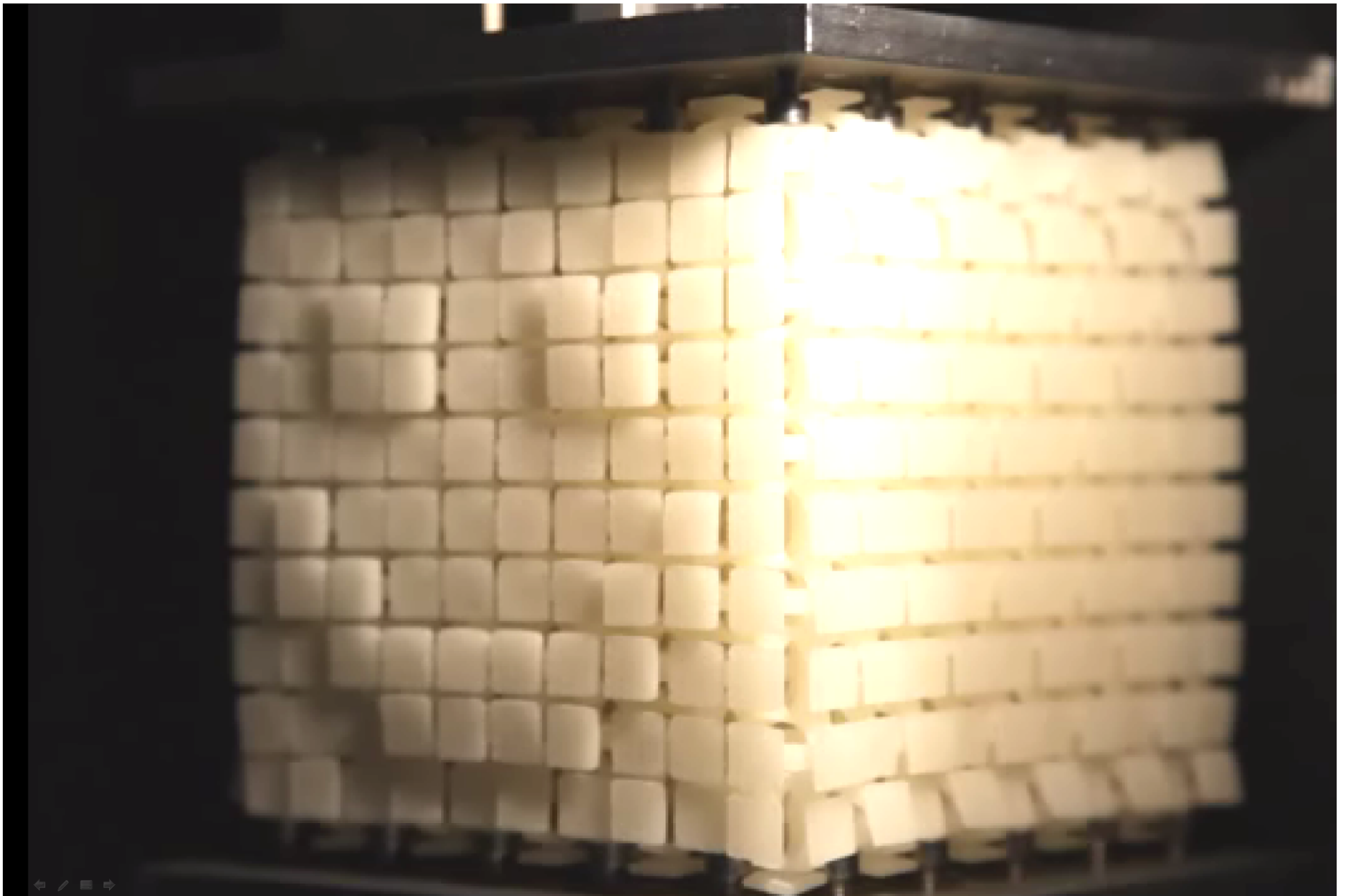


Floxedated Metamaterial

Nature 535, 529 (2016)



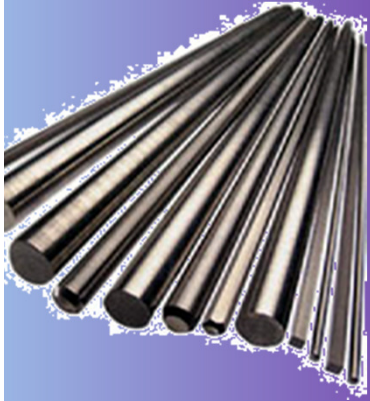
Mechanical Metamaterials

Wikipedia: Metamaterials are artificial materials engineered to have properties that may not be found in nature.

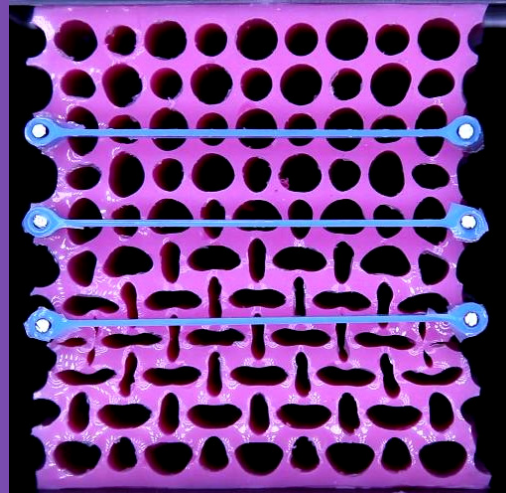
Structure rather than **Composition**

Mechanical Metamaterial

Materials



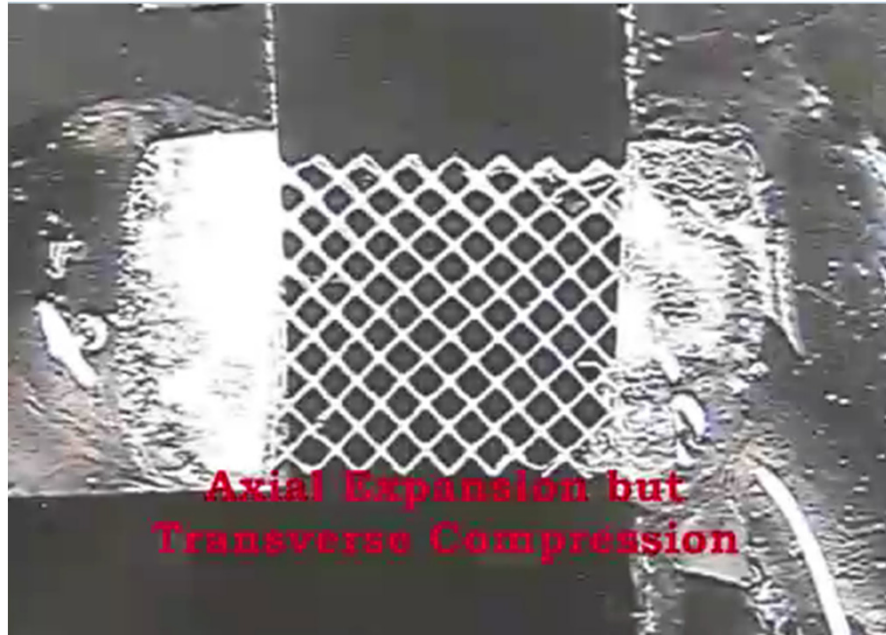
Metamaterials



Structure

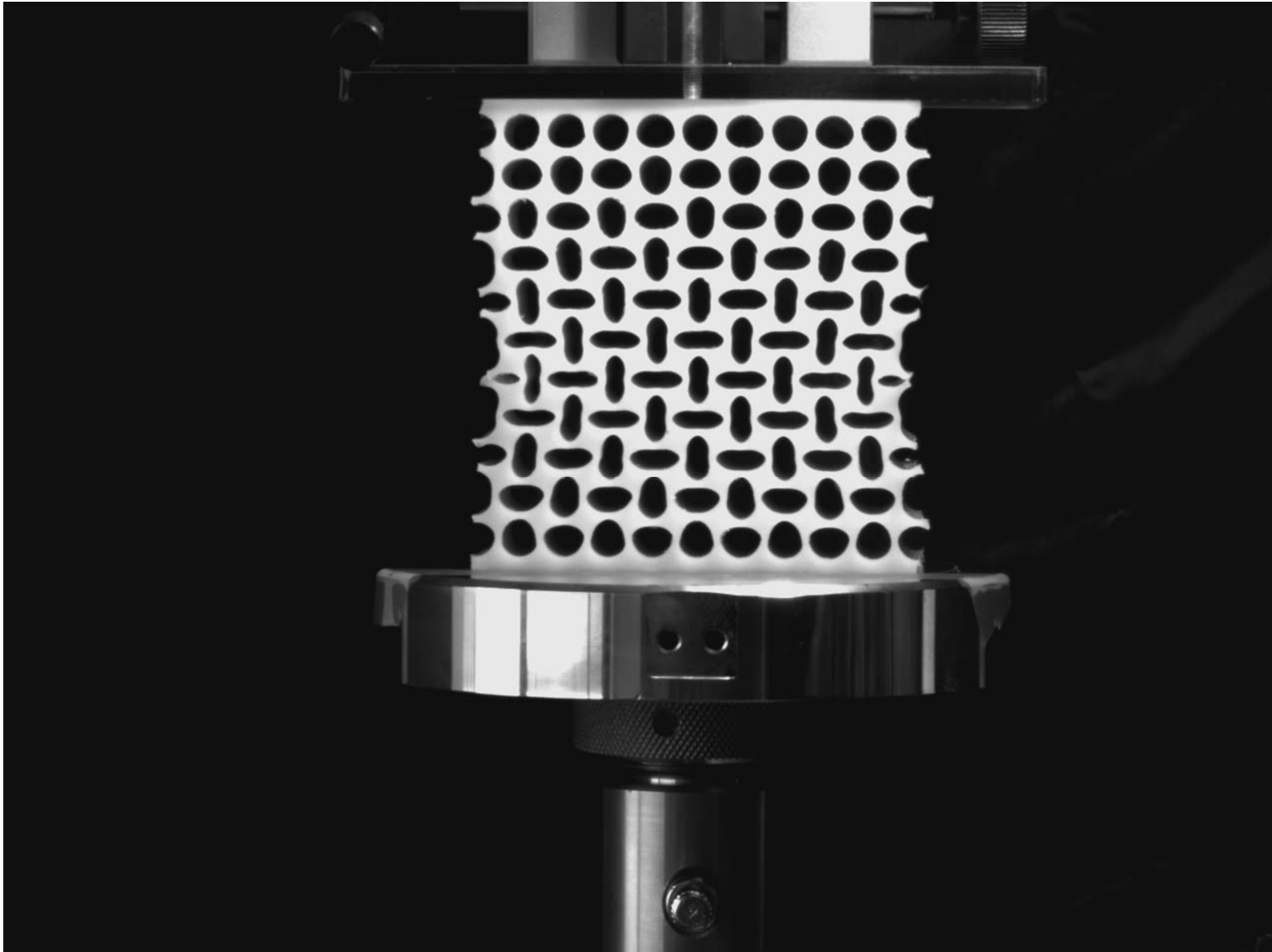


'Impossible' Properties



Science **235** 1038 (1987)

'Impossible' Properties



Mullin et al PRL **99** (2007)

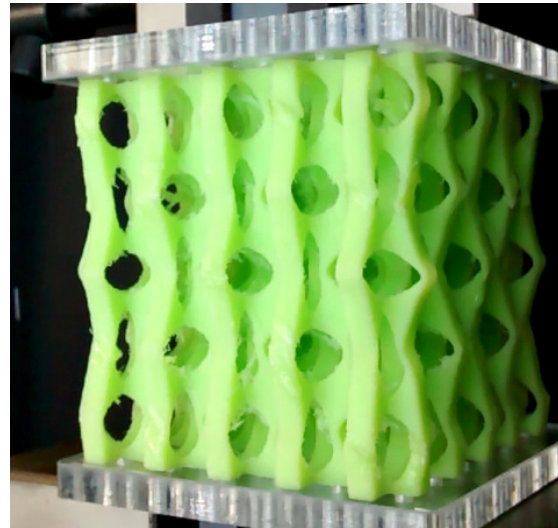
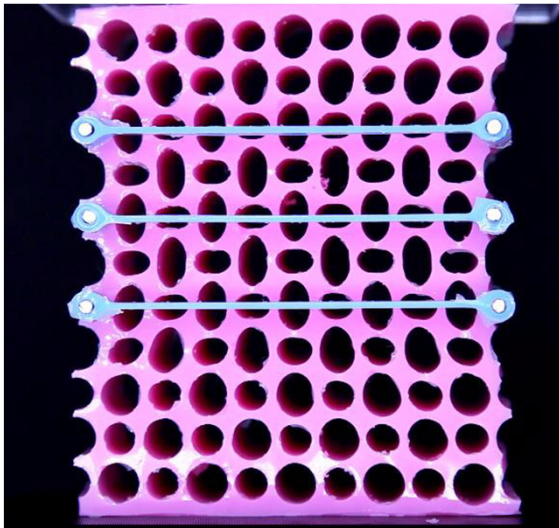
Mechanical Metamaterials

Designable & Unusual Mechanics

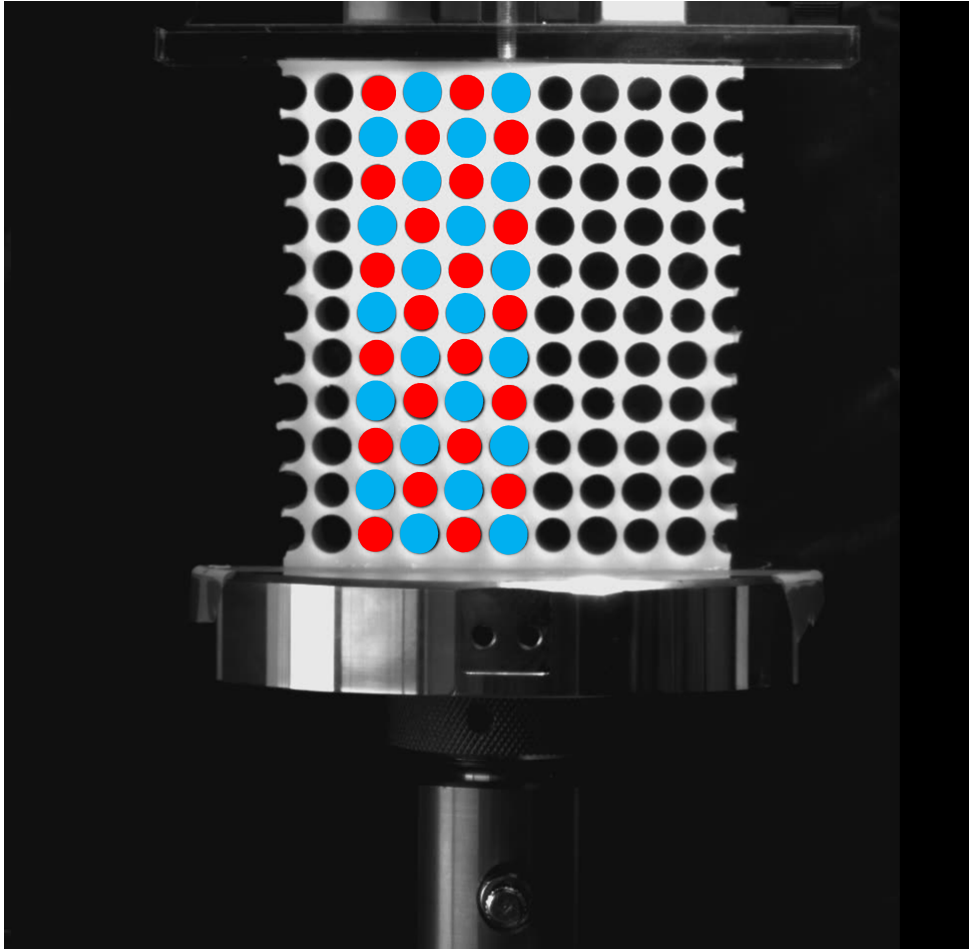
Multifunction

2D \rightarrow 3D

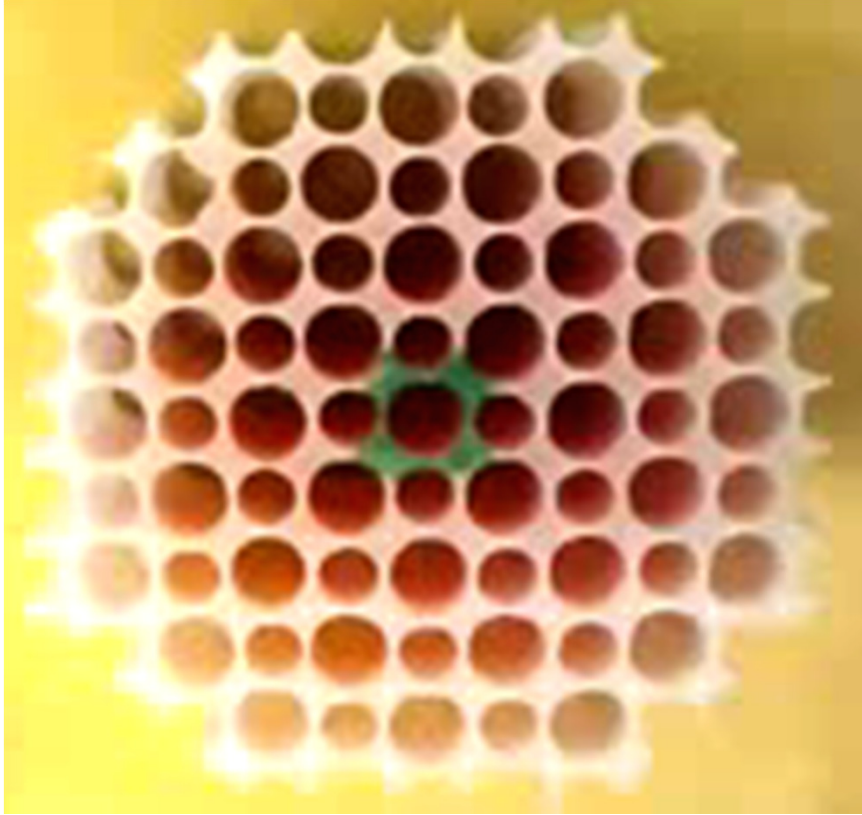
Aperiodic



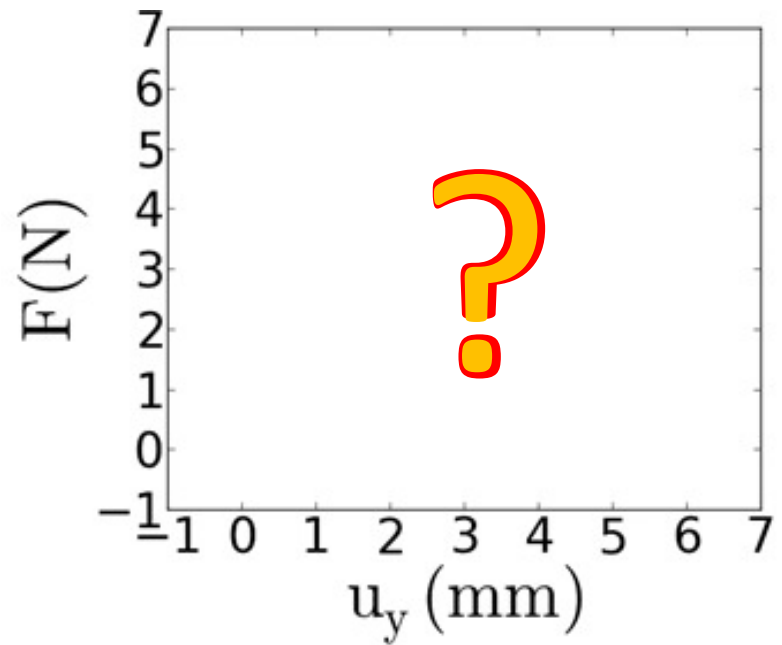
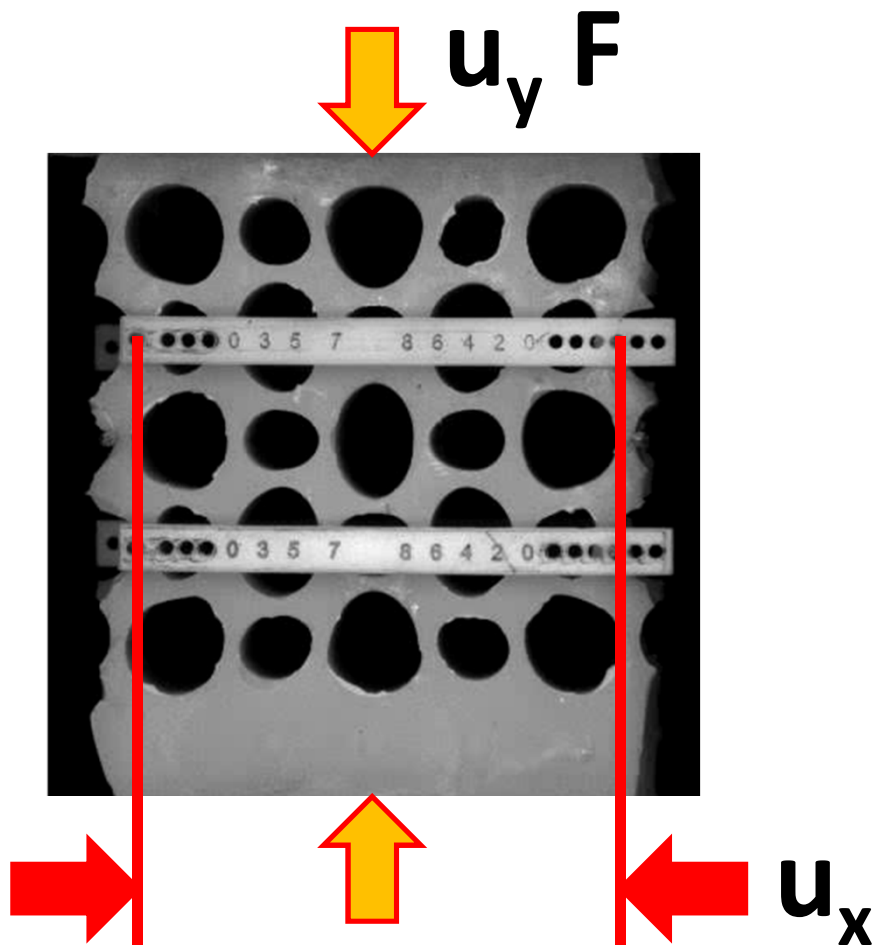
Programmable Metamaterials



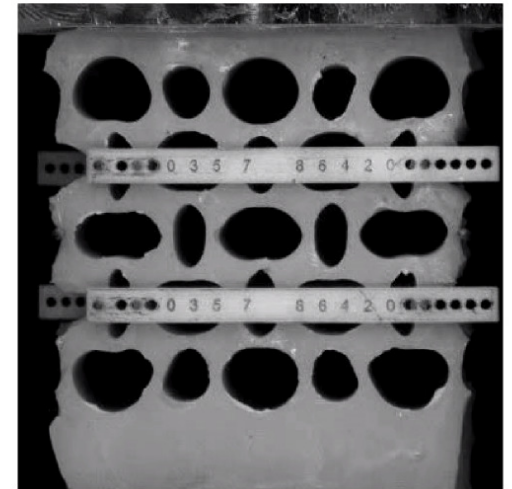
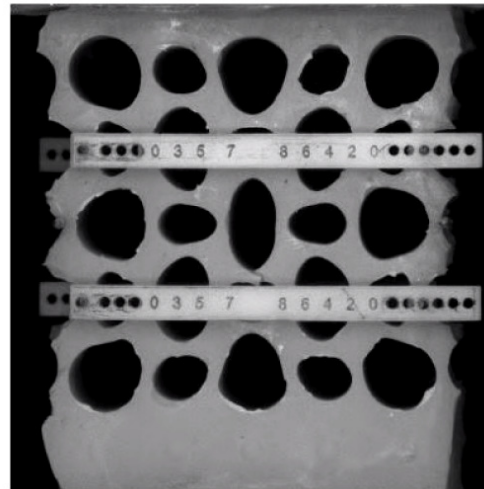
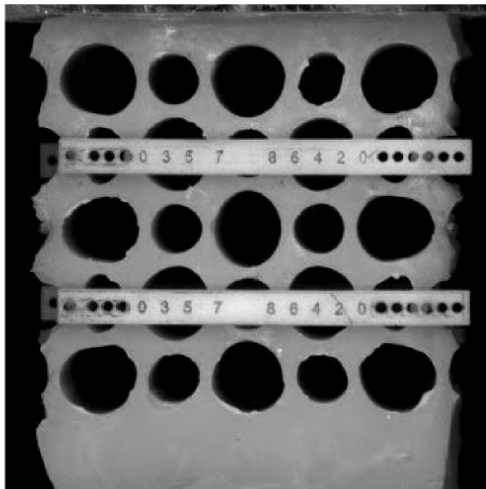
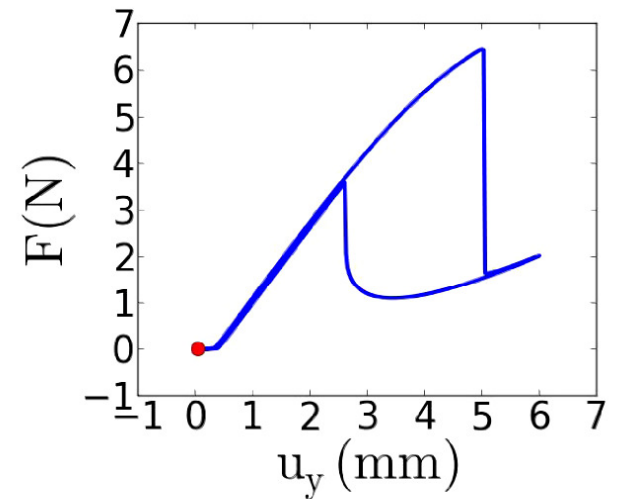
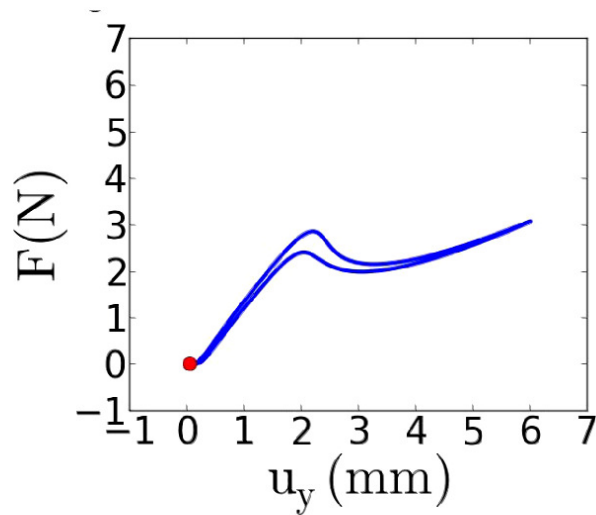
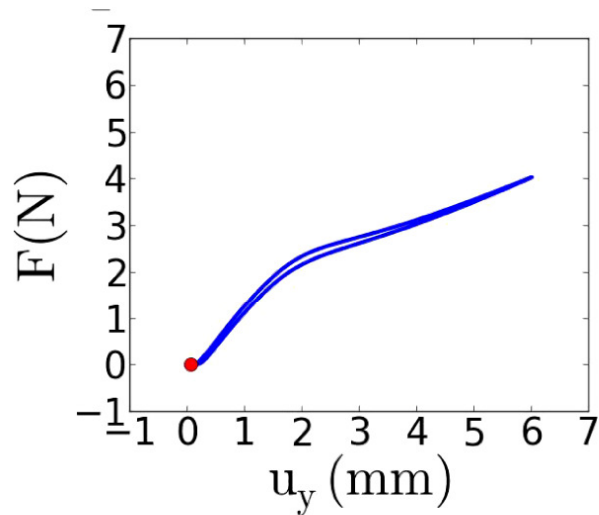
Broken Symmetry



Programmable through Clamping



Reprogrammable Material



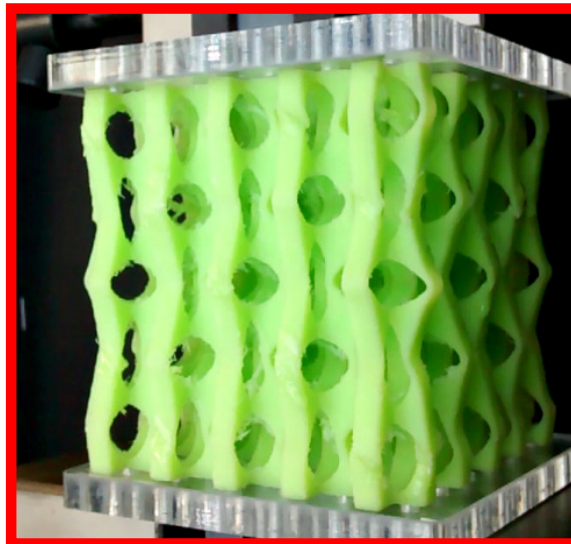
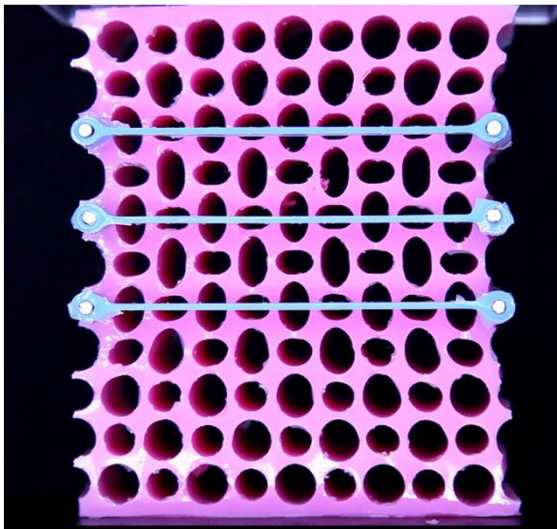
Mechanical Metamaterials

Designable & Unusual Mechanics

Multifunction

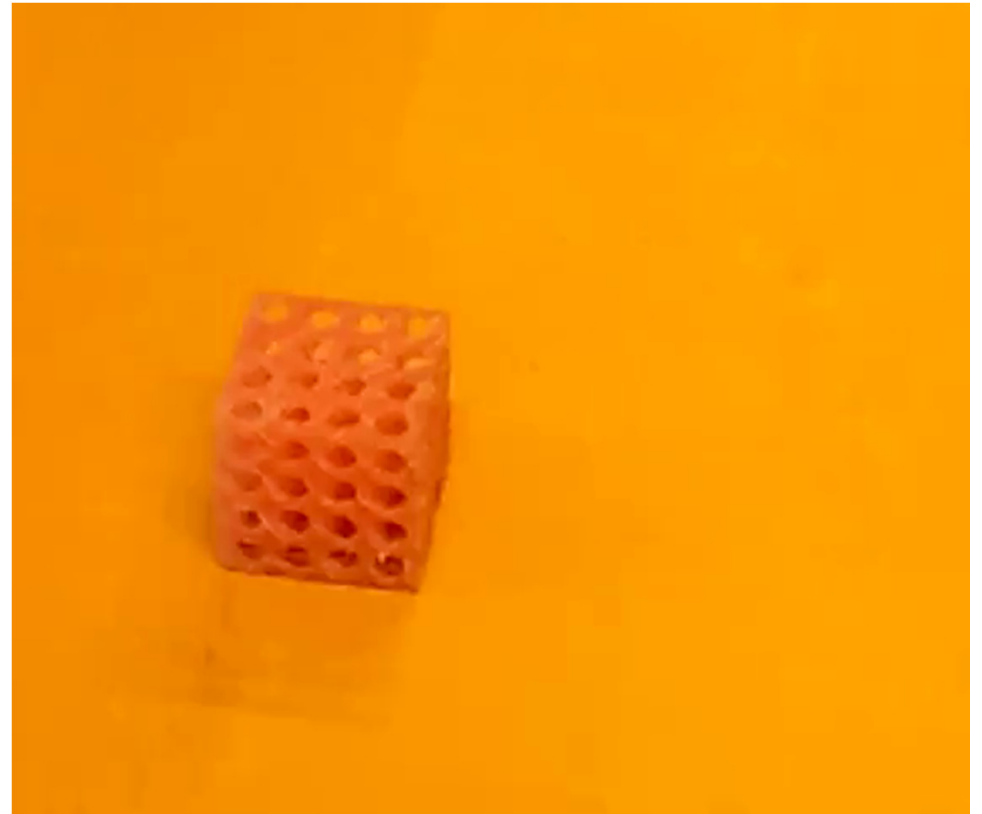
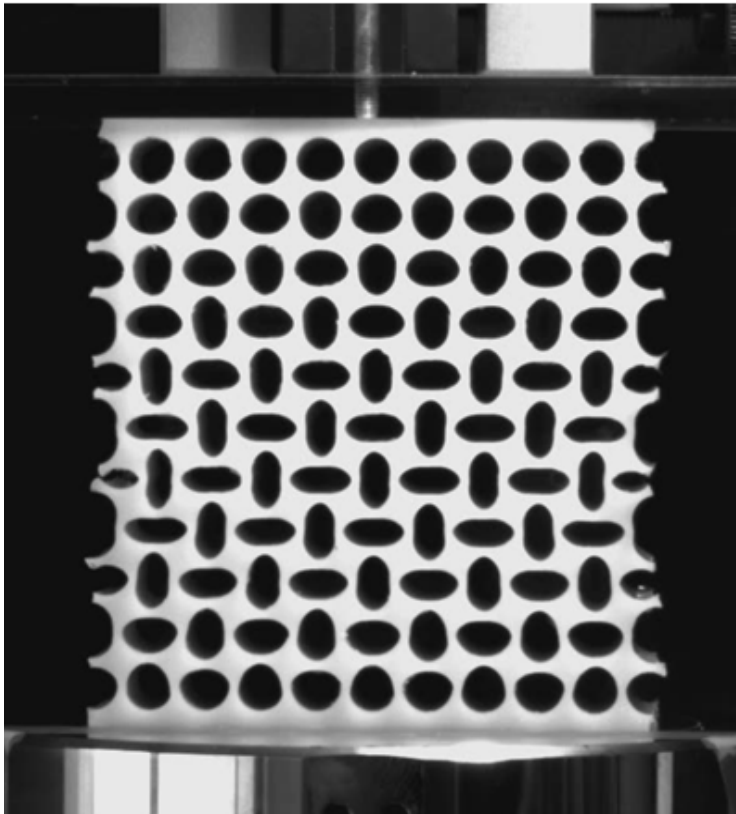
2D \rightarrow 3D

Aperiodic

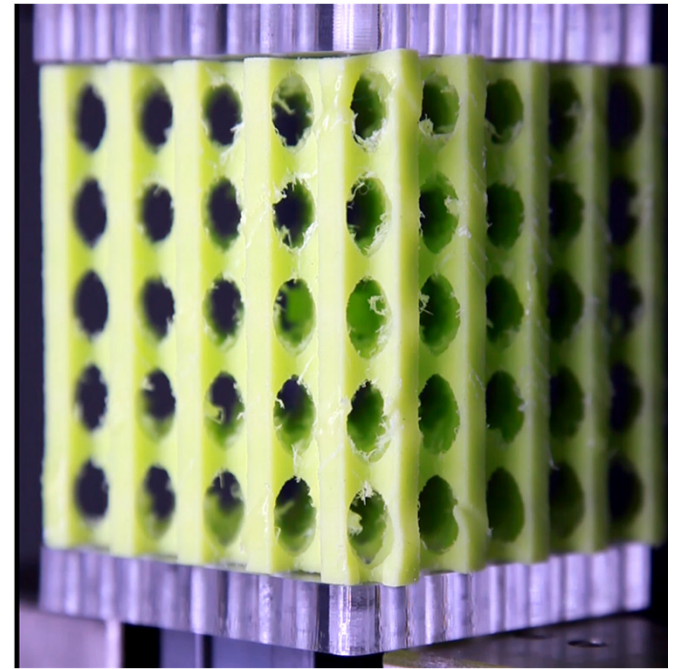
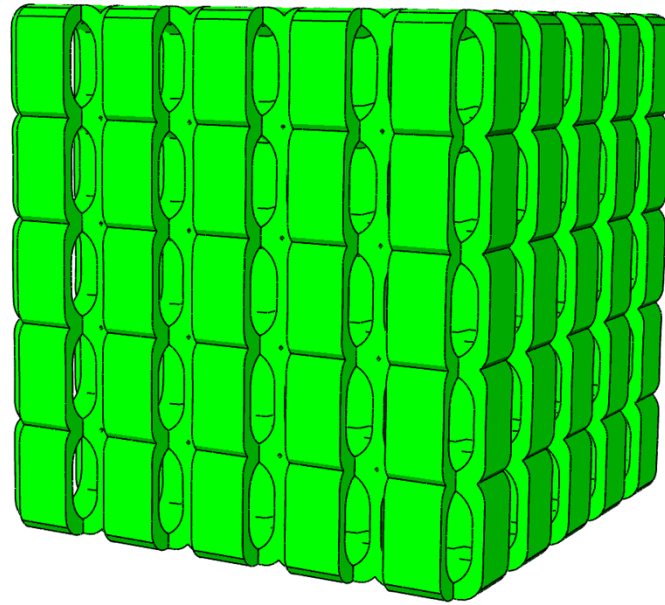


DONE

$2D \rightarrow 3D?$



Go 3D



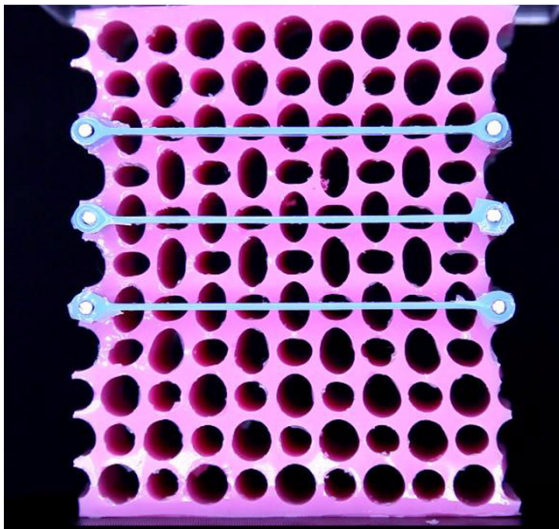
Mechanical Metamaterials

Designable & Unusual Mechanics

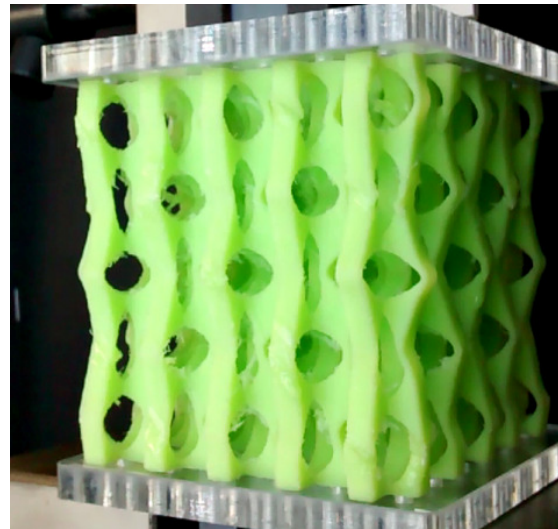
Multifunction

2D \rightarrow 3D

Aperiodic



DONE

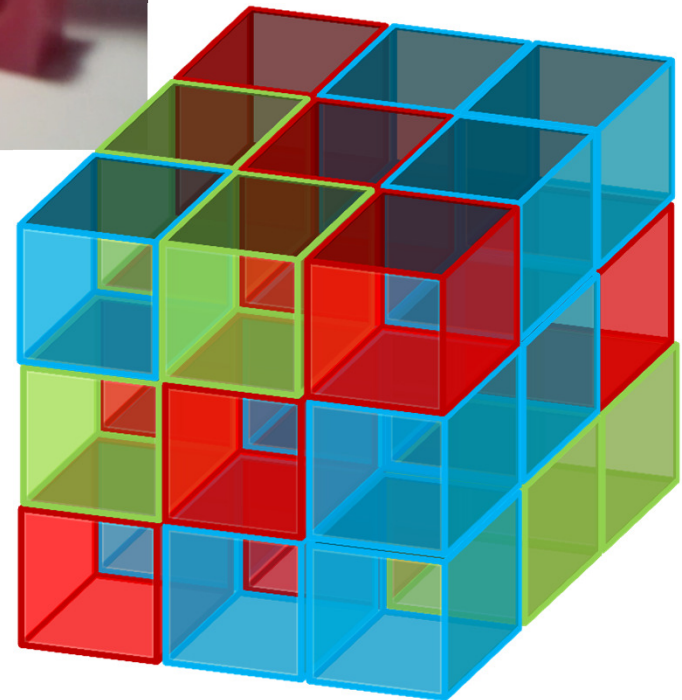
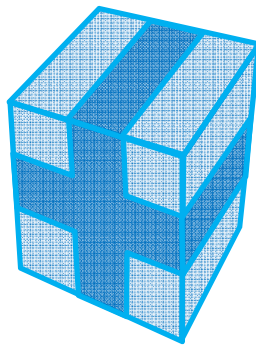
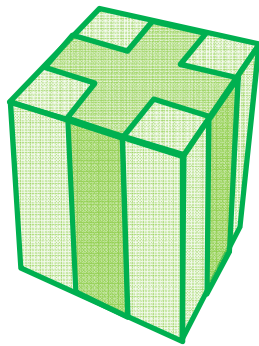
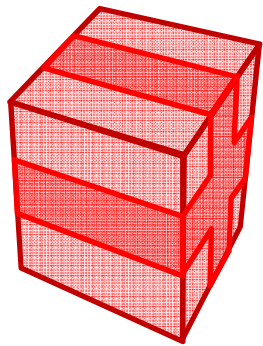


DONE

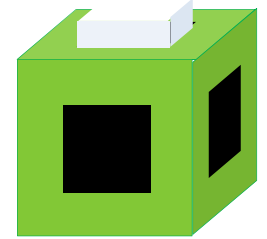
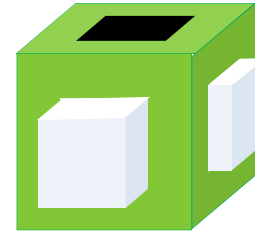
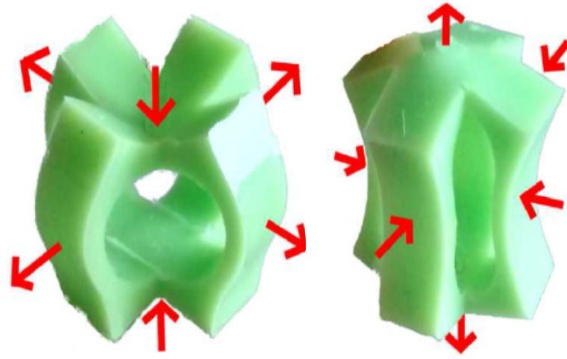


Aperiodic Metamaterials

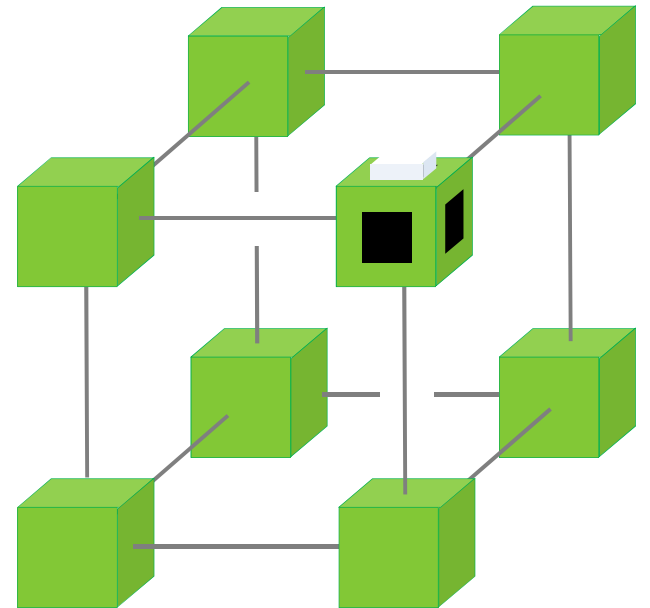
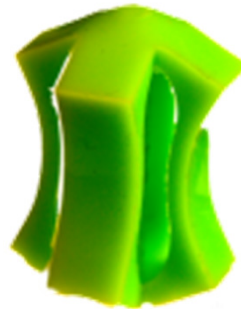
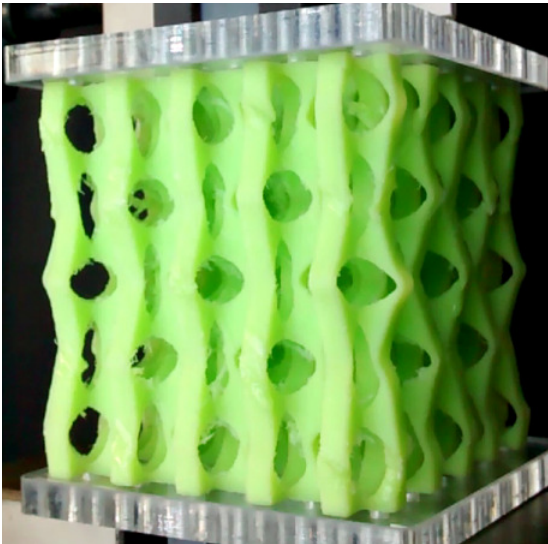
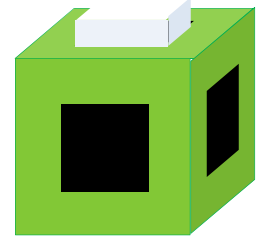
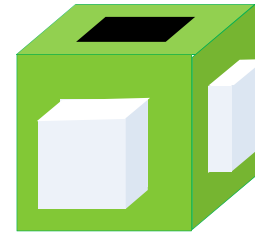
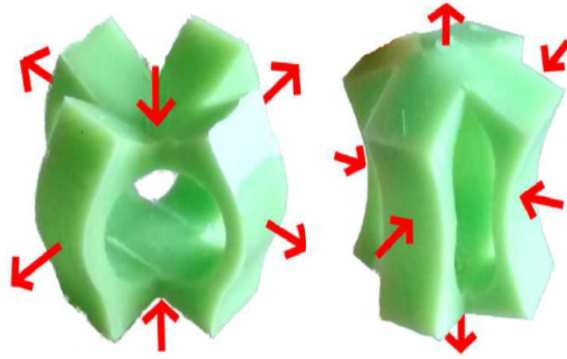
Floxels



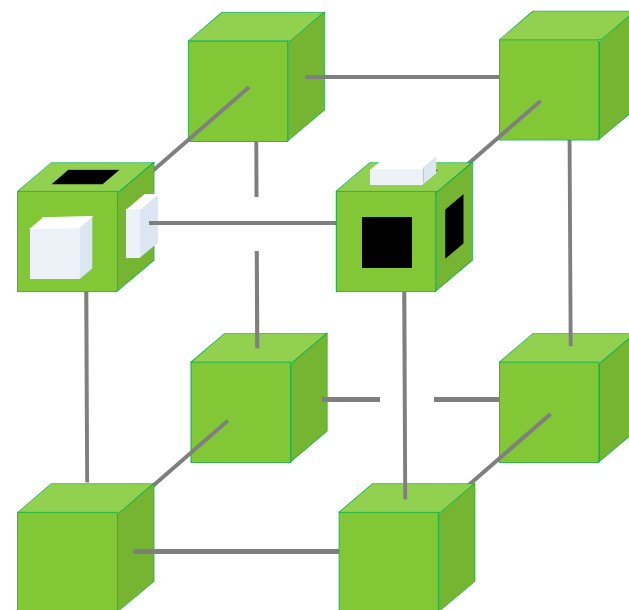
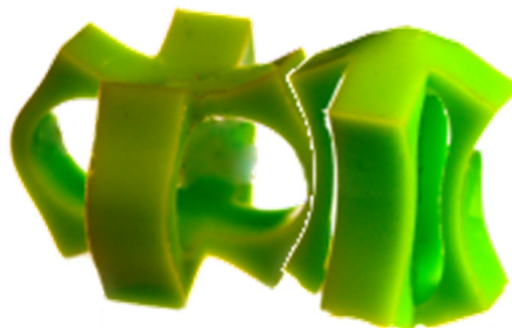
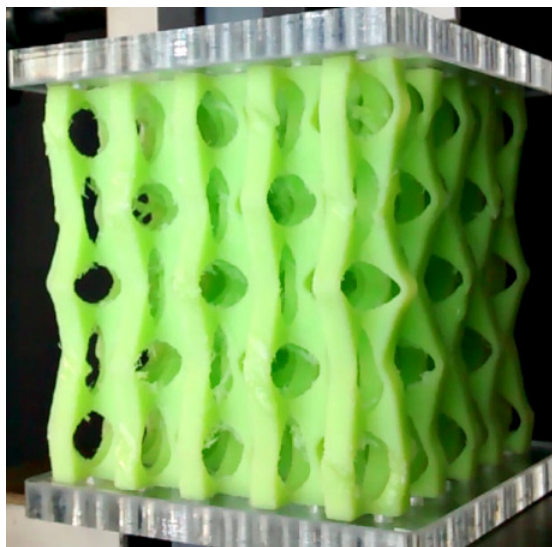
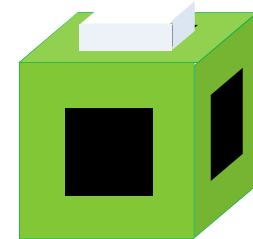
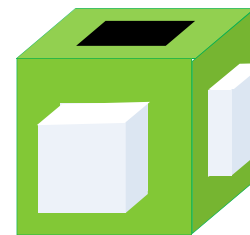
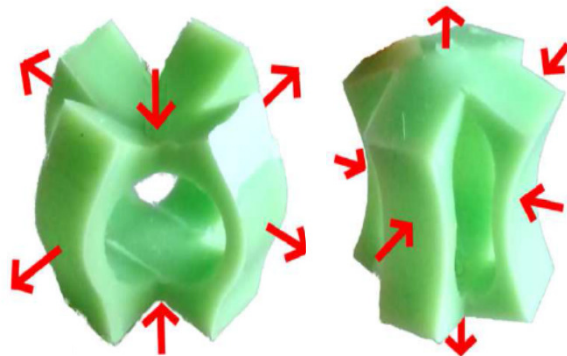
Building Blocks and Bricks



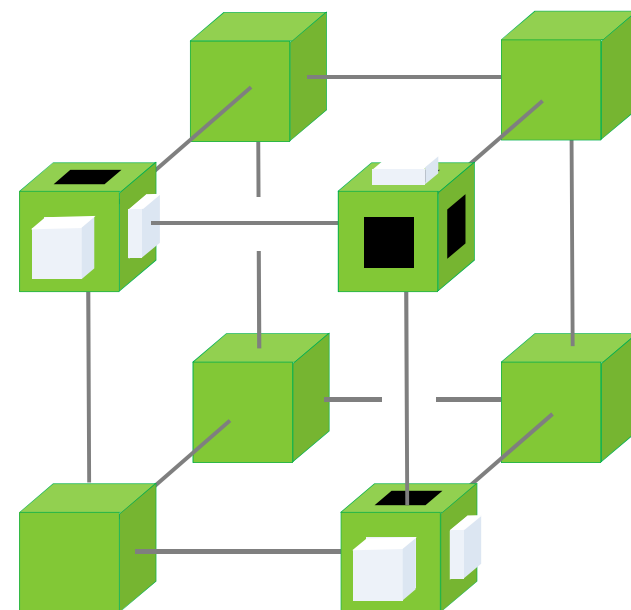
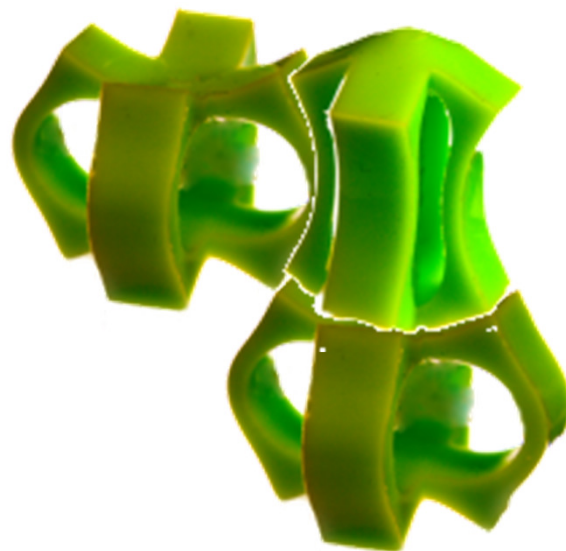
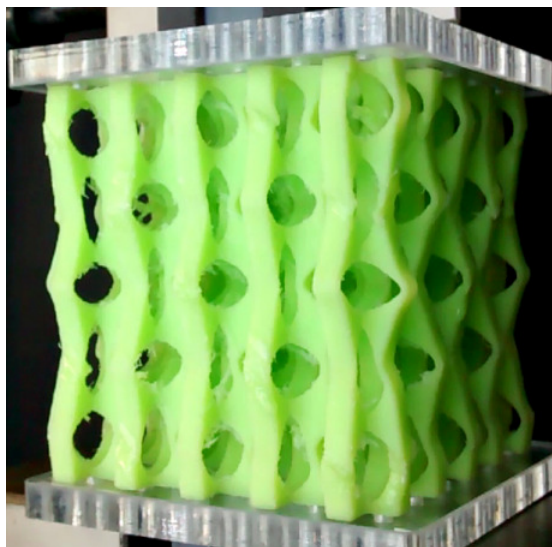
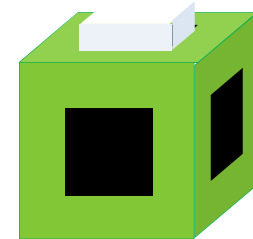
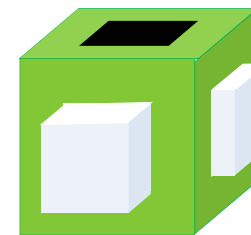
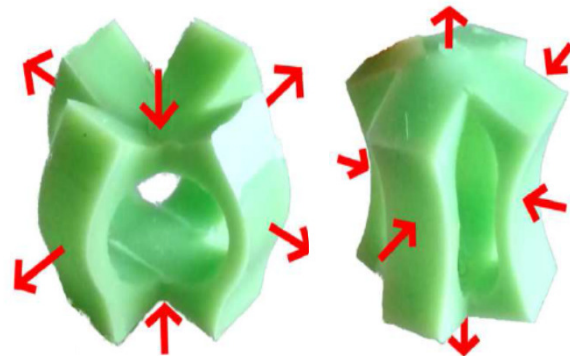
Building Blocks and Bricks



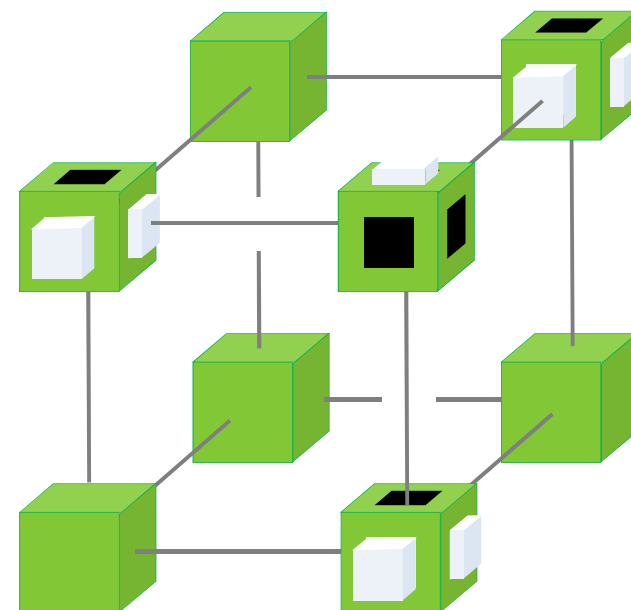
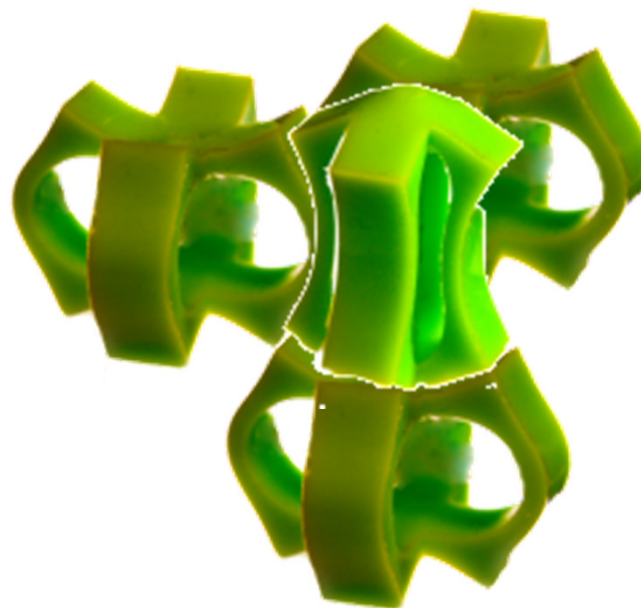
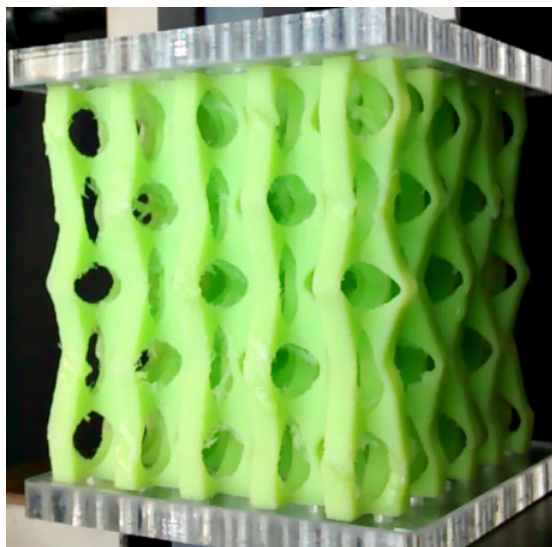
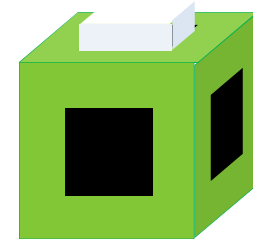
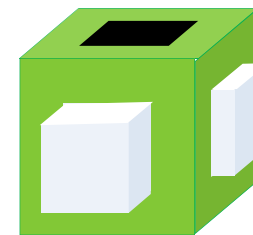
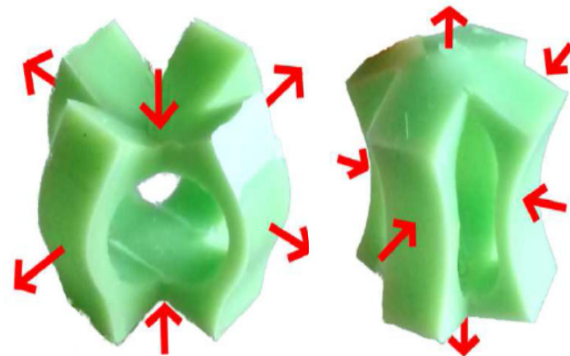
Building Blocks and Bricks



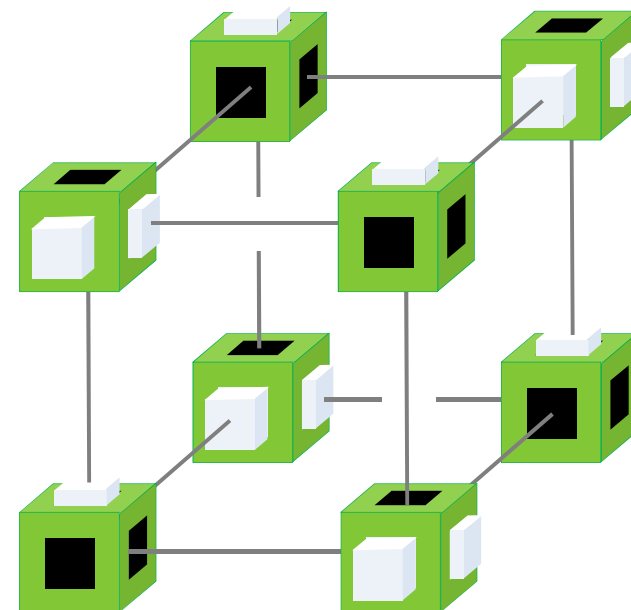
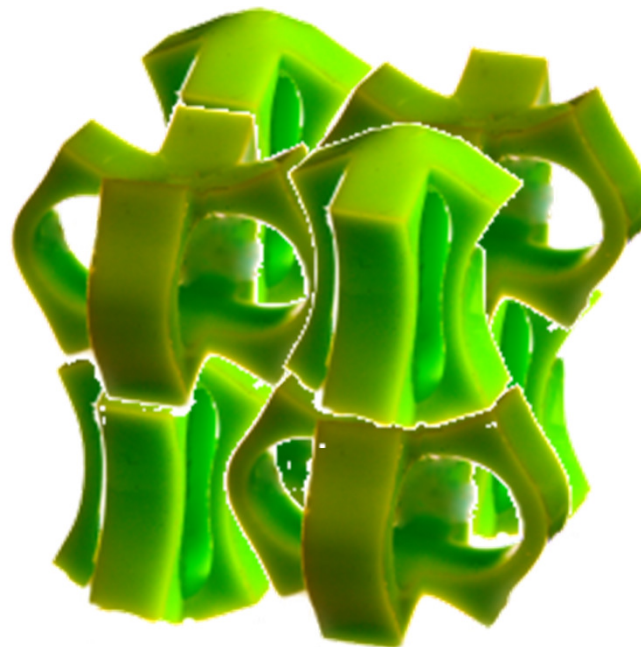
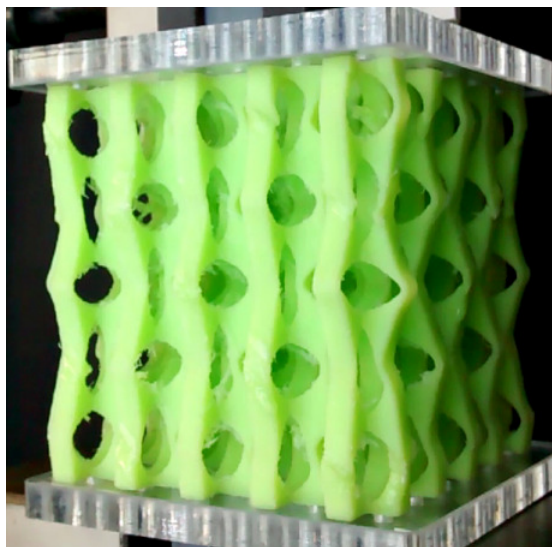
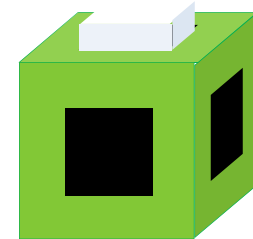
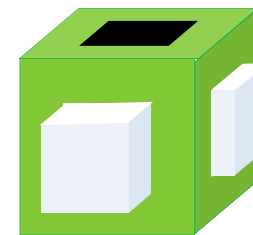
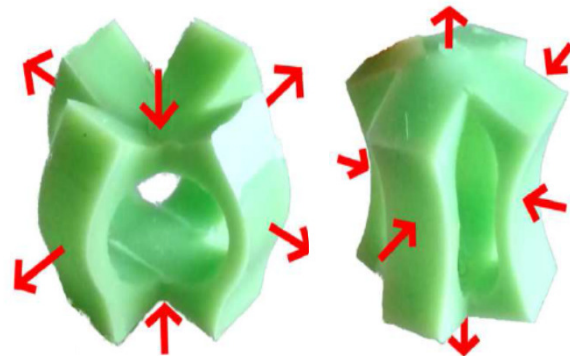
Building Blocks and Bricks



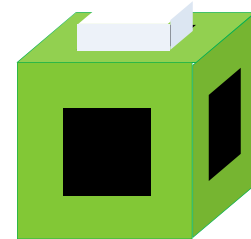
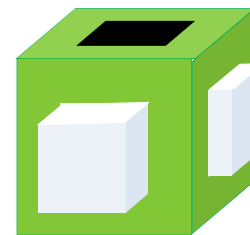
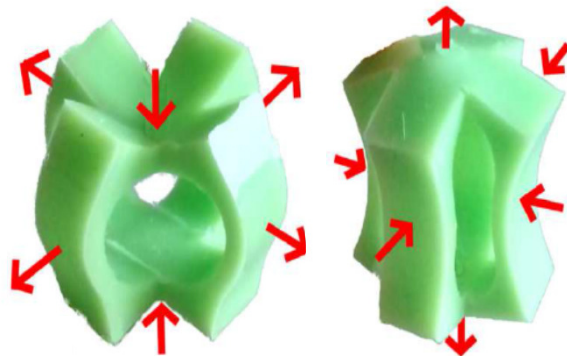
Building Blocks and Bricks



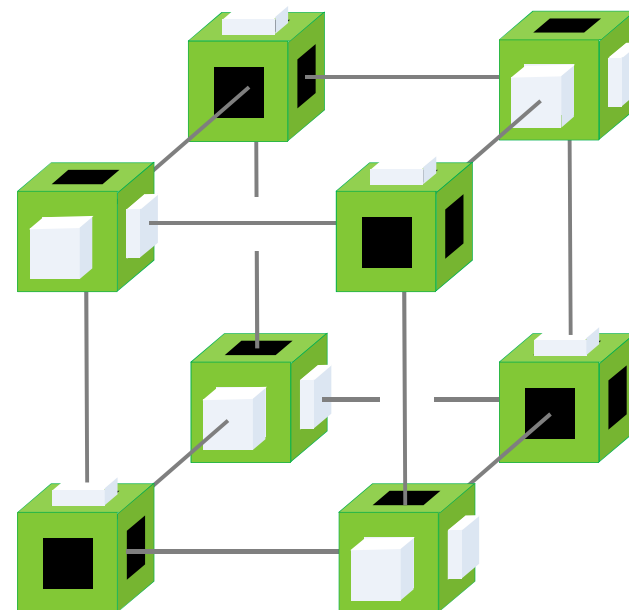
Building Blocks and Bricks



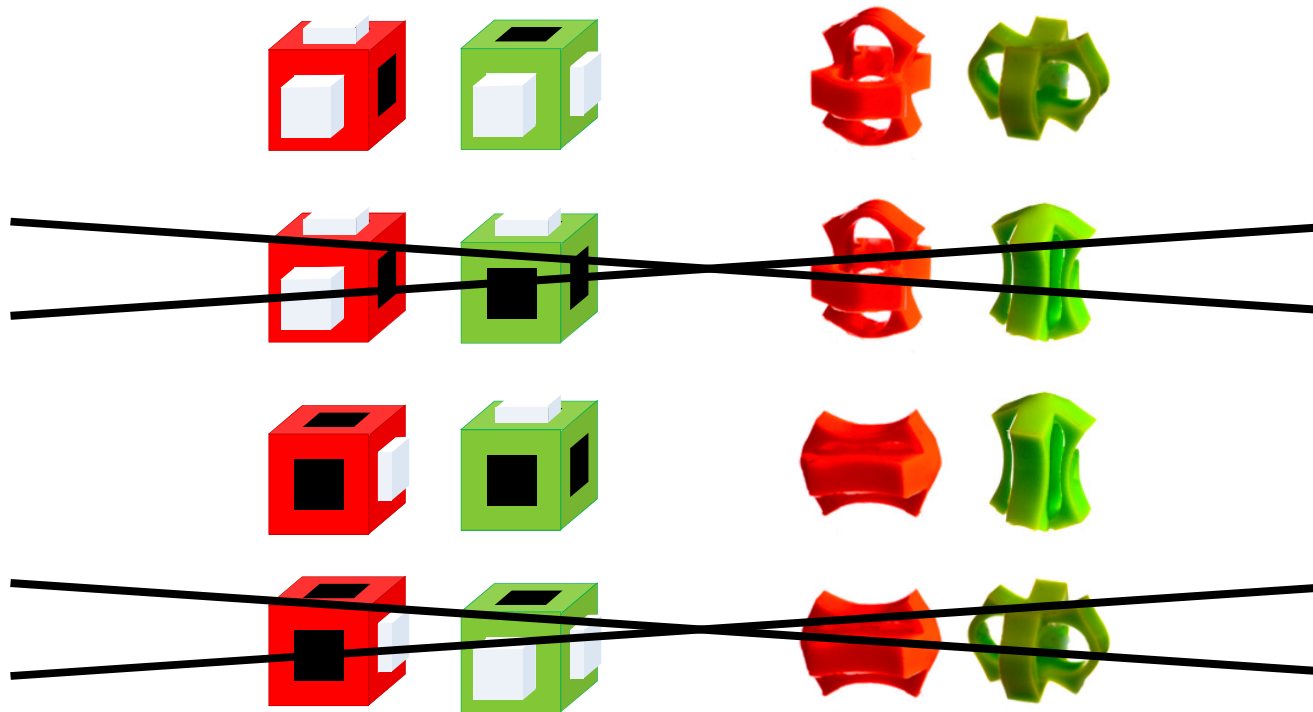
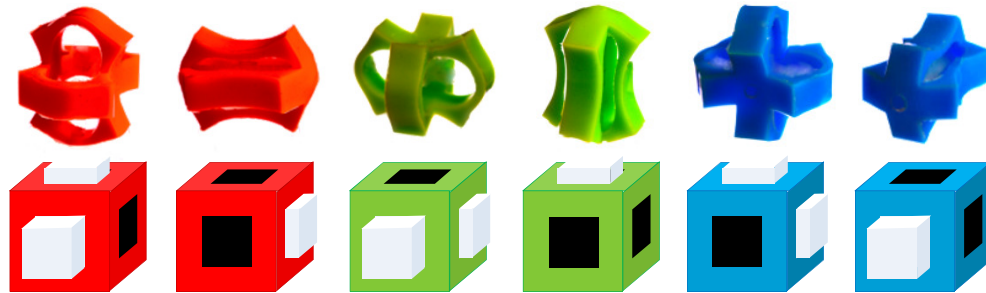
Building Blocks and Bricks



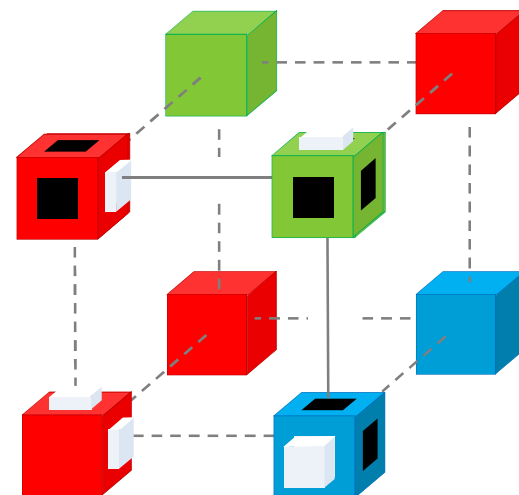
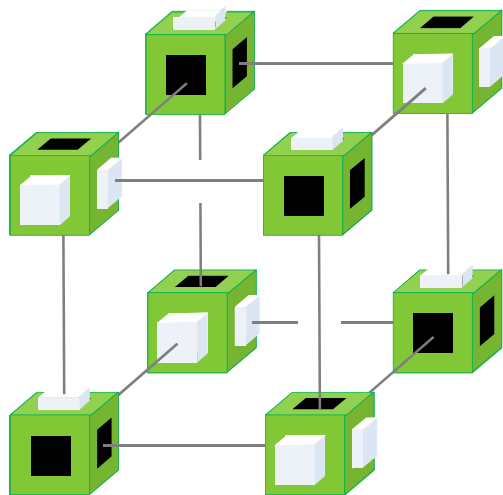
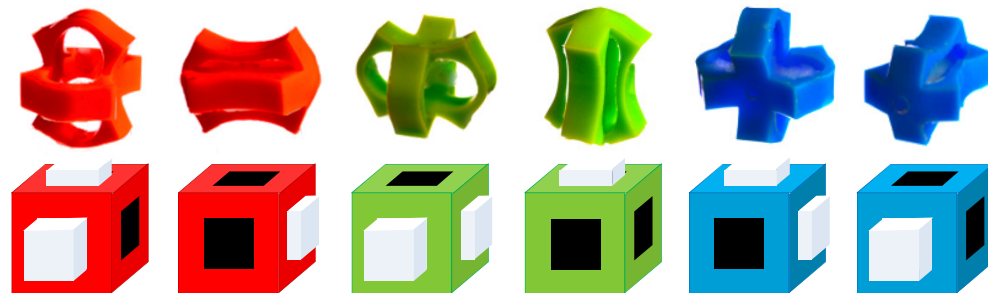
Aperiodic?



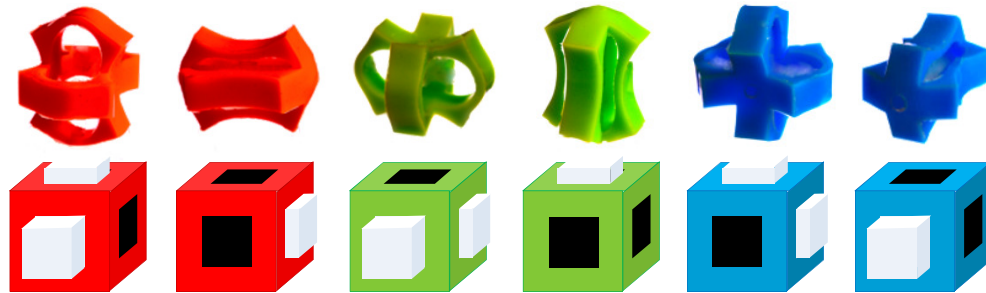
Building Blocks and Bricks



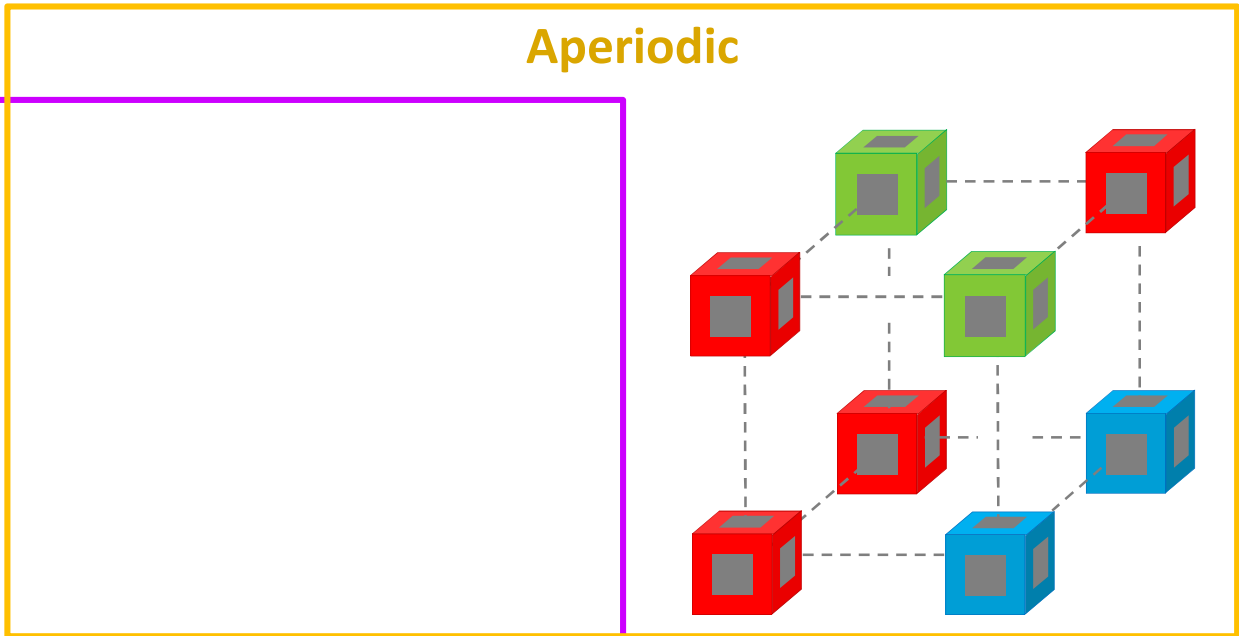
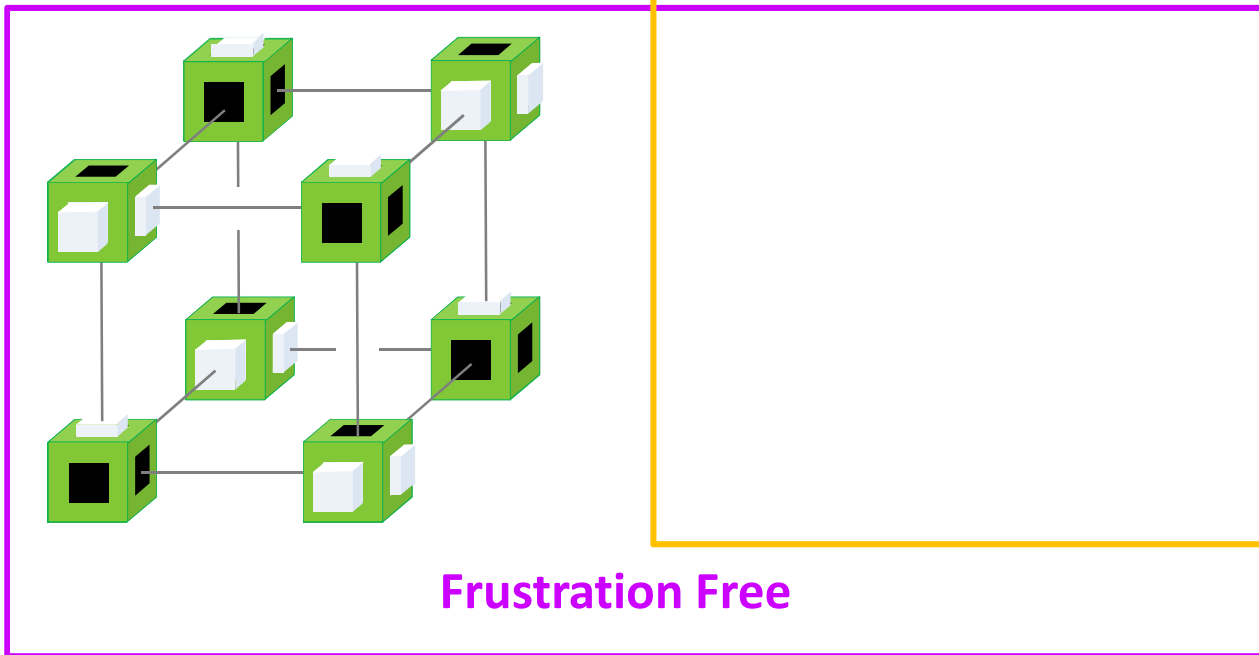
Combinatorial Design: A 3D Jigsaw Puzzle



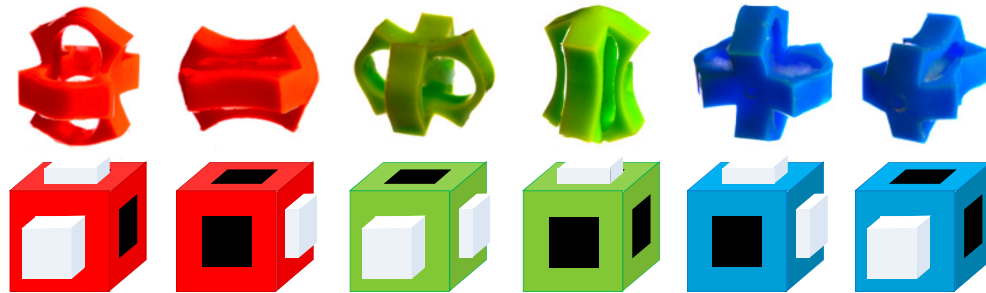
Aperiodic yet Frustration-Free Metamaterials



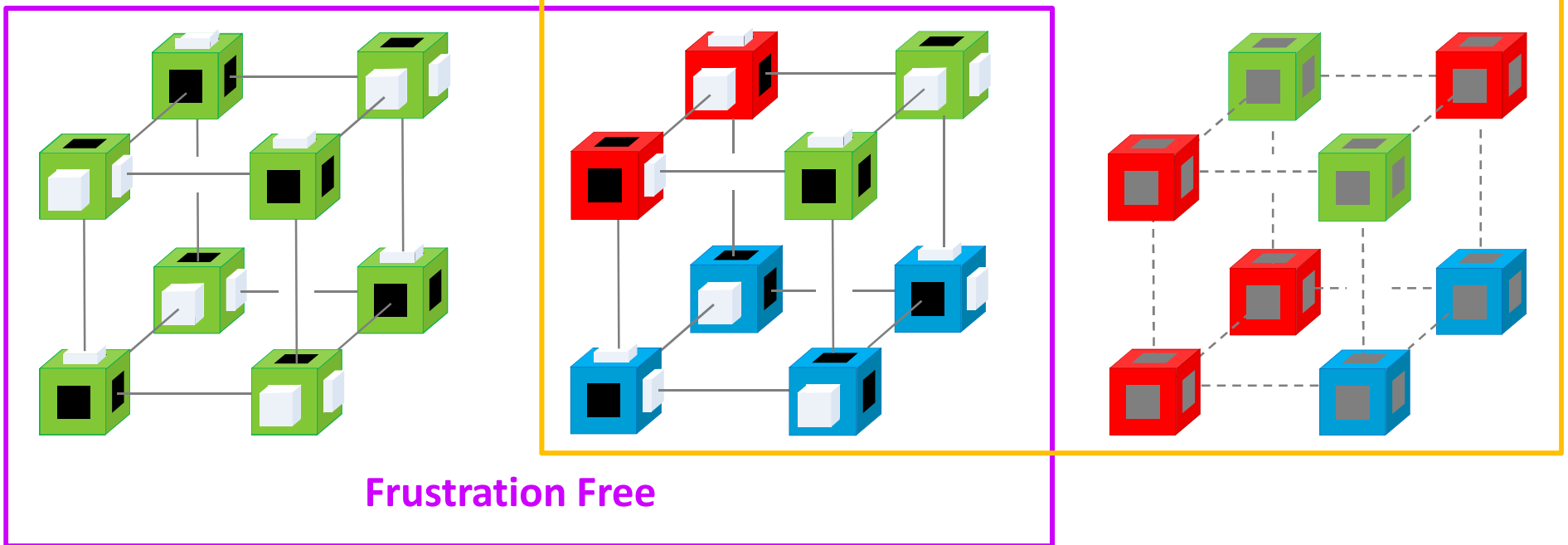
Aperiodic



Aperiodic yet Frustration-Free Metamaterials

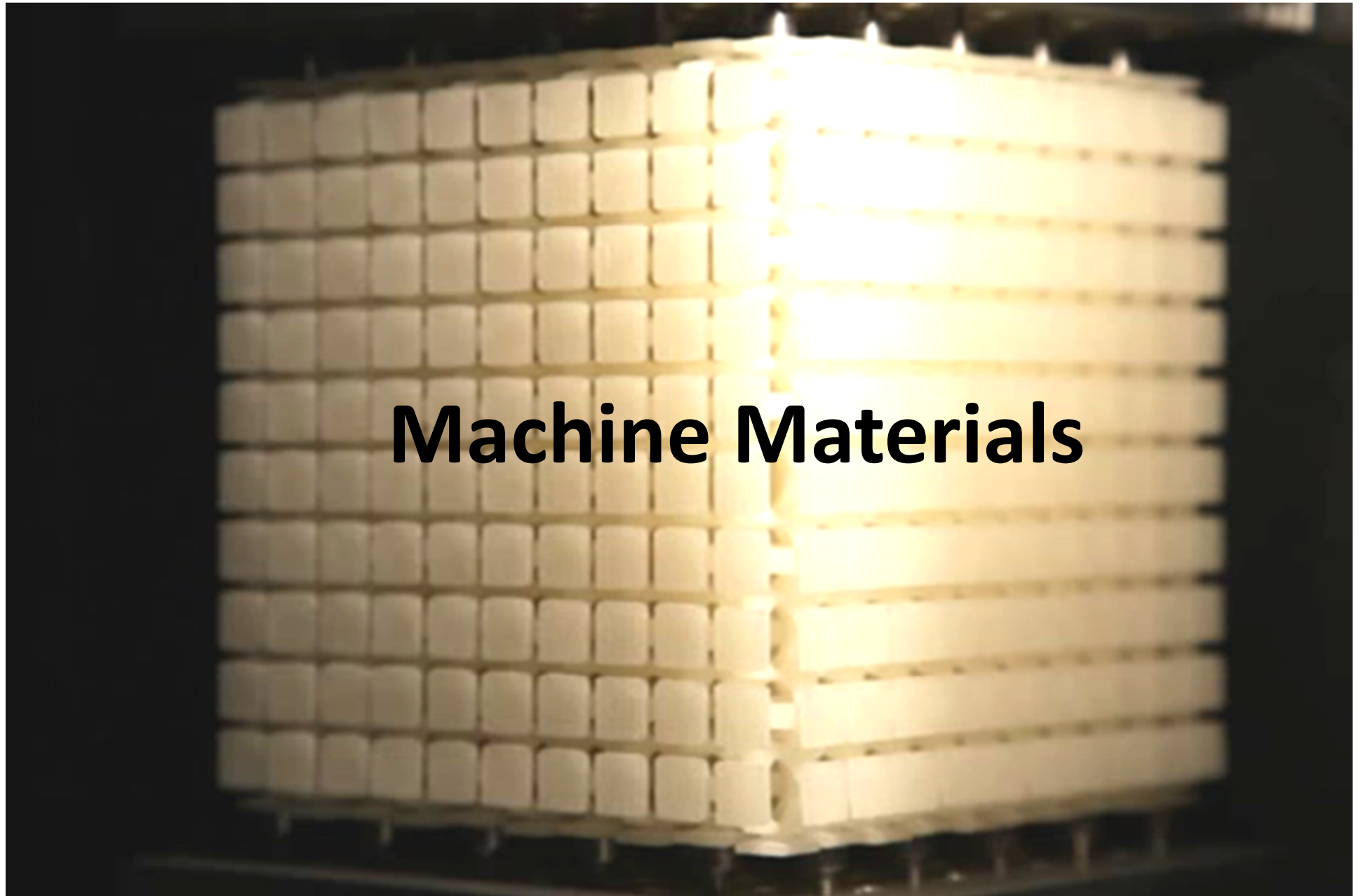


Aperiodic



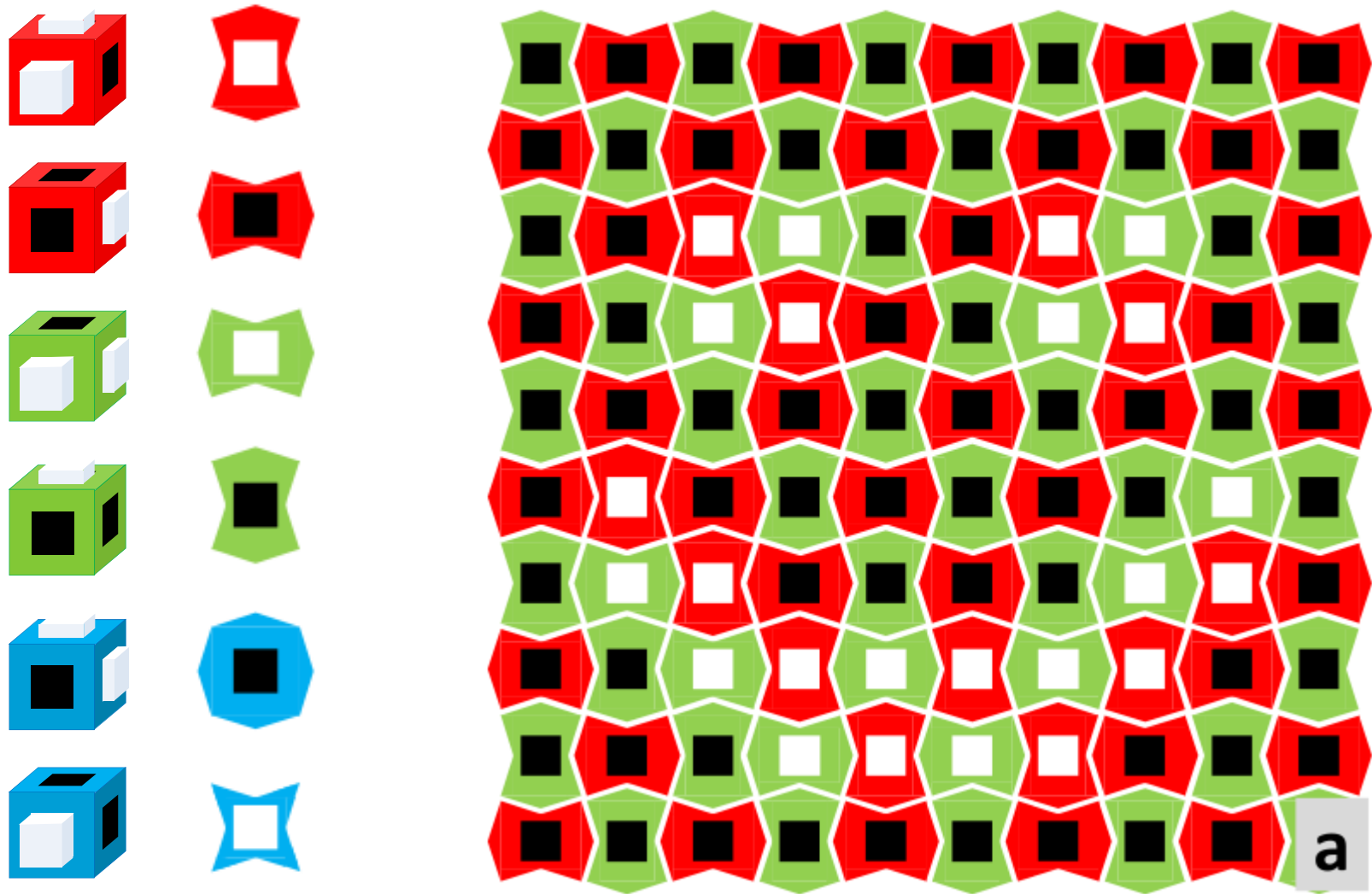
Frustration Free

Rational Design of Floxelated Metamaterial

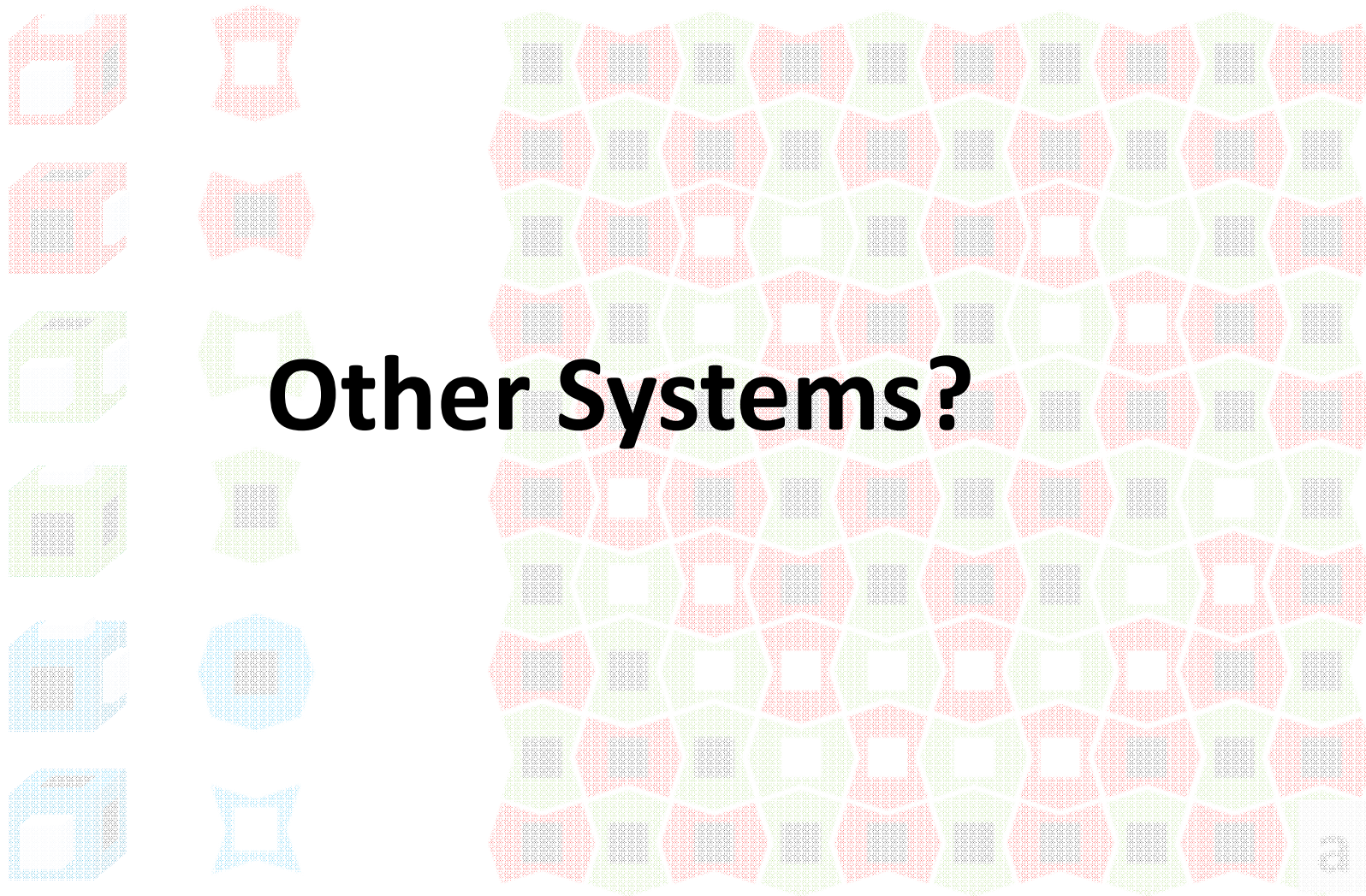


Machine Materials

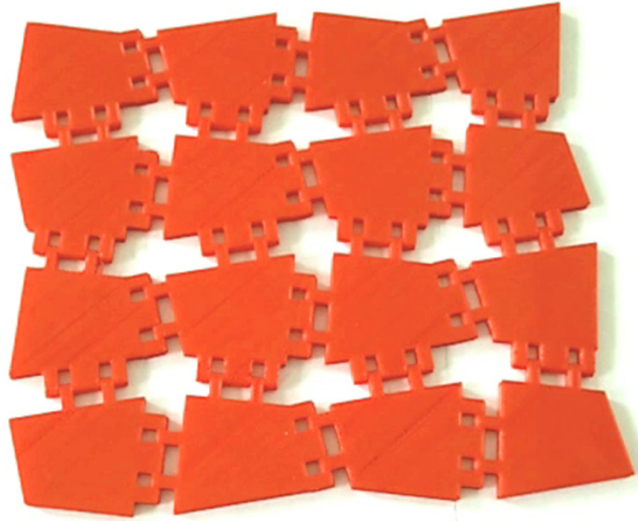
Rational Design of Floxelated Metamaterial



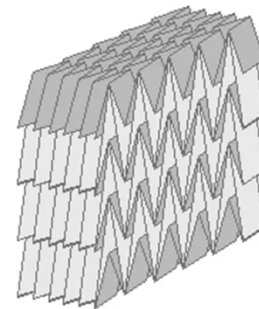
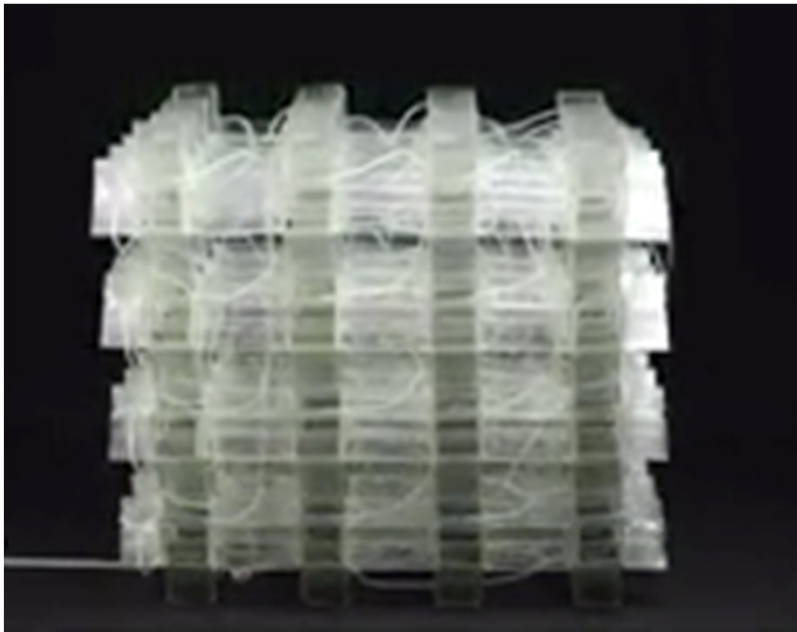
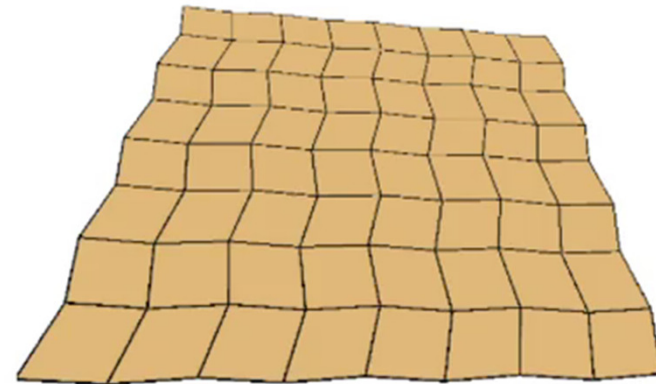
Rational Design of Floxelated Metamaterial



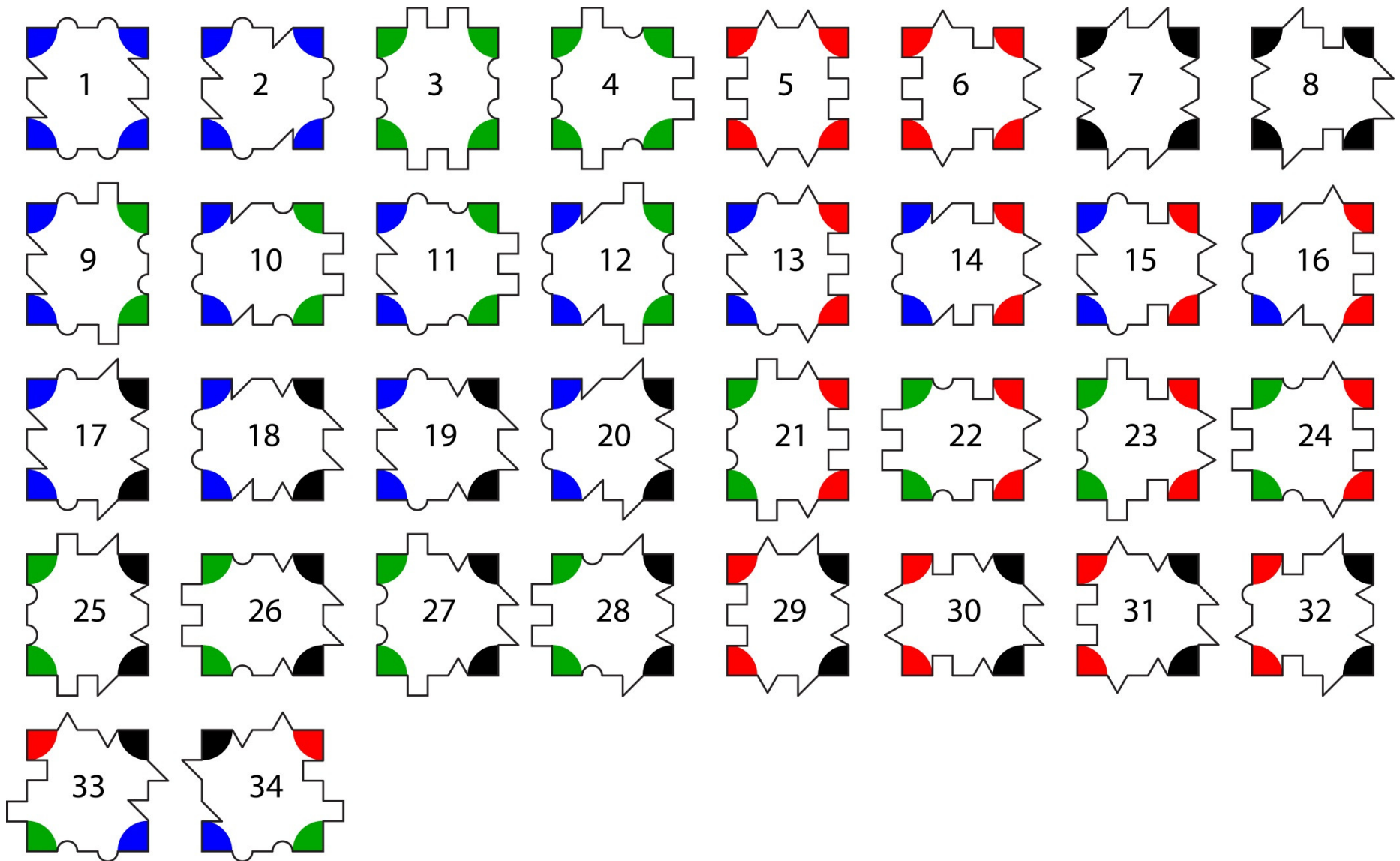
Origami Metamaterials



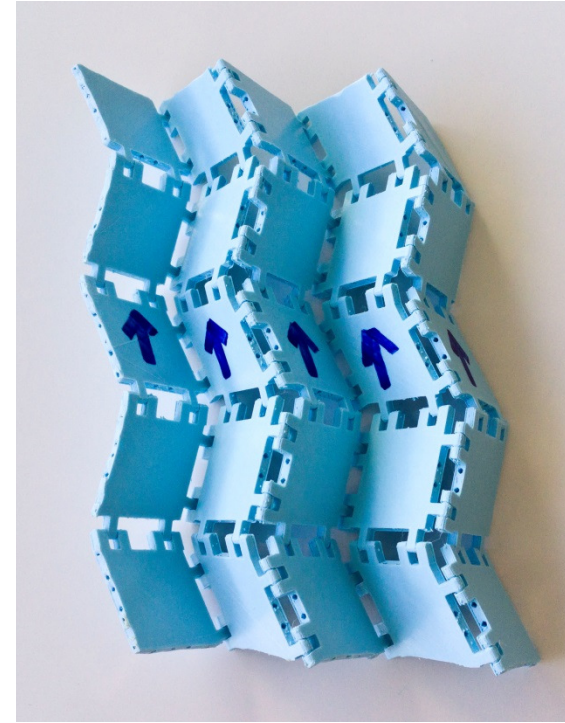
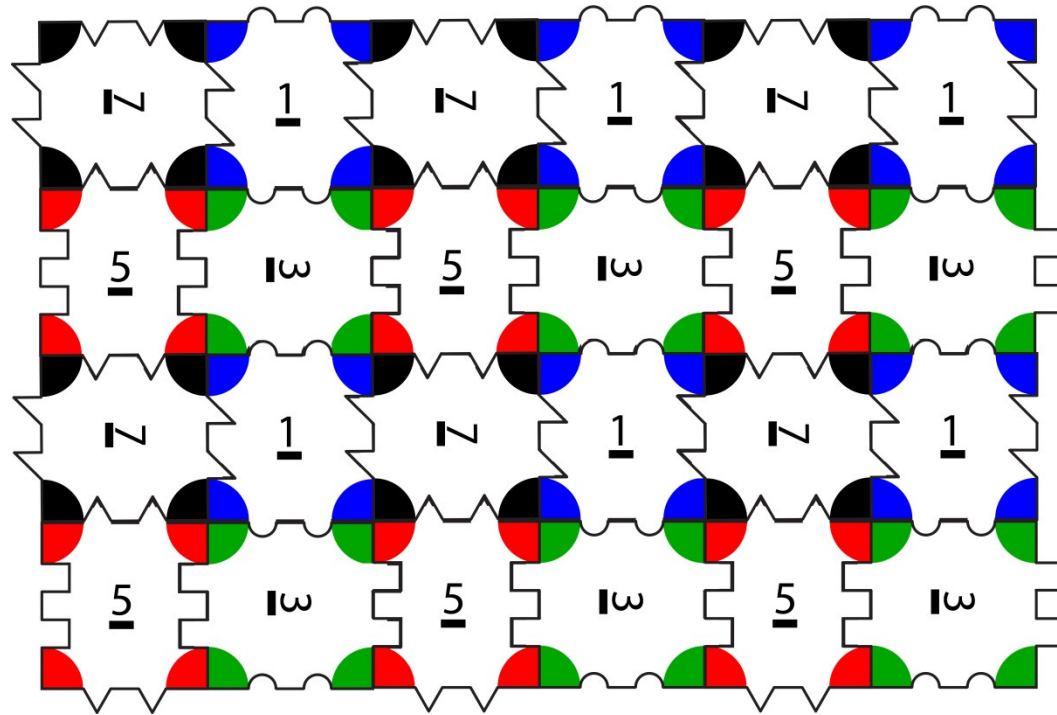
Branch I



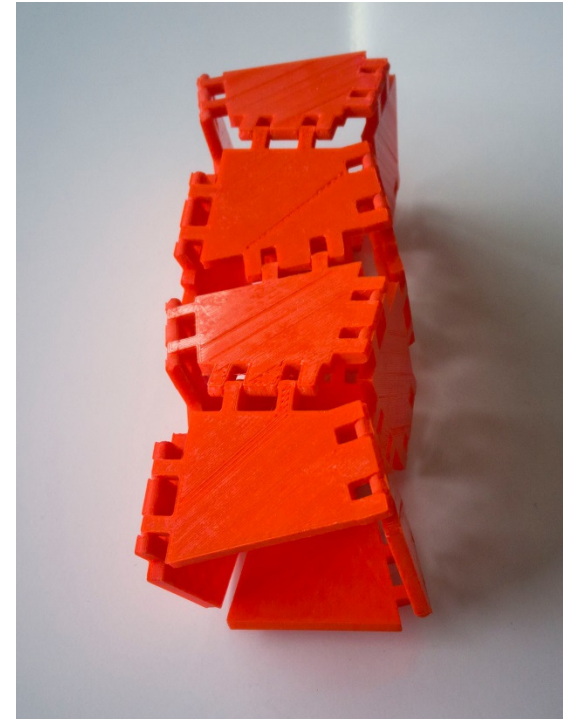
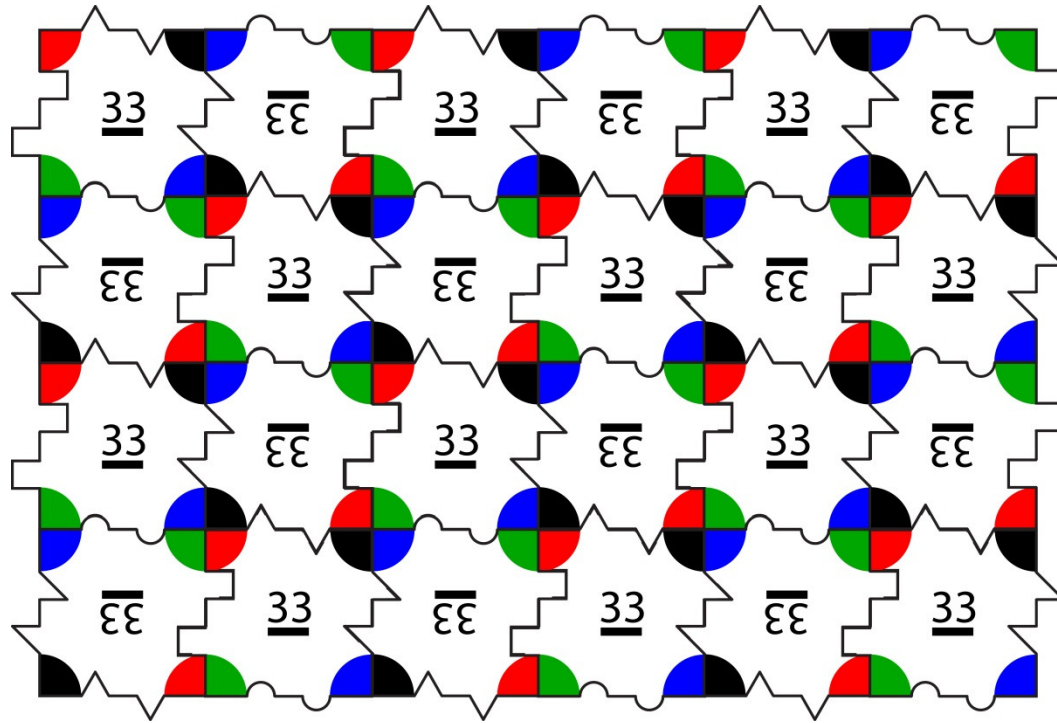
Combinatorial Design of Origami



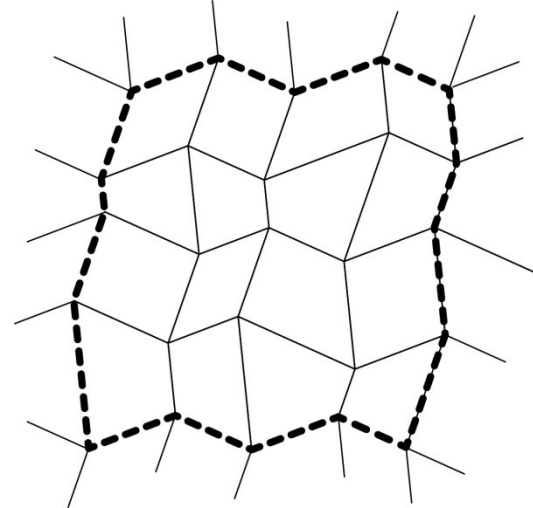
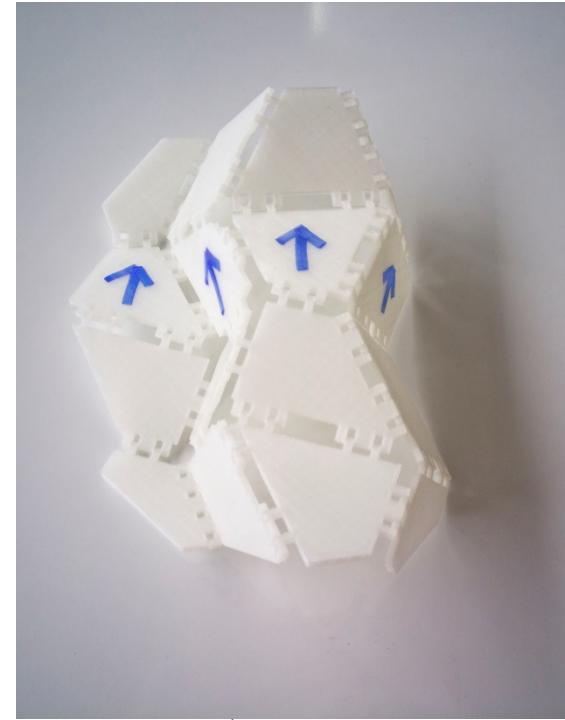
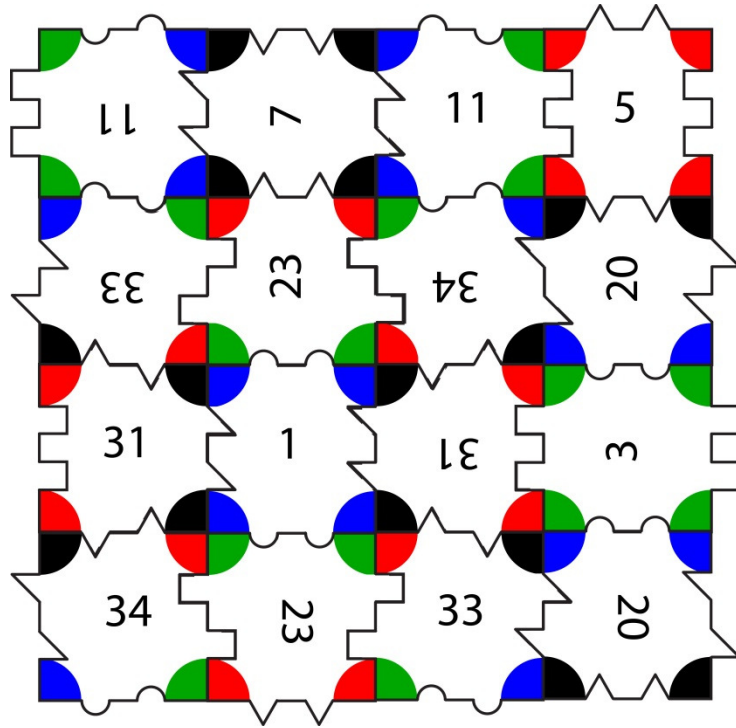
Combinatorial Design of Origami



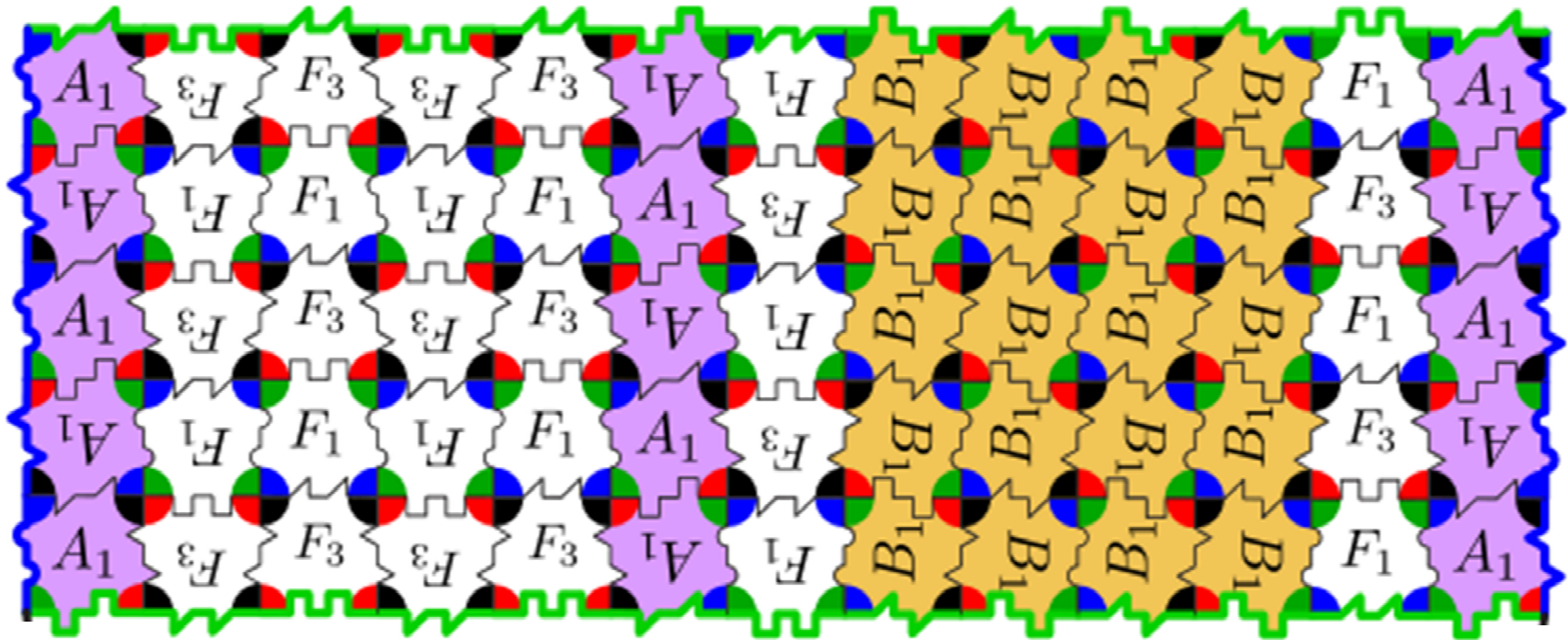
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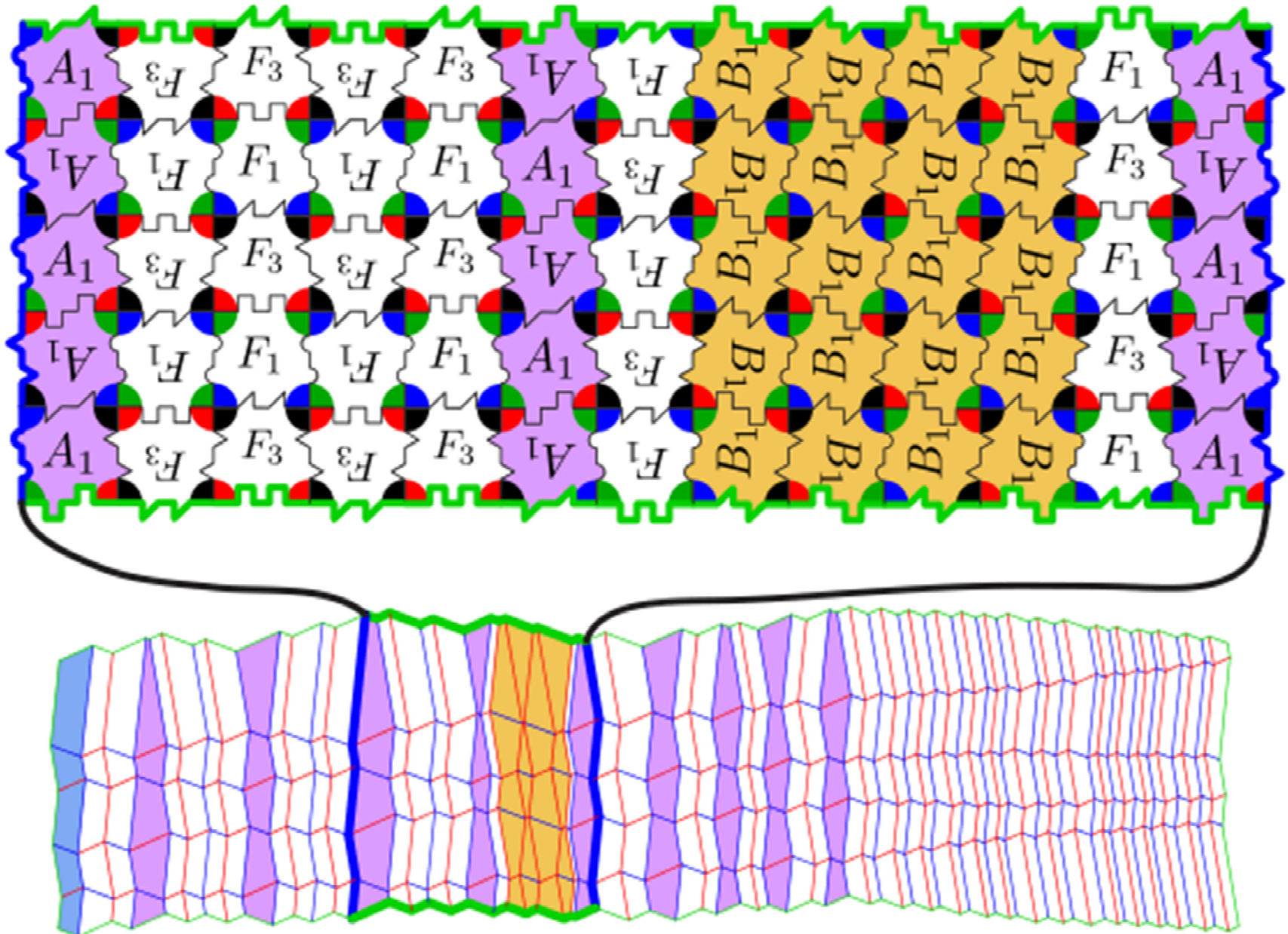
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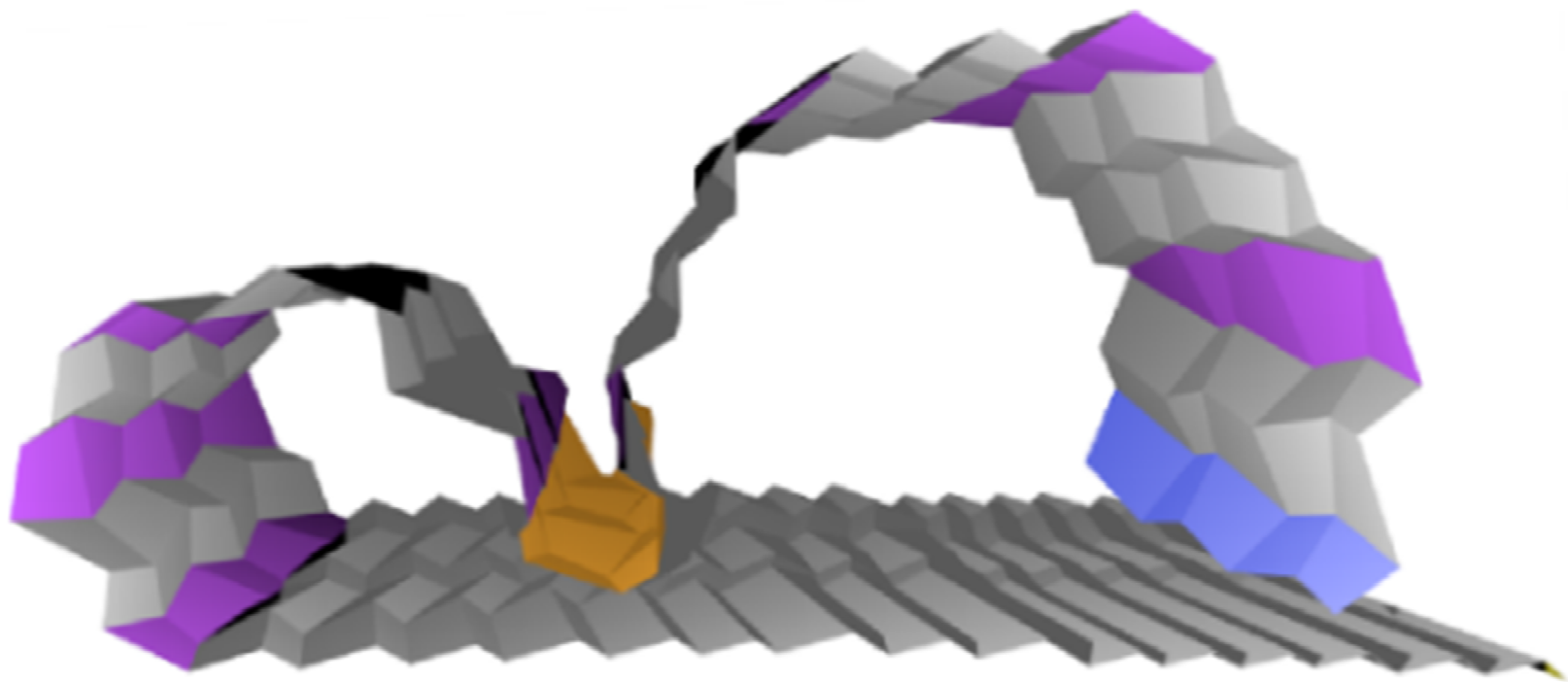
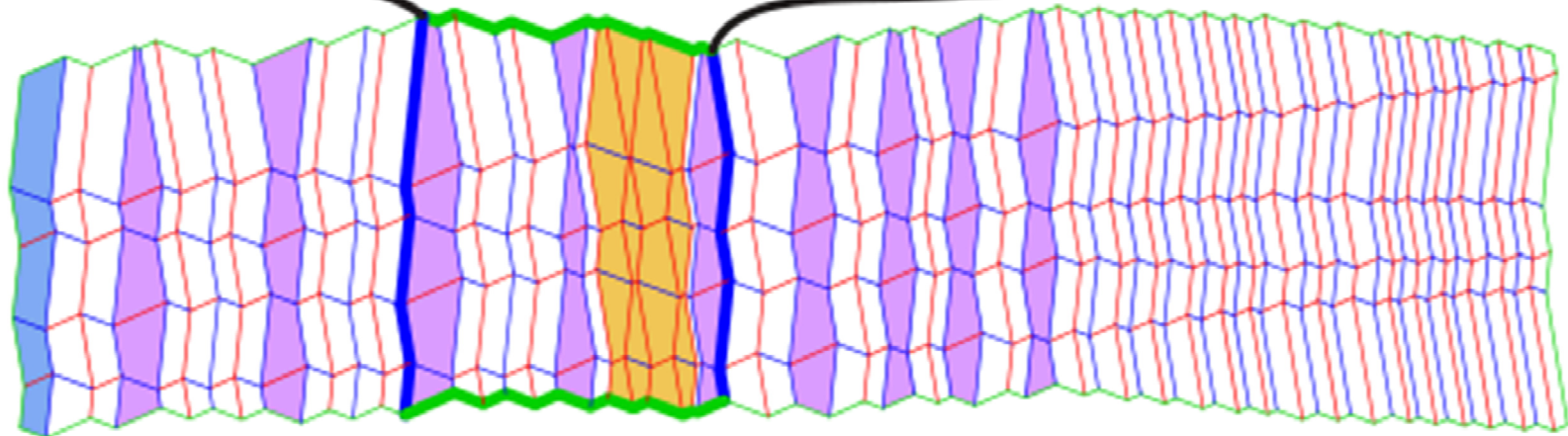
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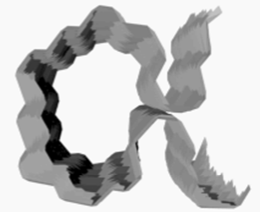
Combinatorial Design of Origami



Combinatorial Design of Origami



Combinatorial Design of Origami



Complexity in Mechanical Metamaterials

Frustration: Complex Energy Landscape

Geometry: Design Shape Transformations

What's Next? Design Energy Landscape