IOCB 2025 Conference
The 2nd International Online Conference on Biomimetics
16–18 September 2025 | Online
MDPI

Cellular Solids And Their Modeling Approach: Review

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INTRODUCTION & AIM

- Cellular solids, found in both nature and engineered materials, exhibit remarkable strength, energy absorption, and lightweight characteristics.
- Their performance depends heavily on internal geometry, making accurate modeling essential.
- By studying different modeling approaches, researchers can better understand their behavior and design efficient materials for engineering and biomedical applications.
- Objective: To review, compare various cellular solids modeling approach.

METHOD

Methods of modeling cellular solids

Unit cell model

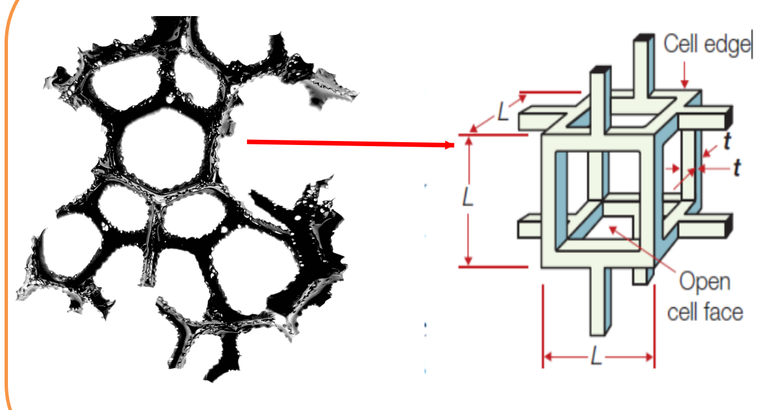
- Cubic model
- Kelvin model
- Tetrahedral model etc...

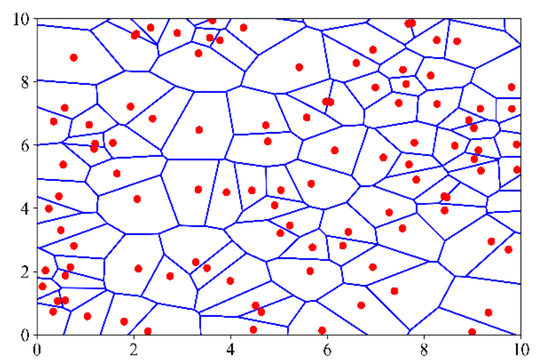
Tessellations models

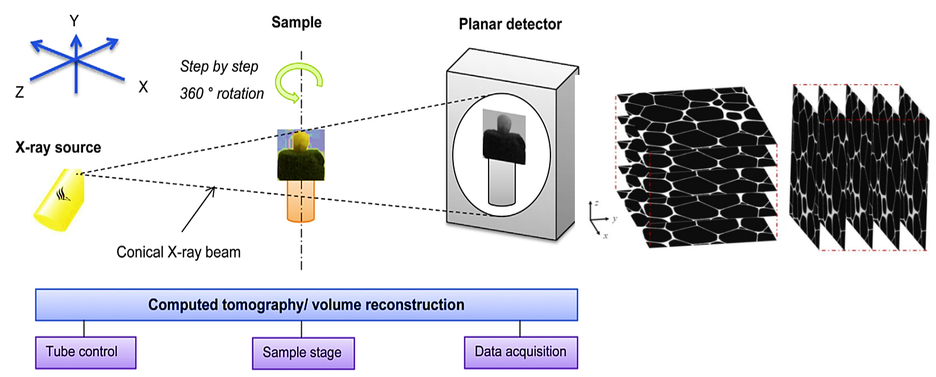
- Voronoi Tesselation
- Laguerre Tesselation
- Poisson-Voronoi Tesselation
- Hard-Core Voronoi Tessellation
- Laguerre-Voronoi tesselation

Digitized Image-Based Models

- Scanning electron microscope (SEM)
- Computed tomography (CT)
- Electron backscatter diffraction (EBSD)
- Magnetic resonance imaging (MRI)







RESULTS & Discussion

Unit cell methods

- can be analyzed by using Euler–Bernoulli beam theory or Timoshenko beam theory.
- Imperfections and randomness that exist in real foam structures cannot be represented in this method

Image based model

- Is the promising method for capture the real microstructure of cellular solids
- it is time consuming, and the computational effort is high, and not al materials are suitable for this method

Tessellation method

- Uses geometric patterns (regular or random) to represent cellular structures.
- Better captures the irregularity compared to unit cell models.
- Provides a balance between accuracy and computational efficiency.

Phenomenological models: gives the best fit of experimental mechanical behavior without direct relationship with the physics of the phenomenon

CONCLUSION

- Cellular solids play a vital role in engineering and biomedical fields due to their unique mechanical properties. Accurate modeling—from simple unit cell methods to detailed CT-based approaches—enhances prediction of behavior and optimization of performance.

FUTURE WORK / REFERENCES

- Future research will continue to refine these models, integrating computational advancements and experimental validation to enhance predictive capabilities and expand the functional applications of cellular solids.

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2. Wacławiak, K.; Myalski, J.; Gurmu, D.N.; Sirata, G.G. Experimental Analysis of the Mechanical Properties of Carbon Foams Under Quasi-Static Compressive Loads. Materials 2024, 17, 5605. https://doi.org/10.3390/ma17225605