Bi-functional scaffold for bone regeneration after osteosarcoma resection

UNIVERSITÀ DI TORINO · Politecnico di Torino

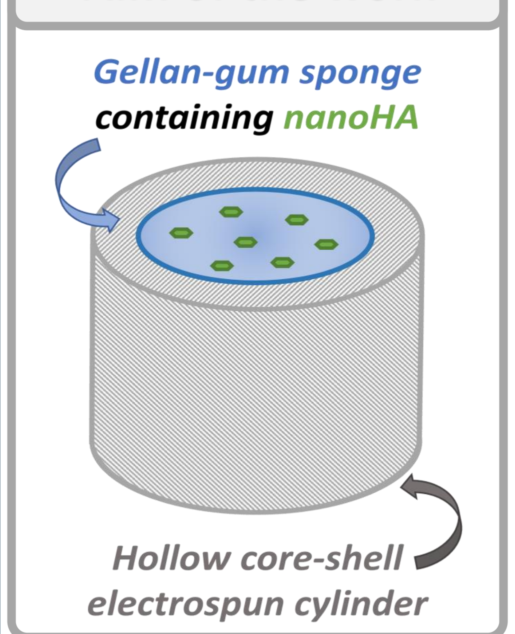
http://www.irisgroup.polito.it/

e-mail:
ilaria.corvaglia@polito.it
chiara.vitalebrovarone@polito.it

Ilaria Corvaglia, 36th Cycle

Department of Applied Science and Technology, Politecnico di Torino, Italy

Aim of the work



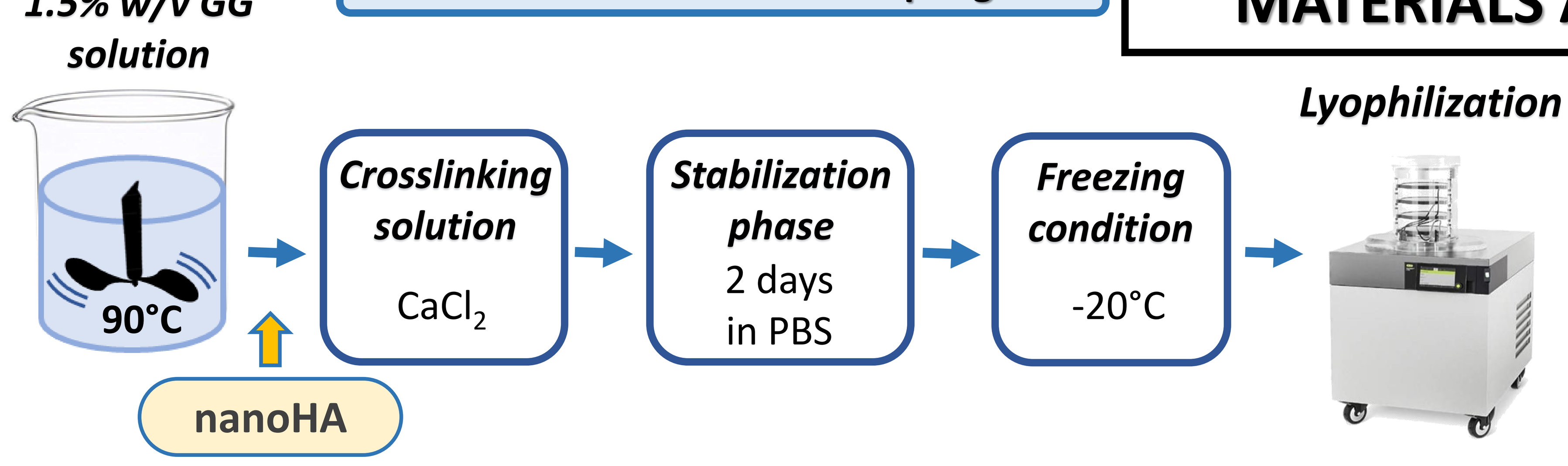
INTRODUCTION

Osteosarcomas (OS) are highly aggressive tumours with a significant prevalence in paediatric patients [1]. OS's therapy usually involves surgery to eradicate tumour mass and subsequently eliminate any residual cells through the administration of chemotherapeutic drugs. OS surgical resection creates large bone defect, therefore there is a considerable interest in developing new strategies for the design of bone substitutes that can fill the void left by the surgical operation and support bone regrowth. Moreover, in order to prevent tumour recurrence several strategies for the release of drugs have been extensively explored.

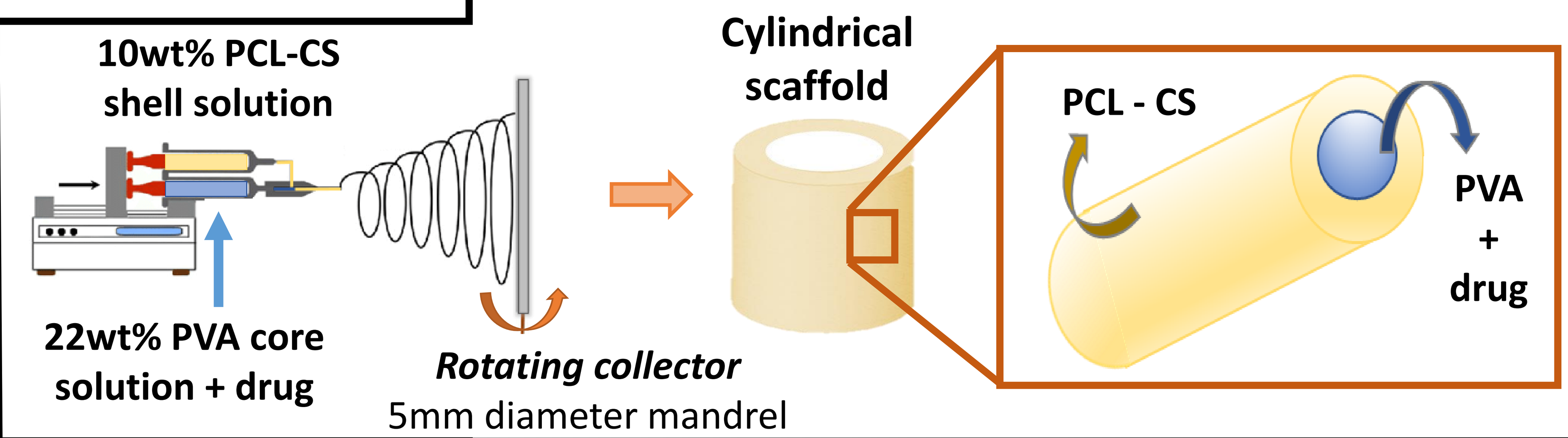
In this research, a multicomponent device is fabricated by combining a hollow, cylindrical electrospun membrane with a gellan-gum (GG) sponge containing nano hydroxyapatite (nanoHA) particles. The electrospun hollow cylinder has a core-shell structure in which the shell is created by using a poly(ε-caprolactone) (PCL) and chitosan (CS) blend, while the core is made with polyvinyl alcohol (PVA) in which a drug is solubilized (N-acetylcysteine as a model). The chosen biomaterials are polymers that have widely shown their potentiality in regenerative medicine approaches [2]; the nanoHA has been added for its osteoconductive properties and its similarity to the natural bone mineral phase [3].

MATERIALS AND METHODS

Production of nanoHA-GG sponges

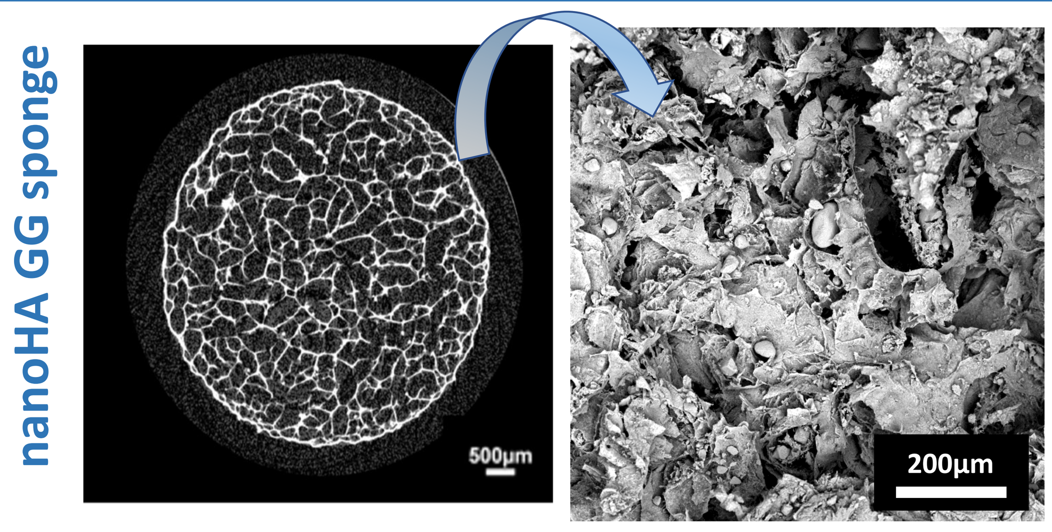


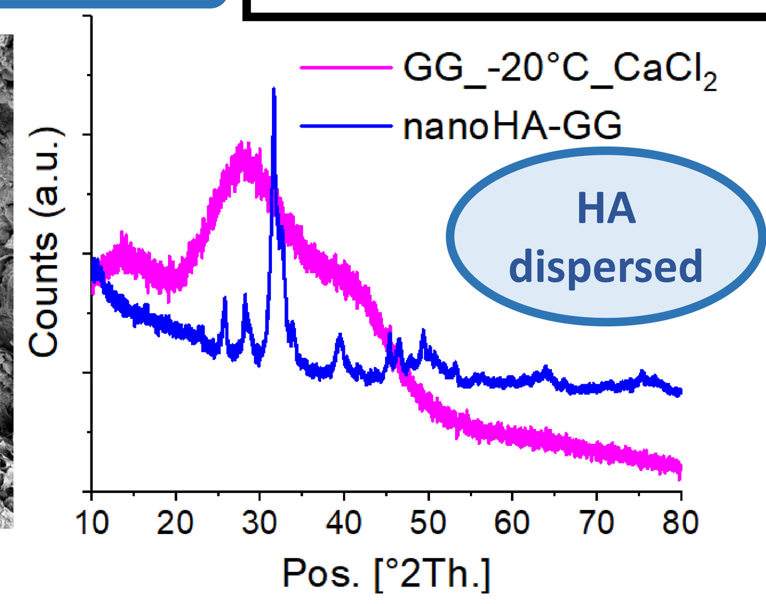
Electrospinning of the hollow cylinder

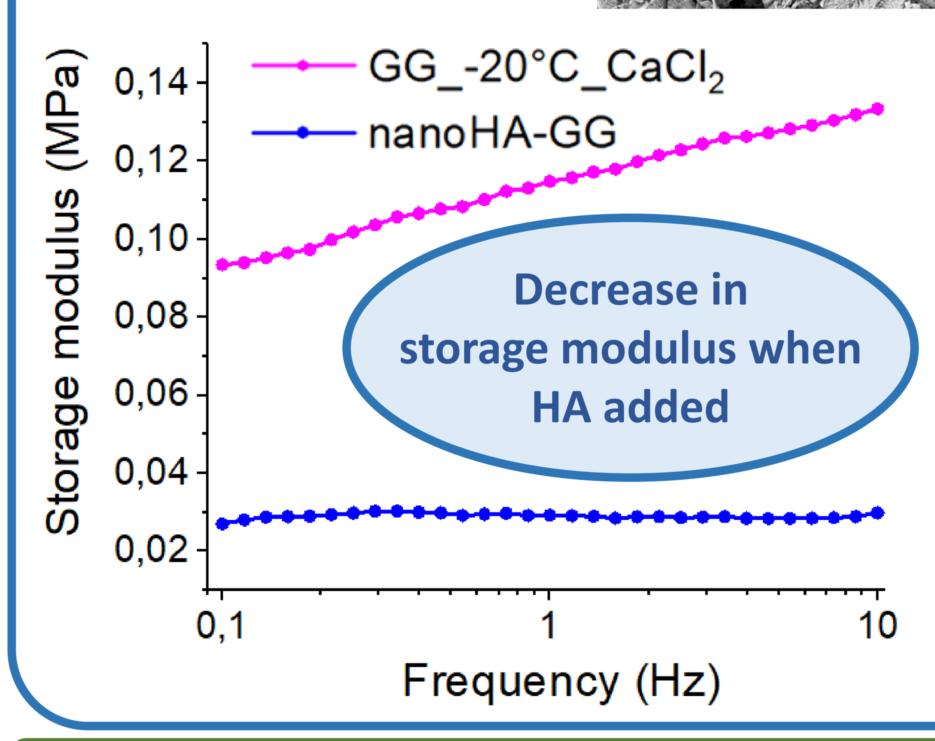


RESULTS

Characterization of the composite sponge



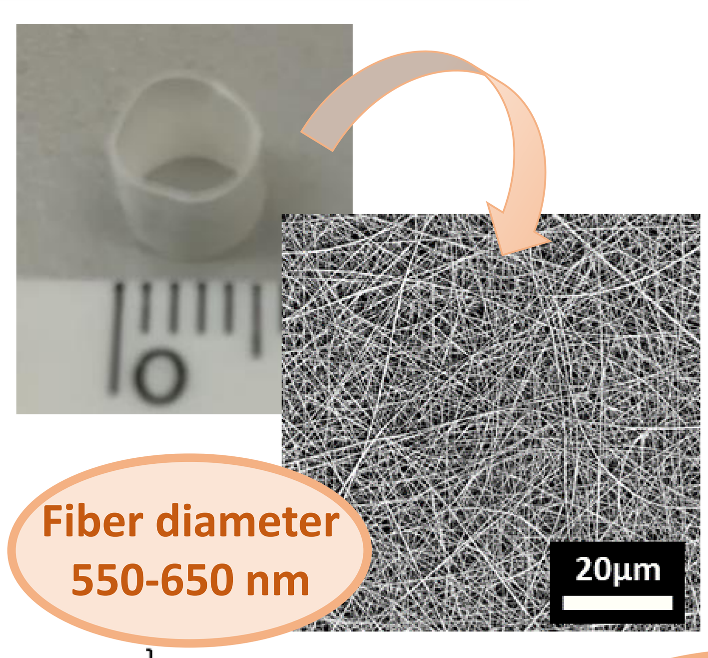


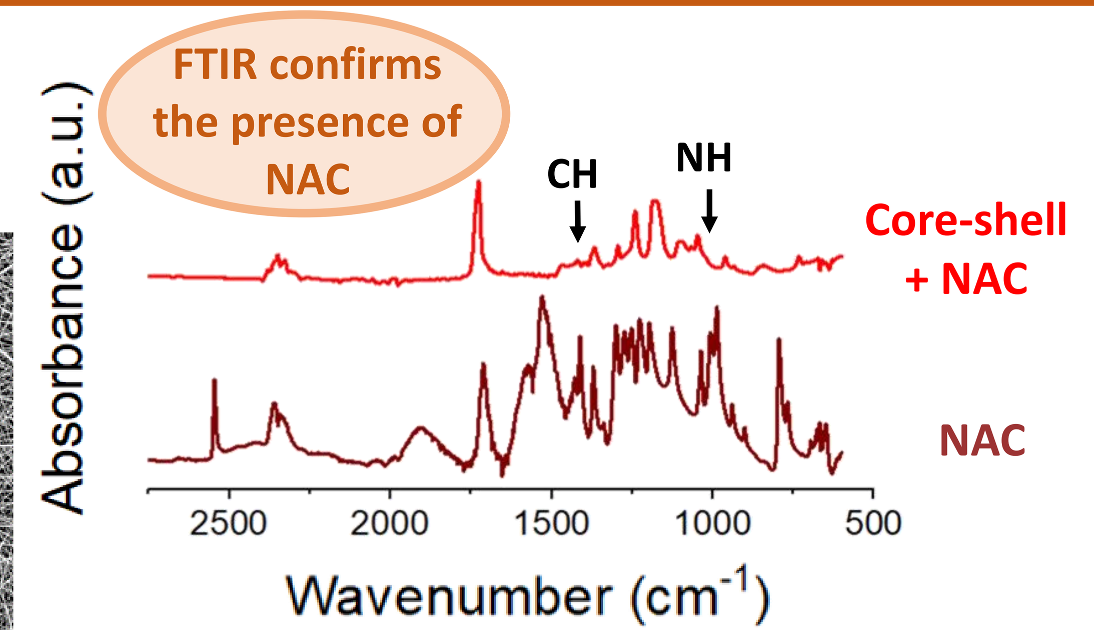


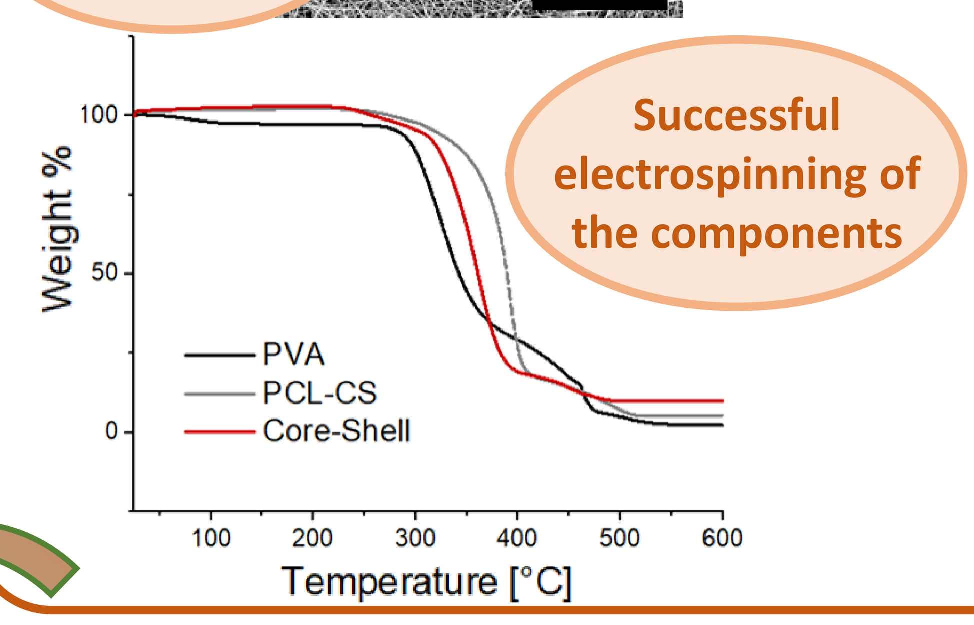
Parameter	nanoHA-GG
Pore size range (µm)	200 - 400
Total porosity (%)	87.1 ± 0.8

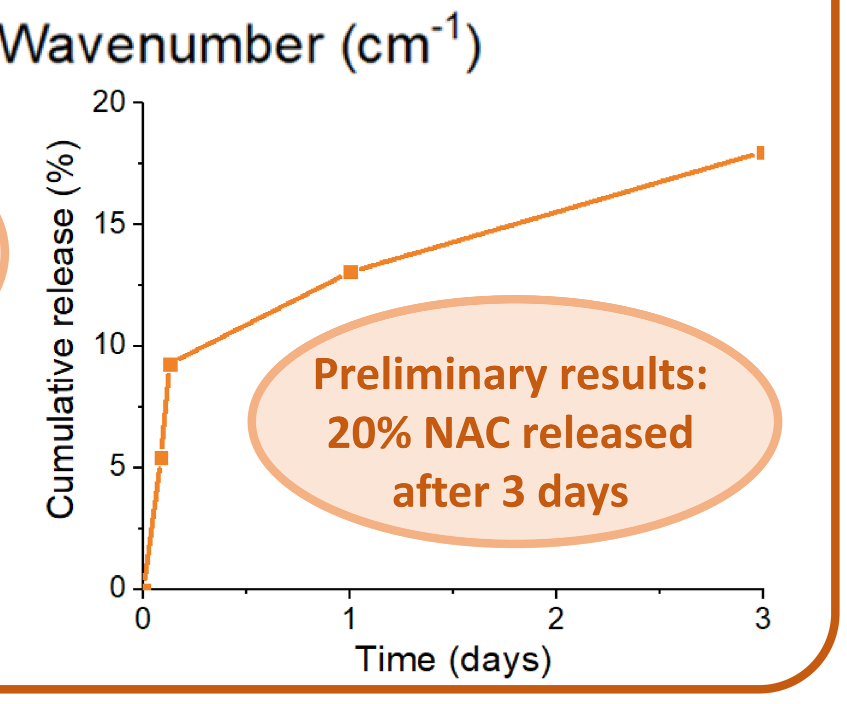
Parameters suitable for cellular colonization and bone ingrowth

Electrospinning of the hollow core-shell cylinder

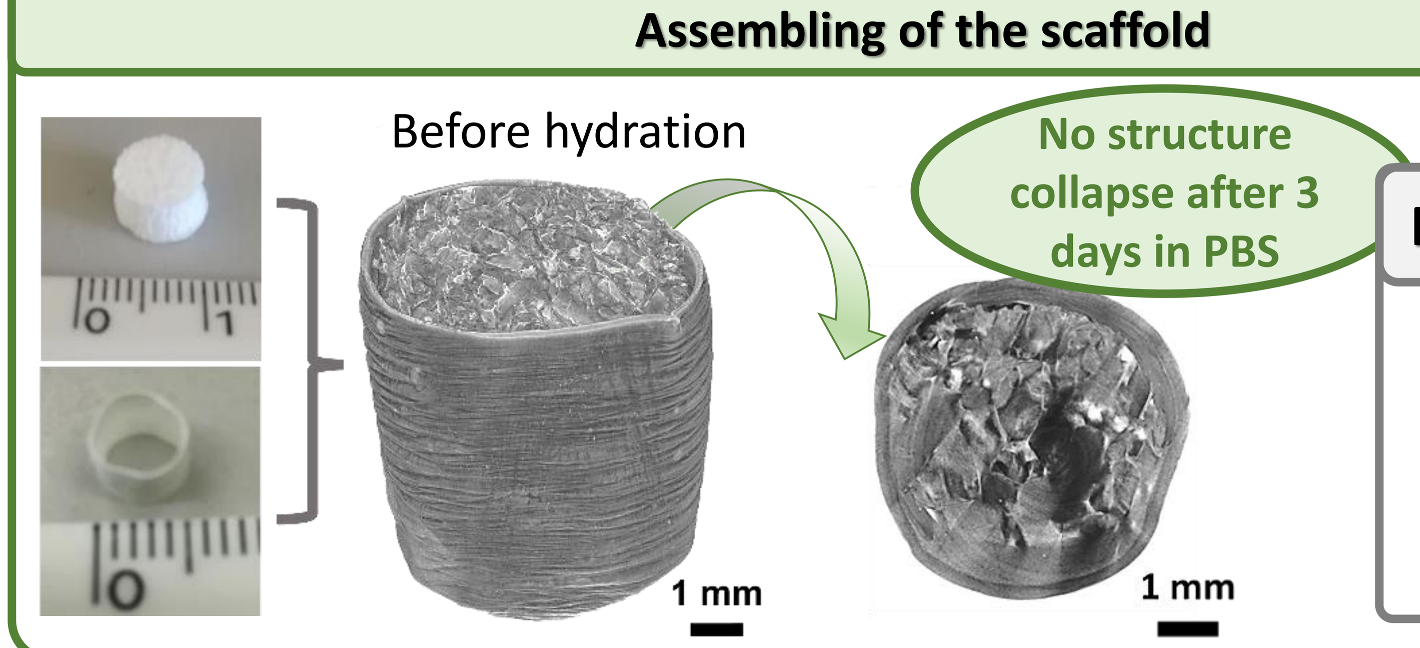








Assembling of the scaffold



FUTURE WORK

- NanoHA degradation
- Cellular validation

CONCLUSIONS

- NanoHA-GG sponges with a uniform inorganic phase distribution and suitable pore dimension for cellular colonization have been produced.
- Tubular electrospun scaffolds with a fiber dimension of around 550-650 nm were prepared and preliminary results proved a sustained drug release over time.
- The combination of the scaffolds produced by two different processing techniques allowed to obtain a bi-component platform that would be able to sustain bone regrowth while releasing drugs to avoid tumoral relapse.

HARD SKILLS

Engineering of surgically inspired medical devices

- Polymeric and inorganic biomaterials
- Surface modifications and nanotechnology
- Biomaterials in surgery: unmet needs
- Case studies

Planning, management and analysis of chemical and laboratory research

- approach on literature search
- plan lab test and clinical research
- legislation of clinical research, ethical committee

Additive Manufacturing: electron beam melting (EBM)

- Overview on EBM technique
- Practical studies of EBM applications
- Practical activities in lab

Tools and technologies for product development

- application of CAD/CAE technologies to design, simulate and virtual verify the product development

→ CSWA certification acquired

Synthesis methods to tailor the surface and the structure properties

- Synthesis methods for inorganic and hybrid materials
- Strategies to control surface and structure properties
- Case studies

REFERENCES

1. Rickel K., Bone, 102:69-79, 2017
2. Shi C, Annals of Joint, 1:27-27, 2016
3. Costa L., Osteochondral T. Eng., 1058:281-304, 2018

SOFT SKILLS

- Computer ethics
- Communication
- Research integrity

Tutors: Prof. Chiara Vitale-Brovarone, Prof. Sonia Fiorilli

PhD Day 2022
25th October 2022, Dental School, Torino