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OPTIMIZATION OF MICROSTRUCTURES USED IN CMOS-MEMS SENSORS BASED ON TOPOLOGICAL DESIGN PROCESS

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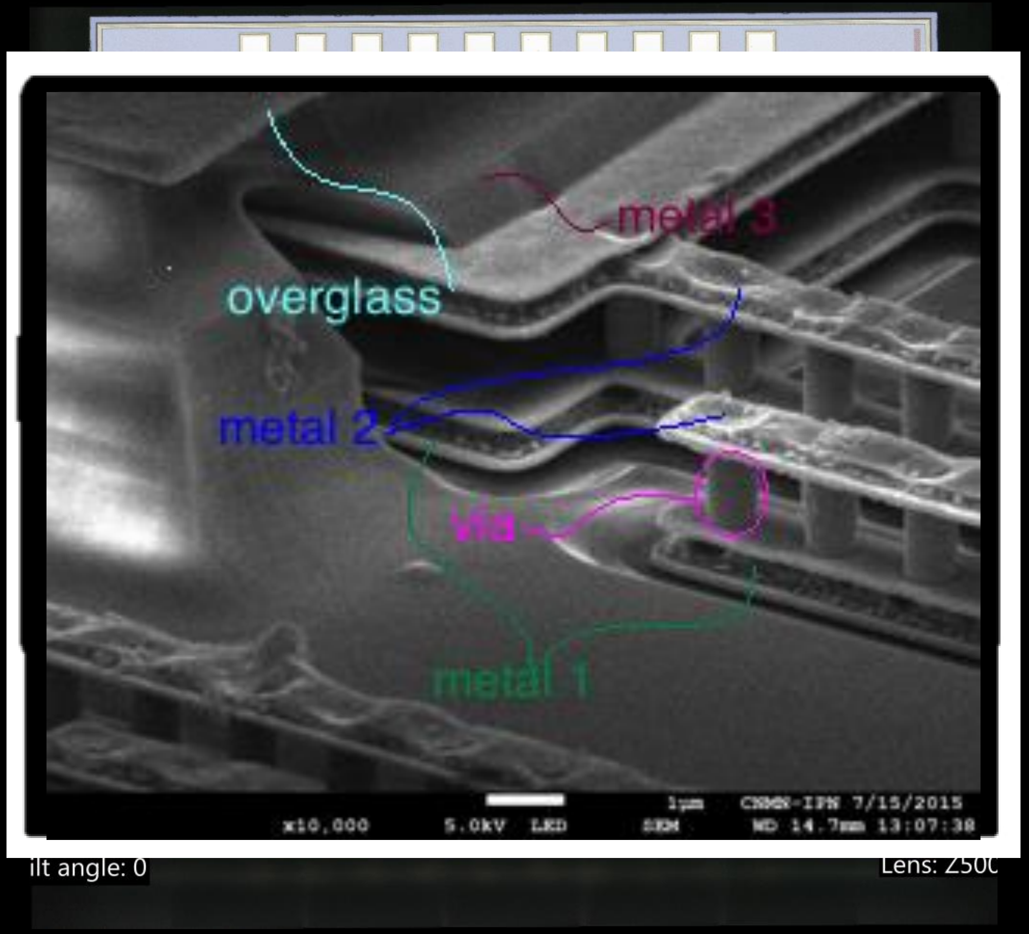
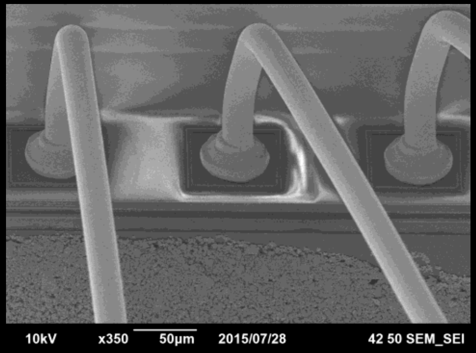
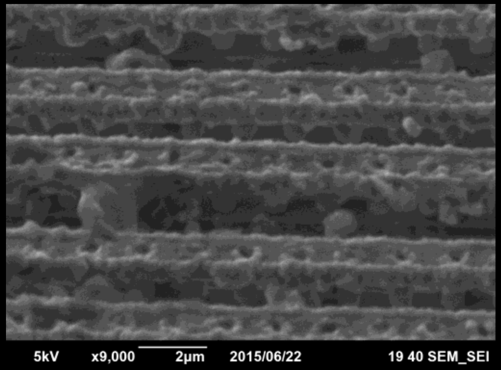
INTRODUCTION

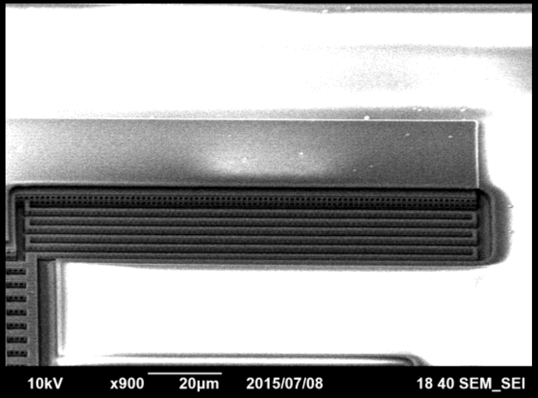
- Inertial MEMS design
- CMOS technology
- CMOS-MEMS



PROBLEM STATEMENT



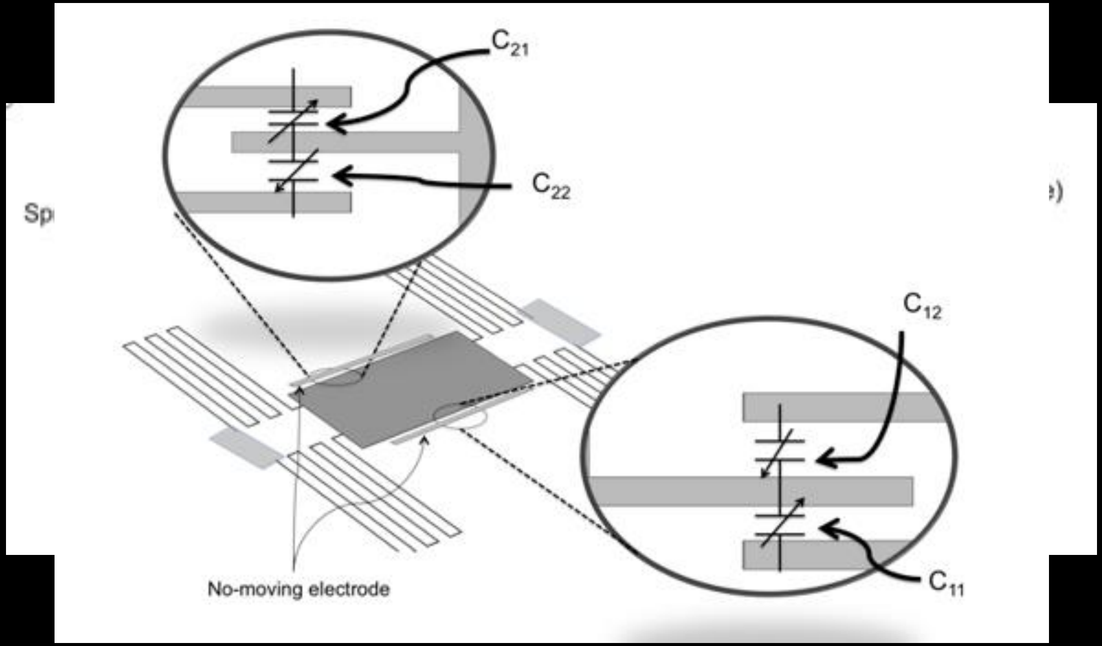




- CMOS-MEMS design efforts focused primary on electronics design
- CMOS technology limitations
- Manufacture dificulties

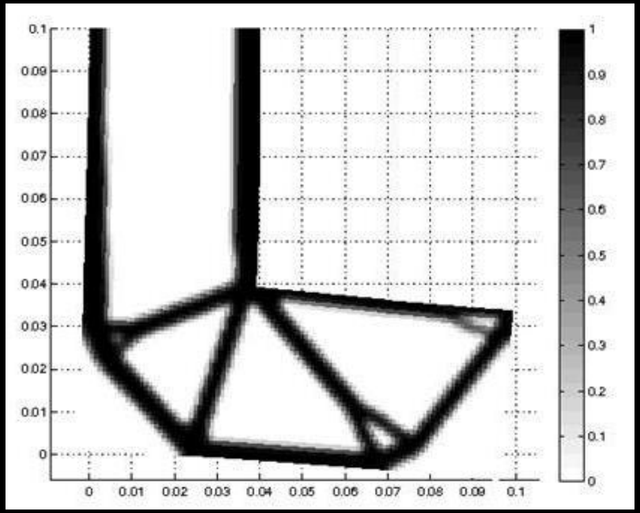
CAPACITIVE STRUCTURE

- Most common transduction principles used in CMOS-MEMS
- Analogy to a parallel plate capacitor
- Based on design rules of a standard CMOS process
  - 0.5 microns
  - N-well
  - Double polysilicon
  - Three metal layers

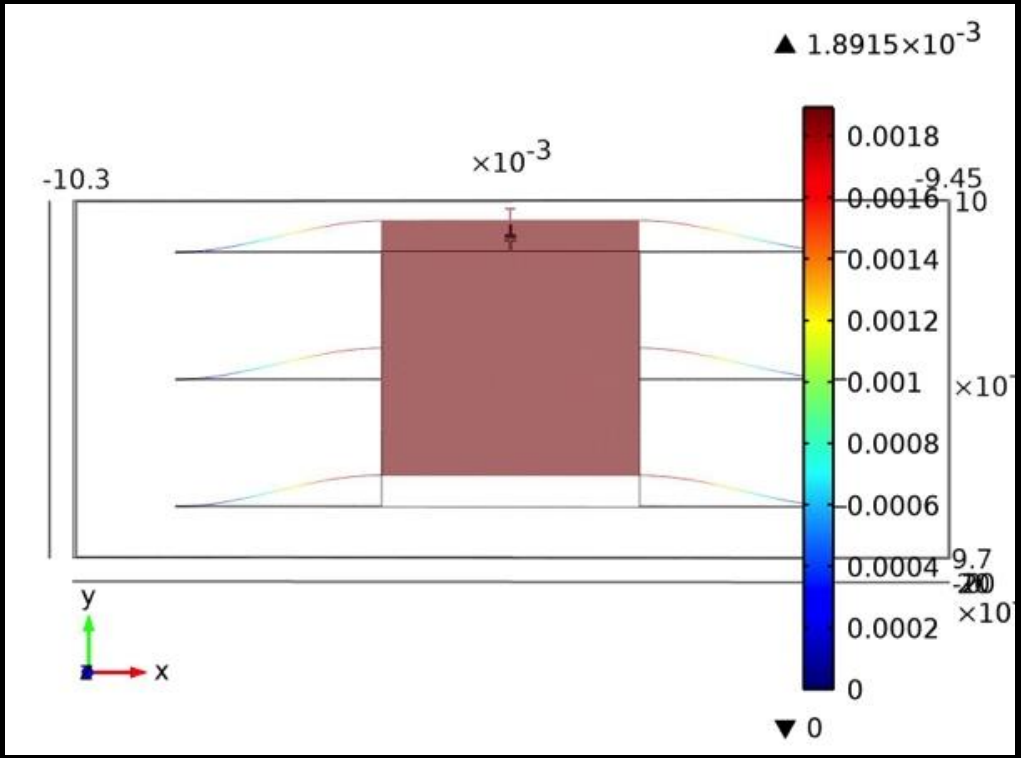


TOPOLOGICAL DESIGN

- Needs and restrictions
  - Anchors dimensions
  - Fixed thickness
  - Optimize stiffness in desired direction
- Size and shape can be modified
  - Topology optimization is suitable
- SIMP model
  - Minimize the weight of the domain setting a minimum rigidity
  - Displacements in a desired direction are constrained



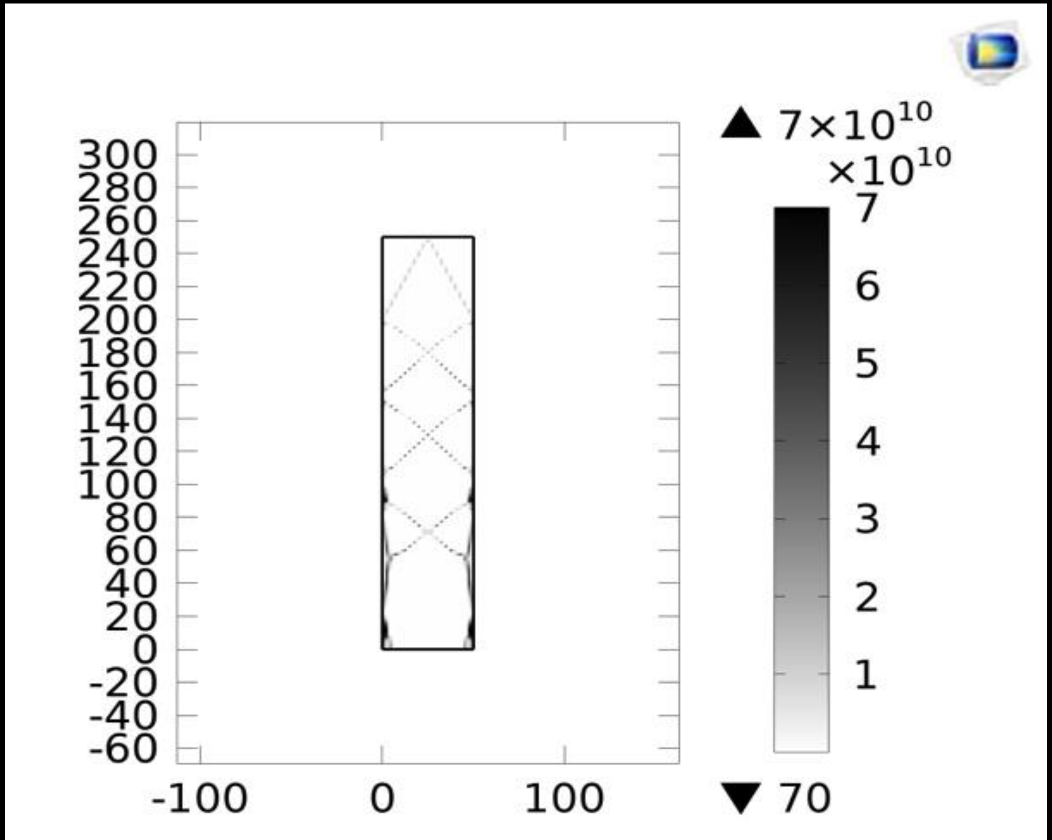
ELECTROMECHANICAL ANALYSIS



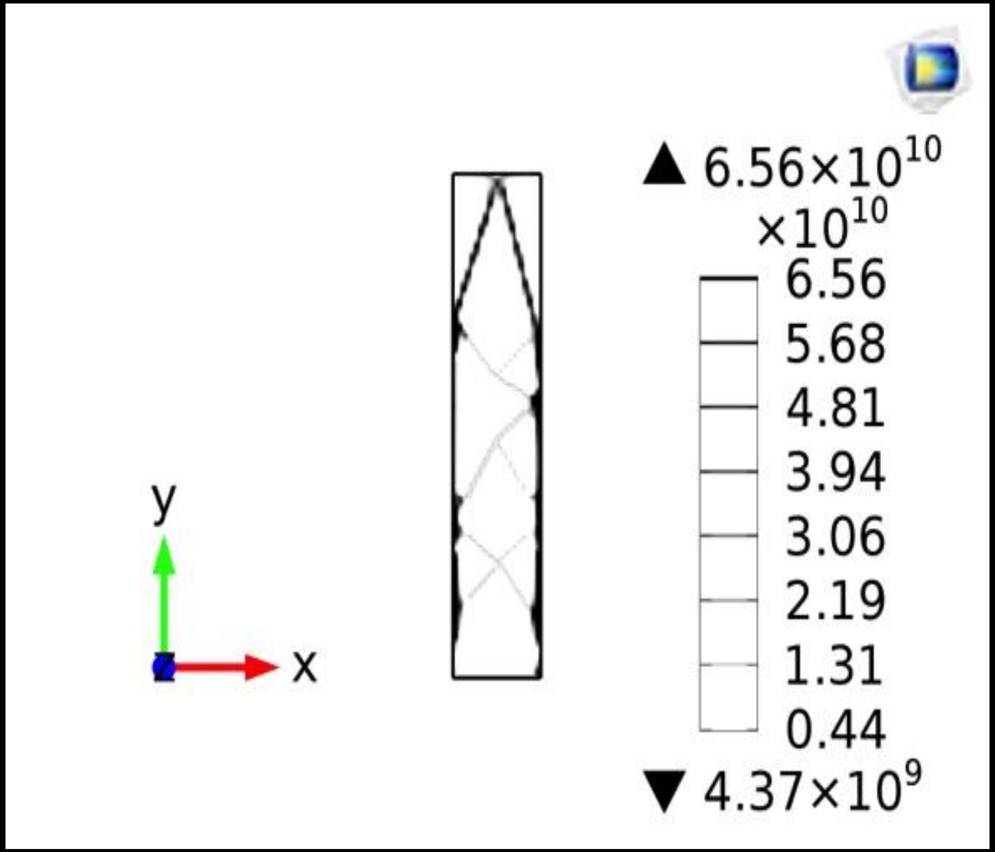
- Simple geometry
- 3D
- Fixed supports on beams
- 5V applied
- Negligible displacements

2D OPTIMIZATION MODELS

- Two models were proposed
  - 16g and 250g
  - Desired displacements 0.5 microns
- Quad equiangular elements
  - Great mesh quality
  - Elements equally distributed
- Mesh independency mechanism omited
  - Checkerboard effect
- Continuation method
  - On penalty factor
  - On mesh size

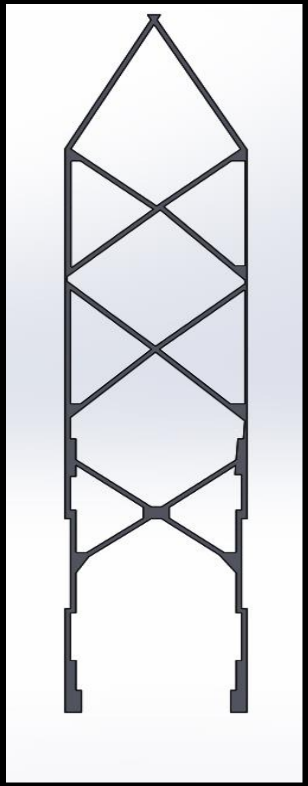


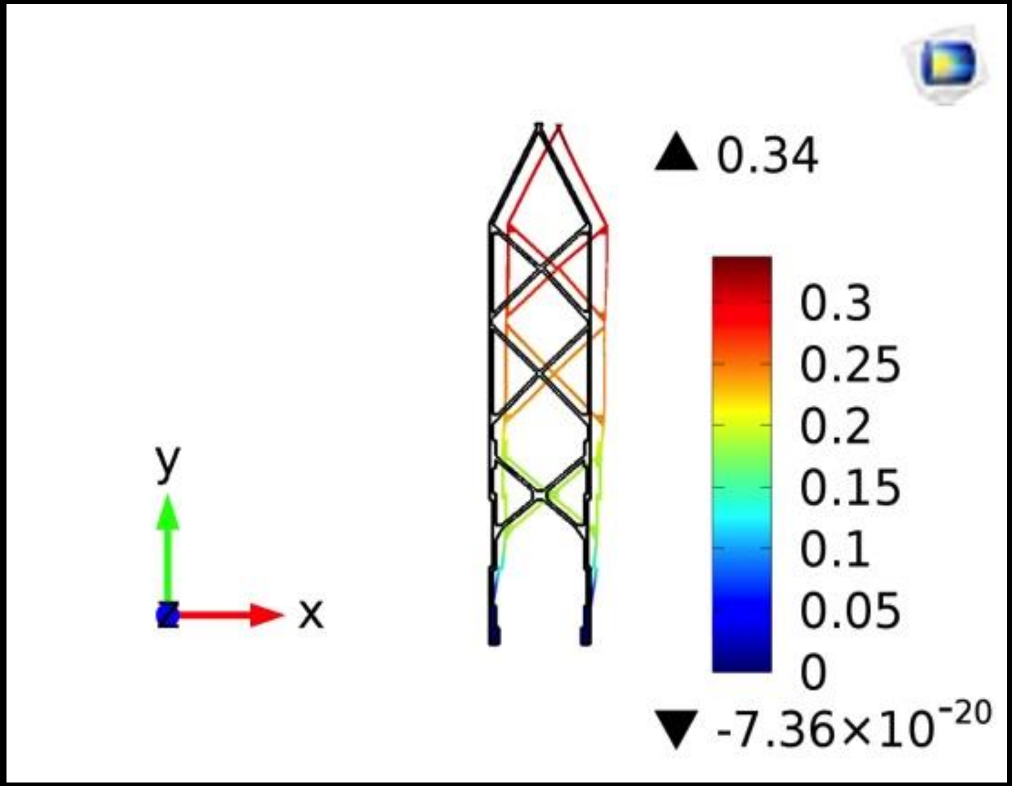
3D OPTIMIZATION MODEL



- One model proposed
  - 250g
- Tetra mesh
  - Great quality
  - Two elements in z-direction
- Material distribution on z-direction
  - Not uniform
- Variation against 2D
  - Gravity applied
- Continuation method

OPTIMIZED CAD MODEL/STATIC STRUCTURAL ANALYSIS





CONCLUSIONS

- Topology optimization in MEMS design
- Forces and proposed design spaces
- Mesh independecy mechanism
- Z-direction material distribution
- Out of plane deflection

THANK YOU FOR YOUR ATTENTION

QUESTIONS?