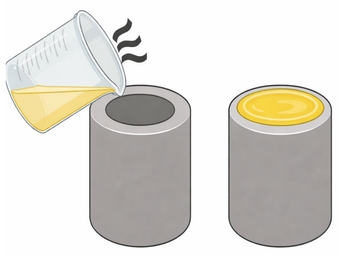
Depending on the intended application, hydrogels and alcogels can be manufactured in various morphologies, from cylindrical molds and particles to personalized shapes created by 3D printing.



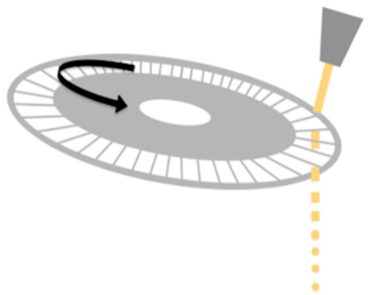
Inkjet printing



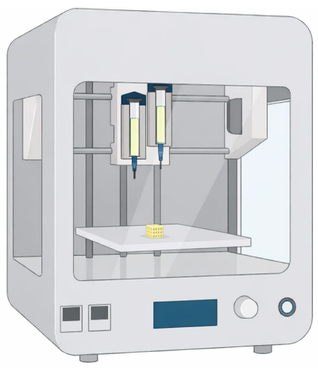
Spraying



Molding



Jet cutting



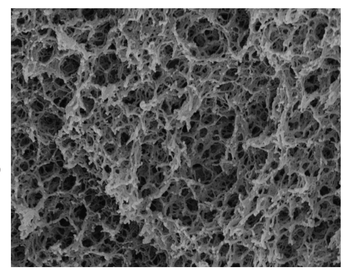
3D printing

Bioaerogels with exceptionally specific surface areas (>100 m^2/g) and porosities above 95% were consistently obtained by the **AerogelsLab** Team, serving as drug delivery systems and tissue engineering scaffolds. The feasibility of *in situ* aerogel sterilization was also strongly demonstrated.

SCAN ME

MEET BIOMEDICAL REQUIREMENTS

$ScCO_2$ STERILIZATION



BIOPOLYMERIC AEROGEL

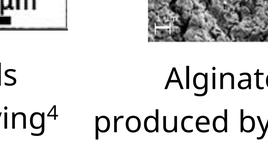
$ScCO_2$ IMPREGNATION

Efficient elimination of microbial contamination under mild conditions, ensuring safety for biomedical applications.[1-2]

STERILE AEROGELS



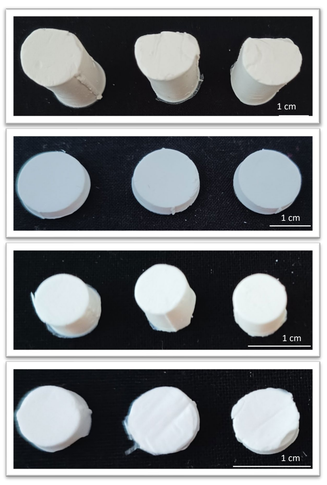
Preservation of initial structure, demonstrating their effectiveness as platforms for controlled drug release.[4-5]



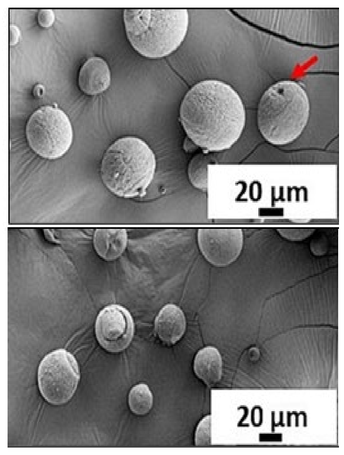
DRUG-LOADED BIOAEROGELS

BIOFABRICATED AEROGELS

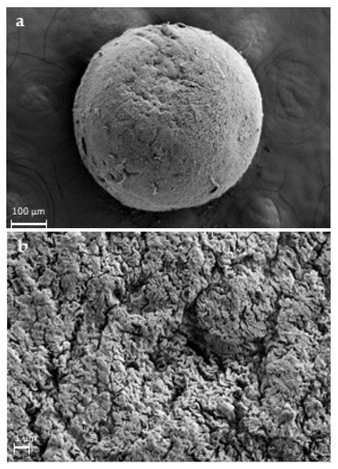
Bioaerogels were able to support cell adhesion and tissue regeneration, enable controlled delivery of bioactive agents, and can be sterilized without compromising structural integrity or bioactivity.



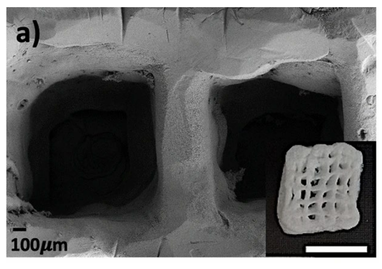
Starch aerogels produced using molds



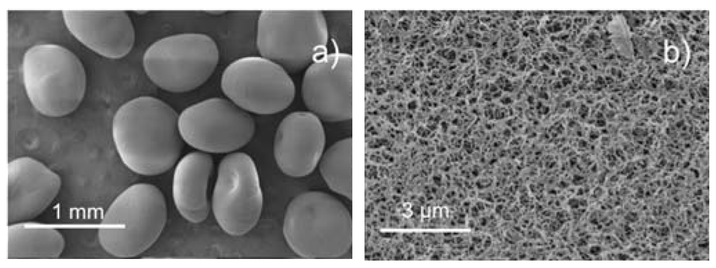
Alginate aerogels produced by spraying[4]



Alginate aerogels produced by inkjet printing[5]



Cellulose aerogels produced by 3D printing[2]



Chitosan aerogel beads produced by jet cutting[6]

REFERENCES

1. M. Carracedo-Pérez et al., Biomater Adv. 2026, 182, 214698.
2. A. Iglesias-Mejuto et al.,Cellulose. 2024, 31, 515-534.
3. L. Goimil et al., J CO2 Utilization, 2017, 18, 237-249.
4. S. Gomes et al., I J Pharm, 2026, 694, 126722.
5. P. Remuiñán-Pose et al., Gels. 2022, 8(7), 417.
6. C. López-Iglesias et al., Chem. Eng. J. 2019, 357, 559–566.

ACKNOWLEDGEMENTS:

This work was funded by MICIU/AEI/10.13039/501100011033 [grant PID2023-151340OBI00], Xunta de Galicia [ED431C2022/2023], GAIN [Vinnovate call, AEROCARE, IN848G 2024/01] and ERDF/EU. S.M.G. and C.I.-B. acknowledge MCINN and FSE+ for their FPI fellowships [PREP2023-000885/AEI/10.13039/501100011033] and [PRE2021-097177/AEI/10.13039/501100011033], respectively. A. I.-M. acknowledges Xunta de Galicia for her postdoctoral fellowship [ED481B-2025/032]. .