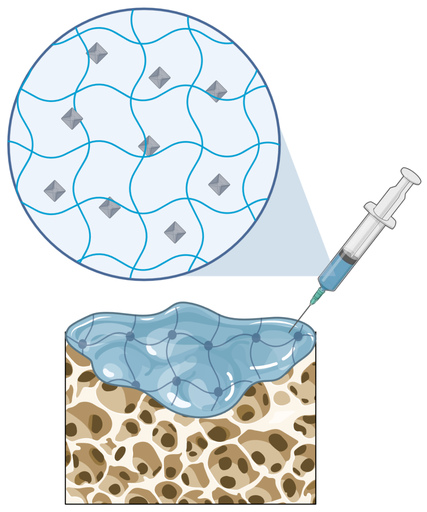
Multi-functional composite hydrogels for bone regeneration

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Introduction

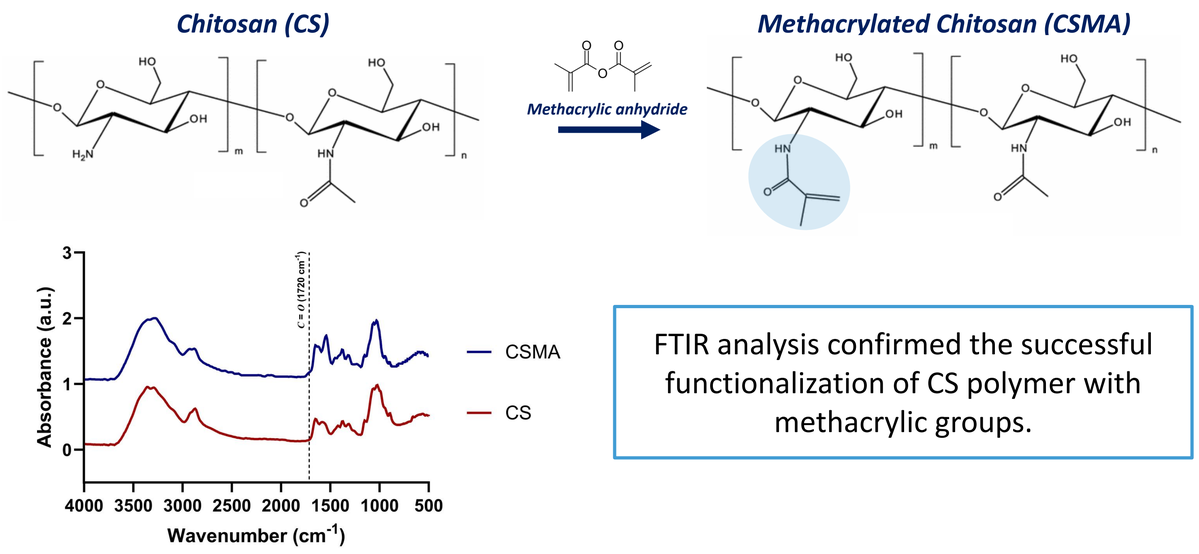
The treatment of **bone atrophy** and **complex fractures** remains a **clinical challenge** as current therapeutic approaches, including bone grafts and synthetic cements, are limited by surgical invasiveness, infection risks, and immune rejection. To address these drawbacks, **injectable hydrogels** have emerged as promising alternatives to develop novel **biomaterial-based solutions** for **bone repair**.



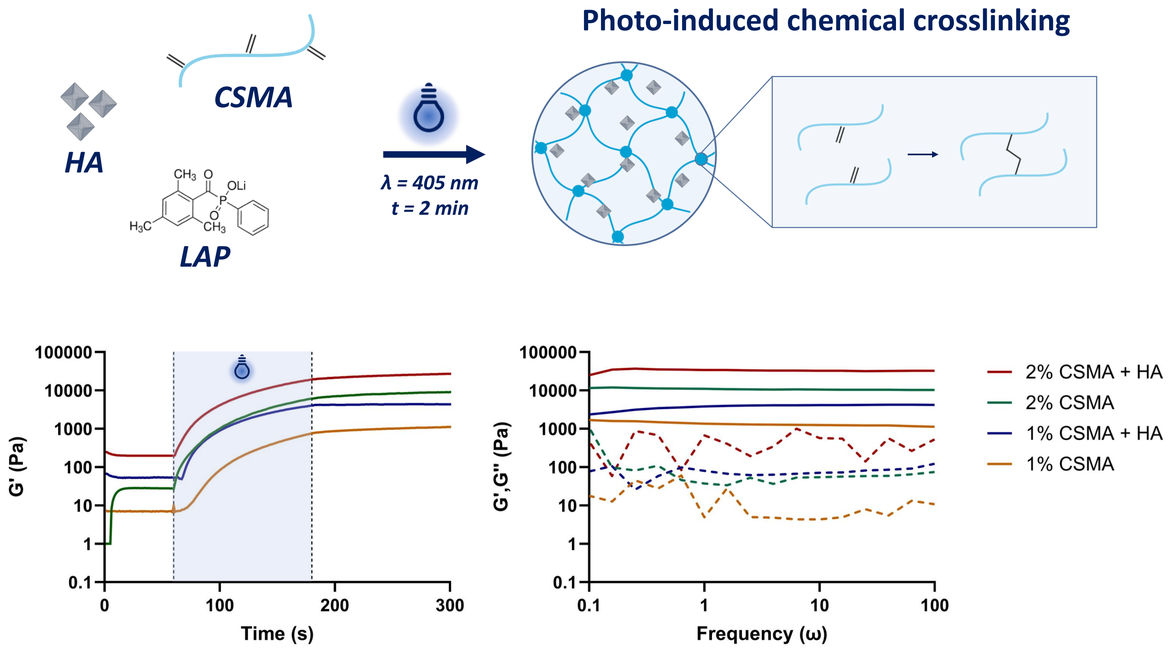
The aim of this work is to **design multi-functional composite hydrogels**, composed of **naturally derived polymers** and substituted hydroxyapatite, to support bone regeneration after vertebral and alveolar fractures.

Methodologies and Main Results

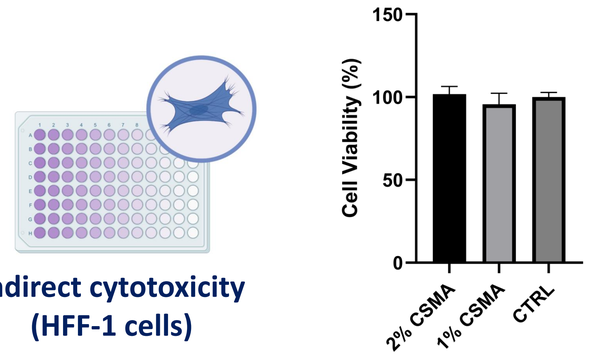
Photo-sensitive hydrogels



FTIR analysis confirmed the successful functionalization of CS polymer with methacrylic groups.

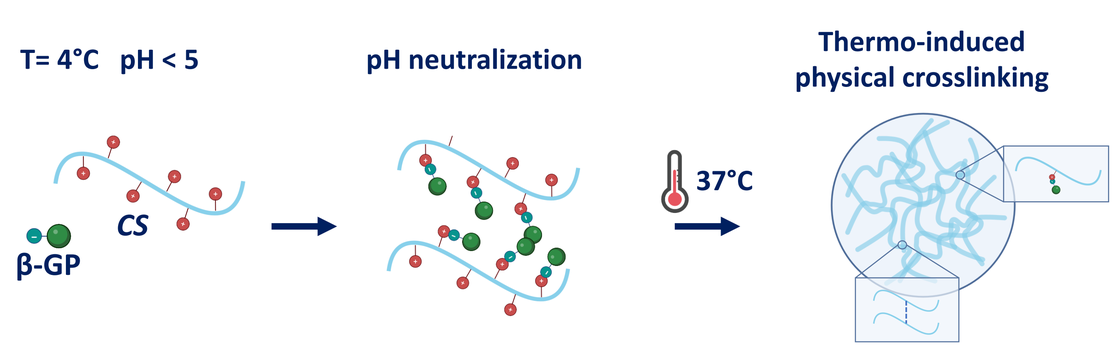


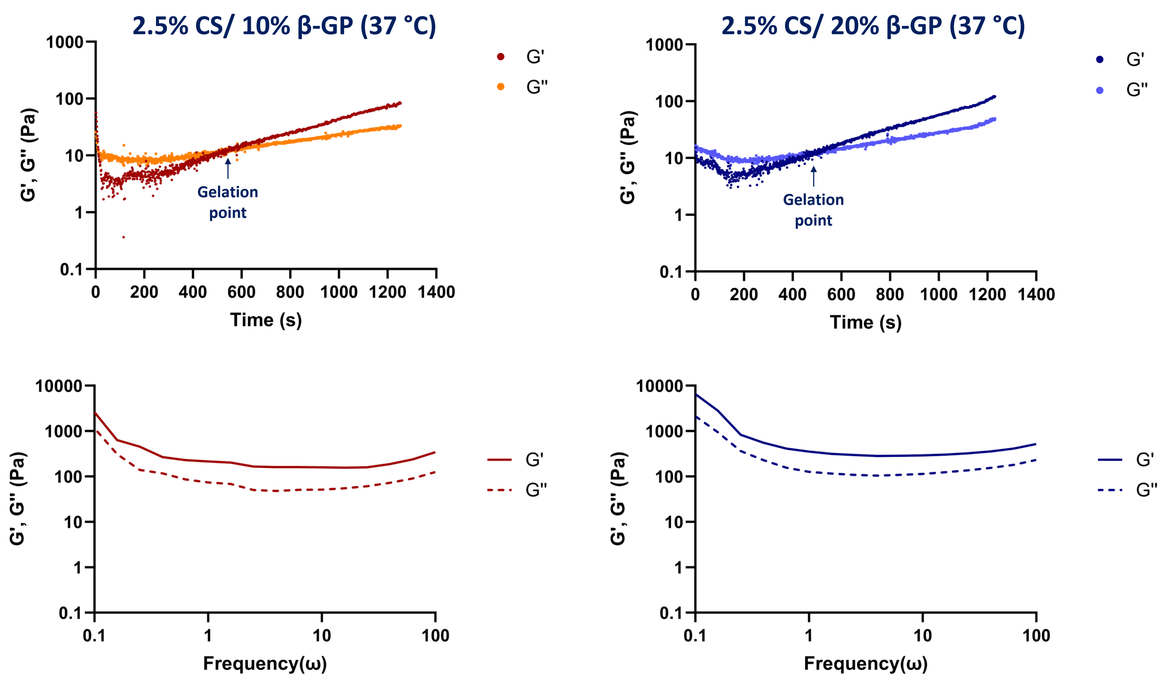
Rheological analyses demonstrated fast crosslinking of CSMA hydrogels after light irradiation and stable gel-like behavior at physiological temperature. The incorporation of substituted HA was proven to increase hydrogel mechanical properties.



In vitro analysis demonstrated the biocompatibility of photo-sensitive hydrogels.

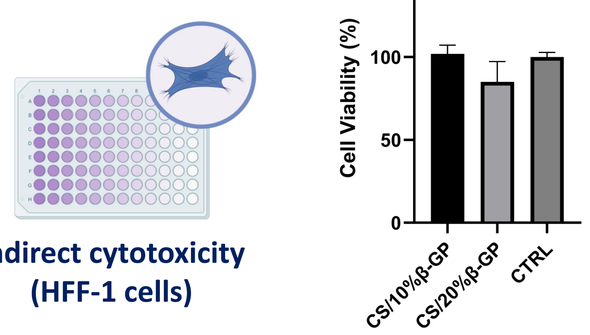
Thermo-sensitive hydrogels





CS (% w/v)	β-GP (% w/v)	pH	Time (min)
2.5	10	6.8	5
2.5	20	7.0	5

Rheological analyses demonstrated sol-gel transition of CS/β-GP hydrogels within 5 min at 37 °C and stable gel-like behavior under physiological conditions.



In vitro analysis demonstrated the biocompatibility of thermo-sensitive hydrogels

Conclusions

The here proposed hydrogels meet essential requirements for in vivo applications, representing innovative solutions to develop minimally invasive methods in bone regeneration. Future studies will be aimed at exploring the use of these systems as functional platforms for the local administration of therapeutic compounds.

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