## CLAIMS

**WHAT IS CLAIMED IS:**

1. A method of digital design and manufacturing, the method comprising:

receiving a rod structure with an original shape for fabrication;

receiving a target shape of the rod structure into which the original shape is to be deformed during a training phase; and

determining a spatially varying Young's modulus distribution for the fabrication of the rod structure in the original shape, the spatially varying Young's modulus distribution enabling deformation of the original shape into the target shape during the training phase, wherein the determining of the spatially varying Young's modulus distribution comprises resolving a nonlinear optimization problem for the spatially varying Young's modulus distribution, wherein an objective of the nonlinear optimization problem is to minimize a deviation of a deformed shape from the target shape.

2. The method of claim 1, further comprising:

fabricating the original shape of the rod structure based on the spatially varying Young's modulus distribution.

3. The method of claim 2, wherein the fabricating of the original shape of the rod structure based on the spatially varying Young's modulus distribution comprises:

voxelizing the original shape of the rod structure to obtain a voxel grid;

determining a material for each voxel of the voxel grid based on the spatially varying Young's modulus distribution; and

fabricating the original shape of the rod structure based on the material determined for each voxel of the voxel grid.

4. The method of claim 3, wherein the determining of the material for each voxel comprises:

mapping a Young's modulus value of the spatially varying Young's modulus distribution corresponding to the voxel to a material ratio; and

dithering based on the material ratio to determine the material for the voxel.

5. The method of claim 2, further comprising:

training the fabricated rod structure from the original shape into the target shape during the training phase.

6. The method of claim 5, wherein the training of the fabricated rod structure comprises applying a set of forces to the fabricated rod structure to deform the fabricated rod structure from the original shape into the target shape.

7. The method of claim 5, further comprising:

recovering the fabricated rod structure from the target shape to the original shape.

8. An apparatus for digital design and manufacturing, the apparatus comprising:

a memory; and

at least one processor coupled to the memory and configured to:

receive a rod structure with an original shape for fabrication;

receive a target shape of the rod structure into which the original shape is to be deformed during a training phase; and

determine a spatially varying Young's modulus distribution for the fabrication of the rod structure in the original shape, the spatially varying Young's modulus distribution enabling deformation of the original shape into the target shape during the training phase,

wherein, to determine the spatially varying Young's modulus distribution, the at least one processor is configured to resolve a nonlinear optimization problem for the spatially varying Young's modulus distribution, wherein an objective of the nonlinear optimization problem is to minimize a deviation of a deformed shape from the target shape.

9. The apparatus of claim 8, wherein the at least one processor is further configured to:

fabricate the original shape of the rod structure based on the spatially varying Young's modulus distribution.

10. The apparatus of claim 9, wherein, to fabricate the original shape of the rod structure based on the spatially varying Young's modulus distribution, the at least one processor is configured to:

voxelize the original shape of the rod structure to obtain a voxel grid;

determine a material for each voxel of the voxel grid based on the spatially varying Young's modulus distribution; and

fabricate the original shape of the rod structure based on the material determined for each voxel of the voxel grid.

11. The apparatus of claim 10, wherein, to determine the material for each voxel, the at least one processor is configured to:

map a Young's modulus value of the spatially varying Young's modulus distribution corresponding to the voxel to a material ratio; and

dither based on the material ratio to determine the material for the voxel.

12. The apparatus of claim 9, wherein the at least one processor is further configured to:

train the fabricated rod structure from the original shape into the target shape during the training phase.

13. The apparatus of claim 12, wherein, to train the fabricated rod structure, the at least one processor is configured to apply a set of forces to the fabricated rod structure to deform the fabricated rod structure from the original shape into the target shape.

14. The apparatus of claim 12, wherein the at least one processor is further configured to:

recover the fabricated rod structure from the target shape to the original shape.

15. A computer-readable medium storing computer executable code, comprising instructions for:

receiving a rod structure with an original shape for fabrication;

receiving a target shape of the rod structure into which the original shape is to be deformed during a training phase; and

determining a spatially varying Young's modulus distribution for the fabrication of the rod structure in the original shape, the spatially varying Young's modulus distribution enabling deformation of the original shape into the target shape during the training phase, wherein the determining of the spatially varying Young's modulus distribution comprises

resolving a nonlinear optimization problem for the spatially varying Young's modulus distribution, wherein an objective of the nonlinear optimization problem is to minimize a deviation of a deformed shape from the target shape.

16. The computer-readable medium of claim 15, further comprising instructions for:

fabricating the original shape of the rod structure based on the spatially varying Young's modulus distribution.