



# BIOINSPIRED DESIGN



“Nature is the ultimate experimental scientist, having billions of years of evolution to design, test, and adapt a multitude of complex materials and organisms”

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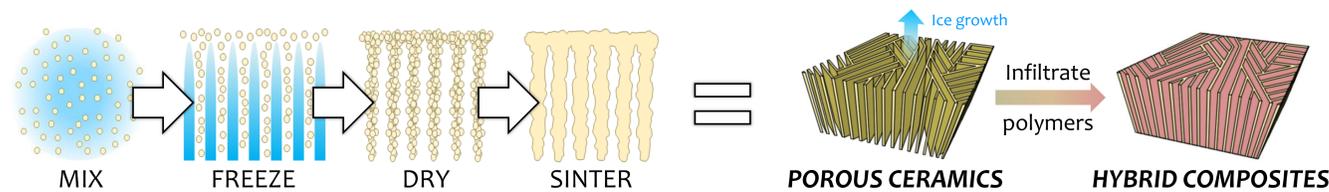
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## Magnetic Freeze Casting

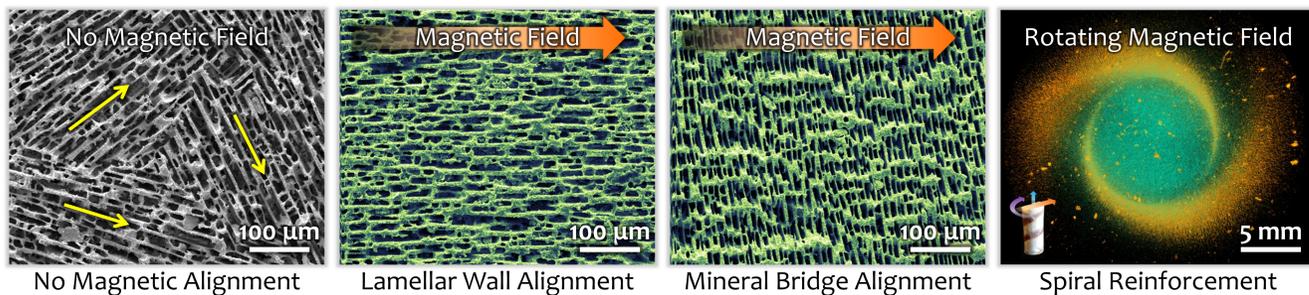
### What is freeze casting?

A materials processing method to form bioinspired materials that mimic the microstructures and mechanical performance of natural materials, such as wood, bone, and abalone nacre.

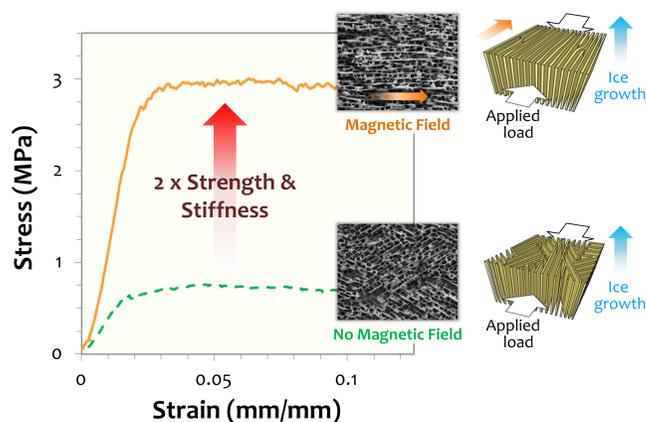


### Why add magnetic fields?

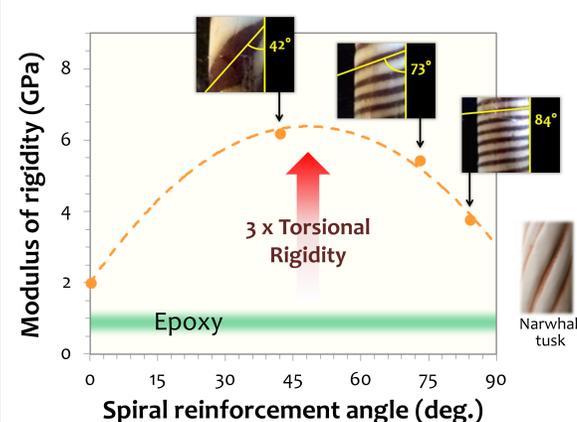
Magnetic fields allow for the manipulation of magnetic particles during ice growth (out of page) to control the microstructural alignment of freeze cast materials in multiple directions.



### Enhanced Compressive Properties



### Enhanced Torsional Rigidity



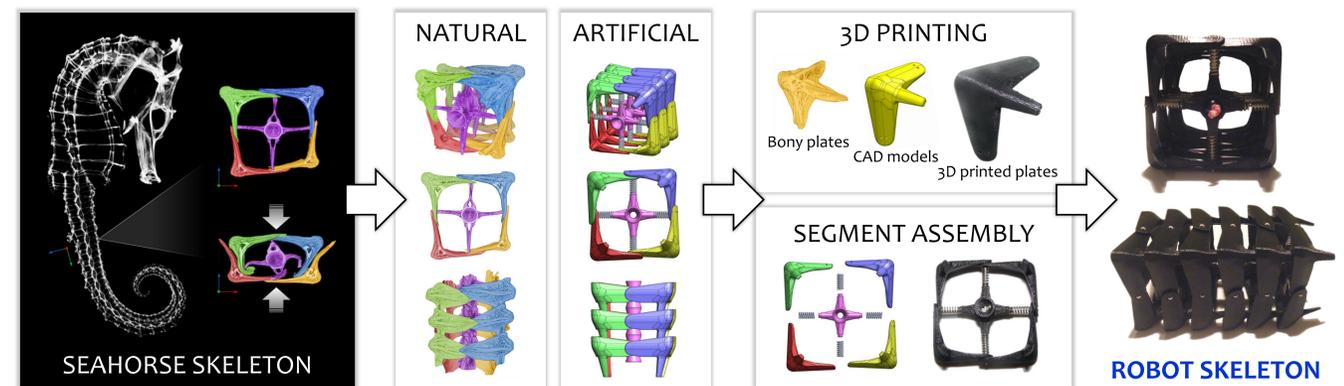
### Potential Applications:

Bone implants, lightweight armor, separation filters, insulators, catalyst supports, fuel cells, piezoelectric devices, and structural materials for automotive and aerospace...

## Seahorse Inspired Robotics

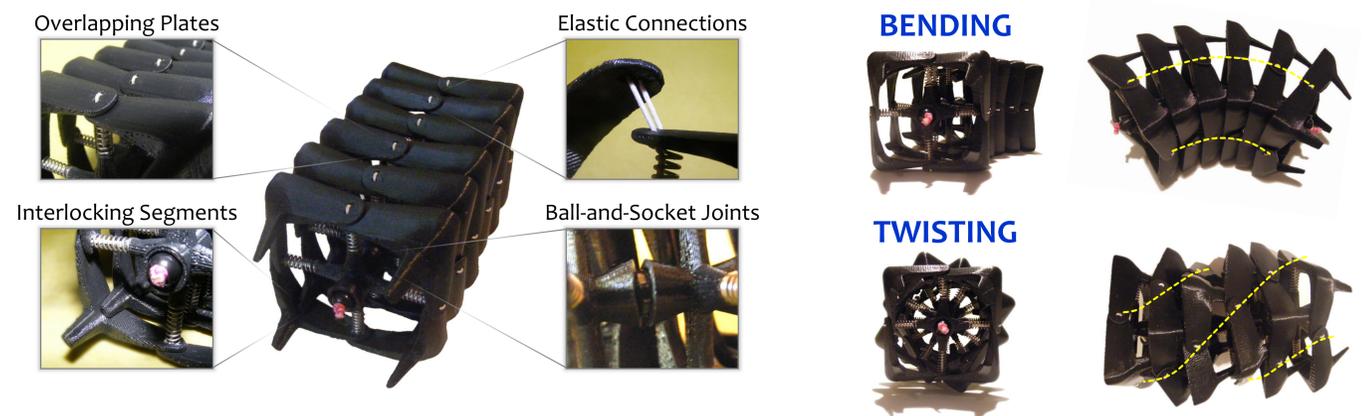
### Why study seahorses?

The seahorse tail is composed of a bony-plated armor arranged in articulating ring-like segments that interlock to facilitate bending and twisting, while overlapping to protect against crushing. Inspired by this unique design, a flexible robot is developed from hard, 3D printed plates and soft, polymer actuators (mimicking the bony armor and musculature of a seahorse tail).



### How are seahorse-inspired robots better than others?

Traditional robots have rigid joints that restrict complex motions, while similar robots inspired by snakes, starfish, octopi, elephants, etc. are composed of hard materials that limit flexibility or soft materials susceptible to failure. This hybrid (hard-soft) design protects the robot, while allowing it to bend, twist, compress, extend, squeeze and expand in multiple directions.



### What's next?

Insert dielectric elastomers and develop control systems to power the robot and navigate motion.

### Potential Applications:

Medical – flexible prostheses, controllable catheters, robotically-assisted surgical instruments...  
Military – flexible armor, surveillance/inspection, armored gripping devices for bomb disposal...