*The 2017 World Congress on*
***Advances in Structural Engineering and Mechanics (ASEM17)***
*Ilsan(Seoul), Korea, August 28 - September 1, 2017*

Keynote Paper

# Bioinspired Structural Materials: Virtual Processing and Virtual Testing

* Chuin-Shan Chen[1)], Heng Lee[2)], Shu-Wei Chang[3)], Yang-Shan Lin[4)]

[1)2)3)] *Department of Civil Engineering, National Taiwan University, TAIWAN*
[1)] *dchen@ntu.edu.tw*
[4)] *Industrial Technology Research Institute, TAIWAN*

## ABSTRACT

Biological structural materials such as nacre and bone have achieved superior mechanical properties as a result of well-designed microstructure with dissimilar, namely soft and bulk, composites. Among all the manufacturing methods to emulate design and assembly principles learned from the nature, freeze casting is a novel and promising way to form a variety of biocomposites with an excellent microstructural control. In this keynote talk, I will present a modeling and simulation framework to perform virtual processing and virtual testing of bioinspired structural materials by freeze casting. For virtual processing, a phase-field model is developed to describe the crystallization in an ice template and the evolution of particles during anisotropic solidification. Under the assumption that ceramic particles can be represented by a concentration field, we derive a sharp-interface model and then transform the model into a continuous boundary value problem via the phase-field method. The adaptive finite-element technique and generalized single-step single-solve time-integration method are employed to reduce computational cost and reconstruct microstructure details. For virtual testing, we adapt the concept of representative volume element and micromechanics to investigate the stress distribution, load transmission as well as crack propagation due to different structural design of soft matrix geometry. We compare different microstructures from freeze casting to explore the relationship between mechanical properties and microstructures of bioinspired structural material. We show that dendritic patterns result in a certain influence on mechanical properties. Finally, we reveal that the design of soft matrix geometry determines the microcrack initiating patterns and impacts the local transmission mechanism of biocomposites.

## REFERENCES

T-H Huang, T-H Huang, Y-S Lin, C-H Chang, P-Y Chen, S-W Chang, C-S Chen (2017) “Phase-Field Modeling of Microstructural Evolution by Freeze-Casting,” *Advanced Engineering Materials*, accepted.

---

[1)] Professor
[2)] Graduate Student
[3)] Assistant Professor
[4)] Research Fellow