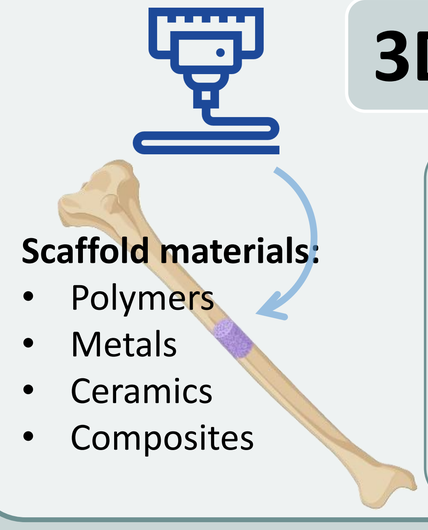
3D-printed pyrolytic carbon microlattices: a novel scaffold platform for musculoskeletal tissue engineering

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3D printed scaffold for bone tissue engineering

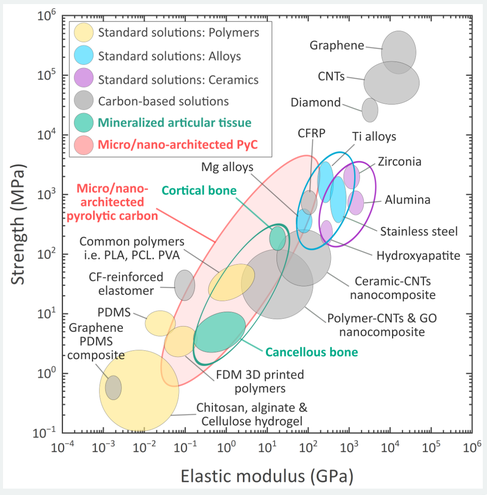


Scaffold materials:
- Polymers
- Metals
- Ceramics
- Composites

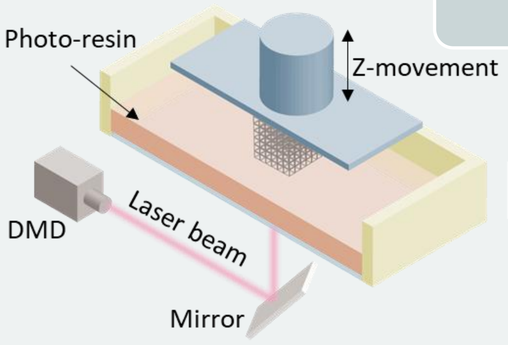
Current challenges:
- **Mechanical mismatch:** Polymer scaffolds are too soft for load-bearing. Ceramics are too stiff.
- **Fabrication limitations:** Challenging and expensive to make metals/ceramics at bone pore scale.

Pyrolytic carbon (PyC): A novel solution

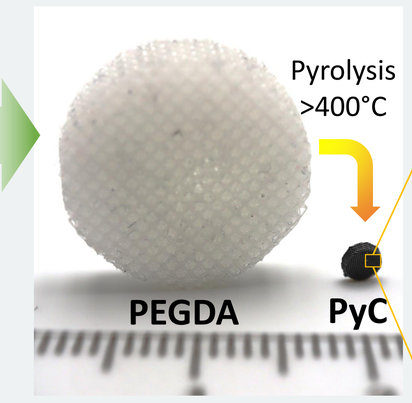
Unique features:
- Facile micro/nano-scale patterning through pyrolysis
- Good biocompatibility
- Mechanical compatibility
- MRI compatible



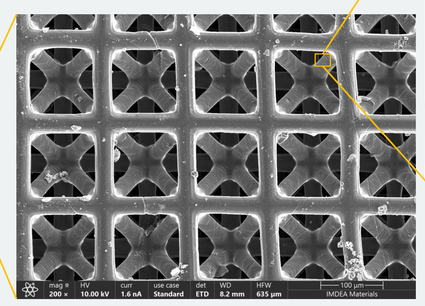
Fabrication of 3D printed PyC microlattices

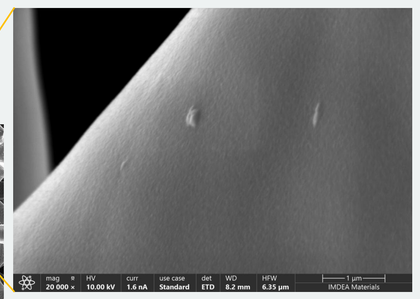


Resin: Polyethylene glycol diacrylate (PEGDA) + Photo-initiator

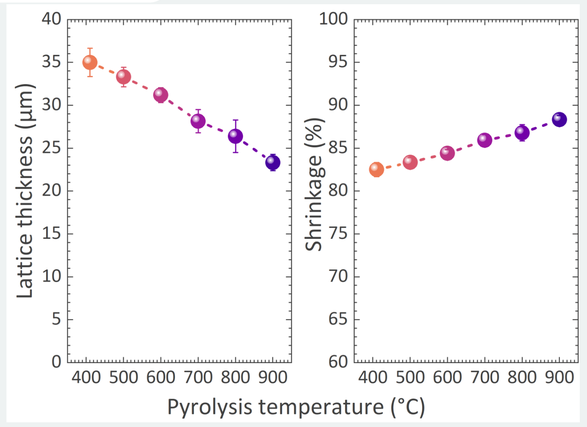


Geometry retention despite drastic shrinkage



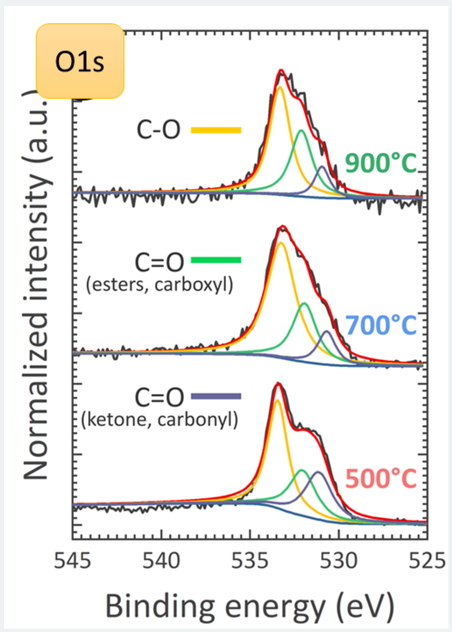


Geometry and temperature-dependent shrinkage

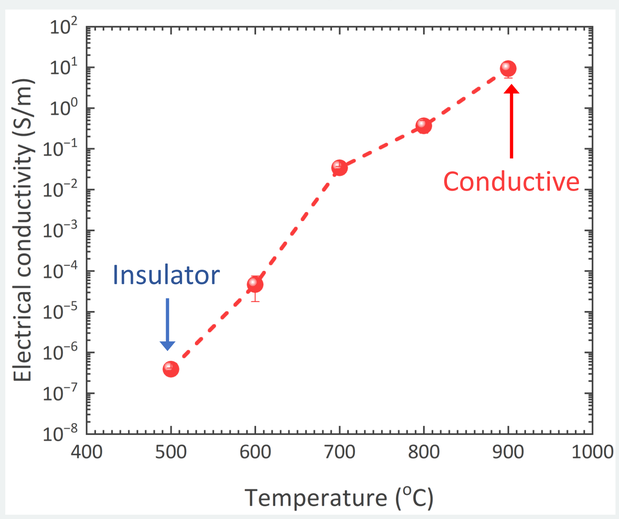


Tunable properties of 3D PyC

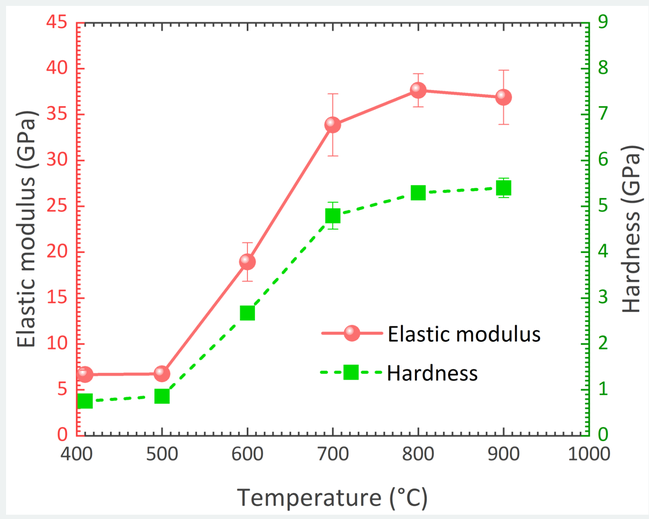
Surface functionalization



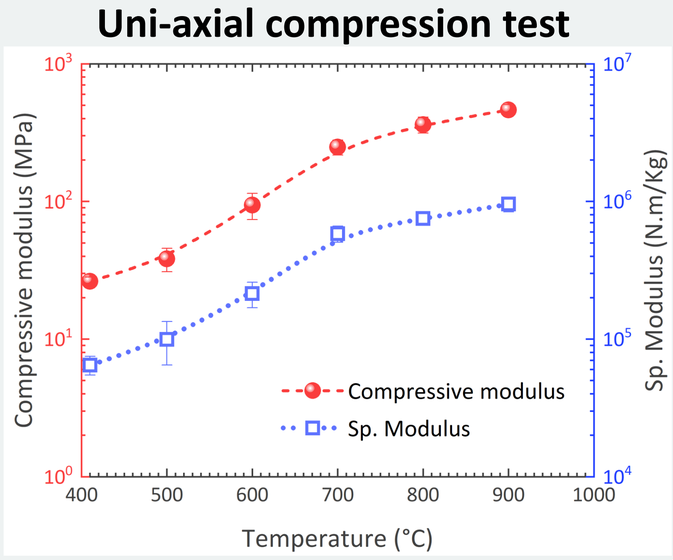
Electrical properties



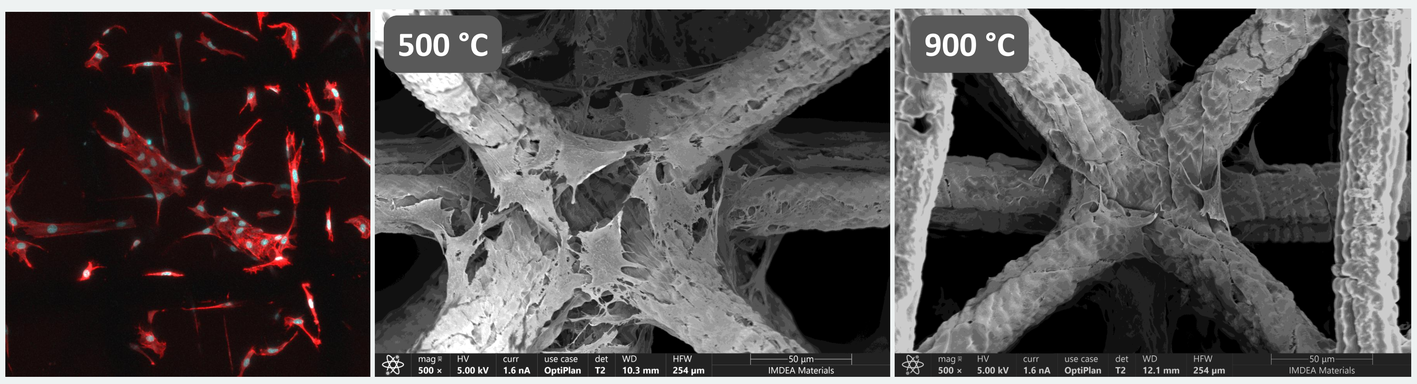
Nanoindentation



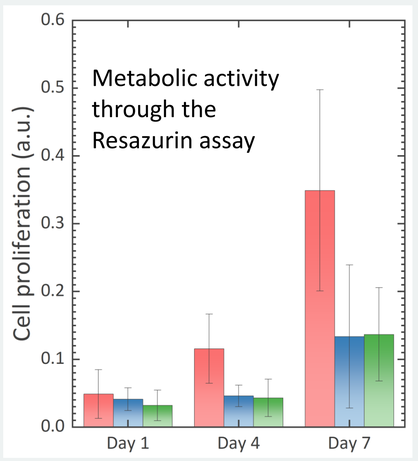
Uni-axial compression test



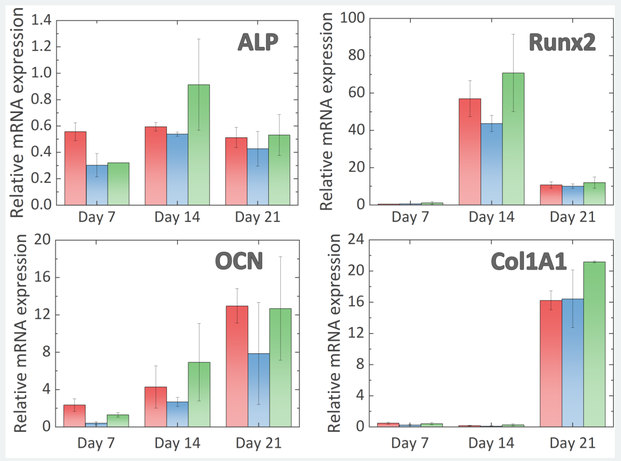
MC3T3-E1 cells on 3D PyC



Proliferation



RT-PCR for differentiation



- Excellent bio-compatibility
- Conformal 3D growth over PyC microlattices
- Temperature-dependent proliferation and differentiation behavior of MC3T3-E1 cells

Conclusion

- **Tailored Fabrication:** 3D printing and pyrolysis enable precise control over scaffold architecture and carbon transformation.
- **Mechanical and electrical properties:** High-temperature processing (900°C) achieves bone-like stiffness (~37 GPa) and high electrical conductivity.
- **Biological Control:** Lower temperatures (500°C) boost cell growth, while higher temperatures (900°C) trigger bone cell differentiation.

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