



# Multiscale Multiphysics Design Optimization: Level set topology optimization

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# OpenVDB-LSTO

[3.2 billion elements on a Workstation]





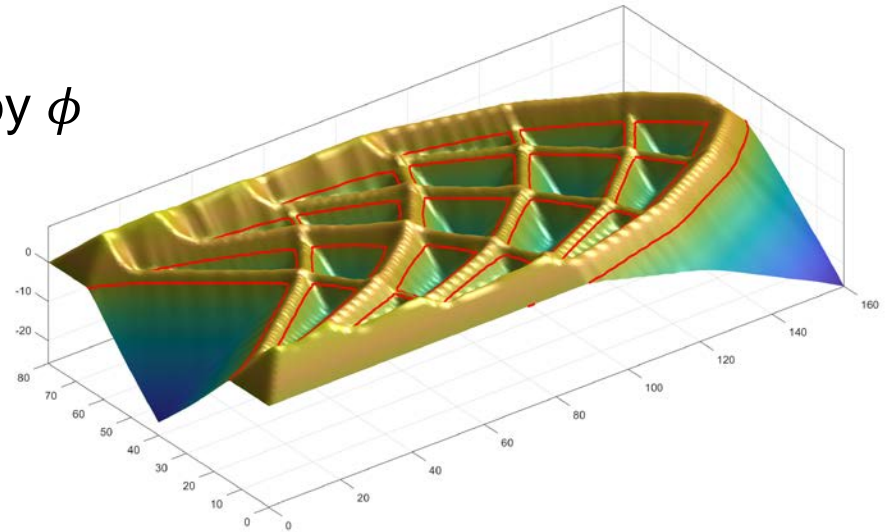
# Level-set Method

Boundary of the structure represented by  $\phi$

$$\phi(x) \geq 0, x \in \Omega$$

$$\phi(x) = 0, x \in \Gamma$$

$$\phi(x) < 0, x \notin \Omega$$



Update  $\phi$  every iteration depending on the normal velocities  $V_n$

$$\frac{\partial \phi}{\partial t} + |\nabla \phi| V_n = 0$$

**No filtering or regularization**

**CFL Condition**

**Narrow band only**

# Bridge

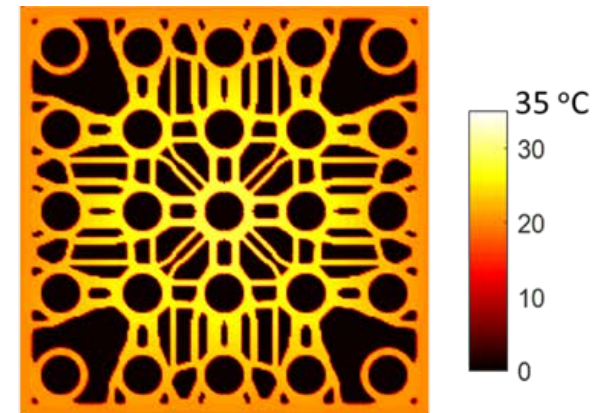
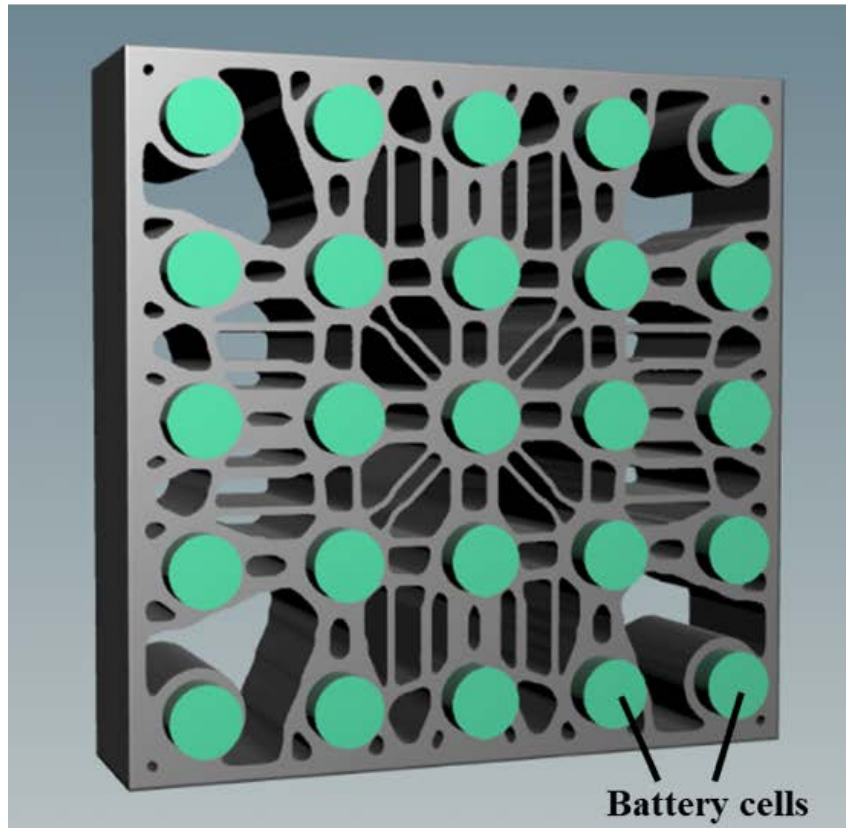
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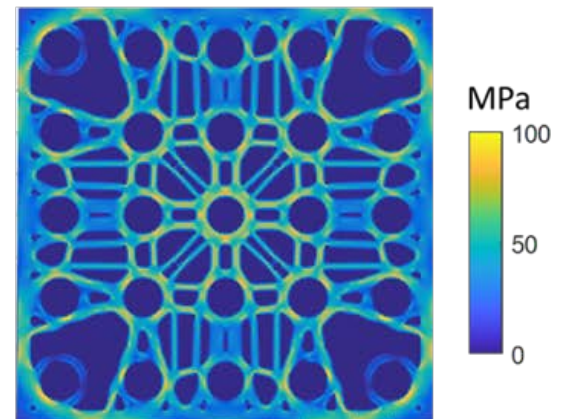
# Multiphysics: Battery pack

Mimize mass

Subject to stress & temperature

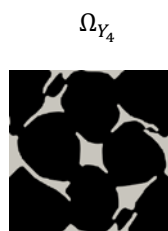
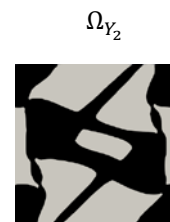
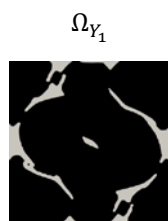
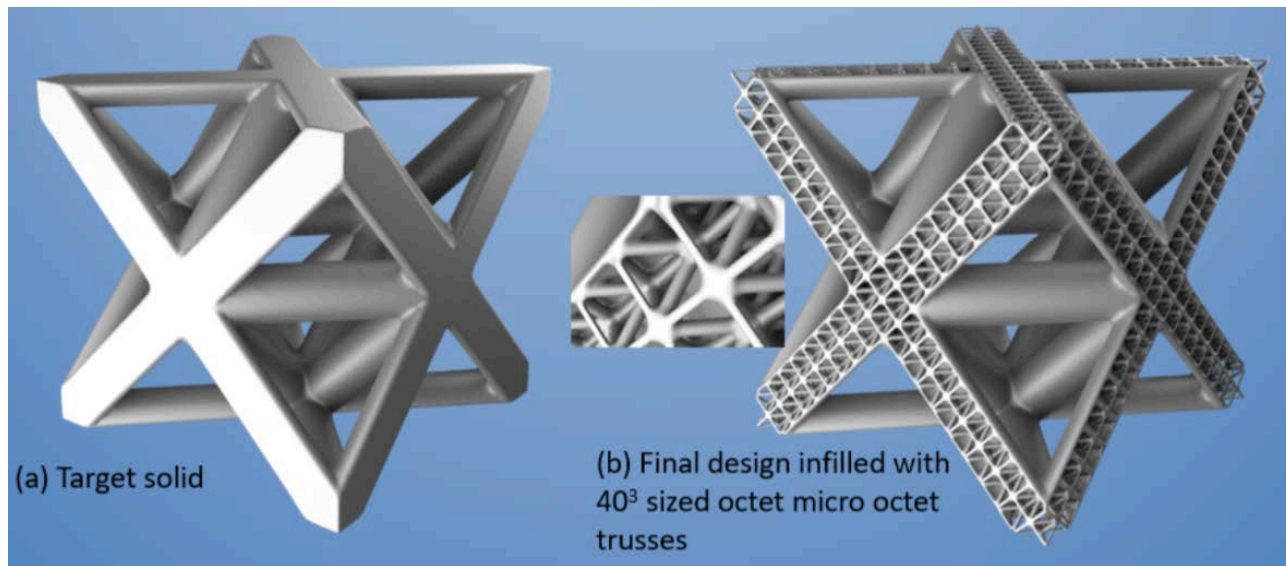


Temperature  $T_{max} = 30^{\circ}\text{C}$



Stress  $\sigma_{max} = 100 \text{ MPa}$

# Multiscale





# Current Research

- Multiscale → integrated material-structural design optimization
- Multiphysics:
  - Mechanics
  - Heat transfer
  - Fluid-structure interaction
  - Aeroelasticity
- Metamaterial
- Multiple material
- Nonlinearity
- OpenMDAO (<http://openmdao.org>)
- Opensource code (<http://m2do.ucsd.edu/software/>)

