



What machine learning can do for inverse design of (meta-)materials

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Mapping structure to property property structure

Delft





Spinodoids: a new class of metamaterials

inspired from spinodal decomposition (rapid separation in a mixture of immiscible components) • •



(W. Deng and J.R. Greer, Caltech)

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Superior mechanical properties



Kumar et al., Inverse-designed spinodoid metamaterials, npj Comp. Mater., 2020



Seamless design & property tunability





COMPUTING

Challenge: multiple topologies can have same/similar stiffness

Inverse problem:



ill-posed!



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Kumar et al., Inverse-designed spinodoid metamaterials, npj Comp. Mater., 2020

MECHANICS MATERIALS COMPUTING

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Kumar et al., Inverse-designed spinodoid metamaterials, npj Comp. Mater., 2020



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Kumar et al., Inverse-designed spinodoid metamaterials, npj Comp. Mater., 2020



Inverse-designed synthetic bone



Predicted synthetic bone topology





Kumar et al., Inverse-designed spinodoid metamaterials, npj Comp. Mater., 2020



Lightweight multiscale structures

... with ML-accelerated topology optimization



Zheng et al., Data-driven topology optimization of spinodoid metamaterials with seamlessly tunable anisotropy, Comput. Methods Appl. Mech. Eng., 2021







Thank you!

Questions & comments . . .

References:

- Kumar et al., Inverse-designed spinodoid metamaterials npj Comp. Mater., 2020
- Zheng et al., Data-driven topology optimization of spinodoid metamaterials with seamlessly tunable anisotropy Comput. Methods Appl. Mech. Eng., 2021

Open-source ML+design codes:

https://www.mech-mat.com/codes

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