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SAND

COMSOL CONFERENCE ROTTERDAM2013

# Simulation of ZnO Enhanced SAW Gas Sensor

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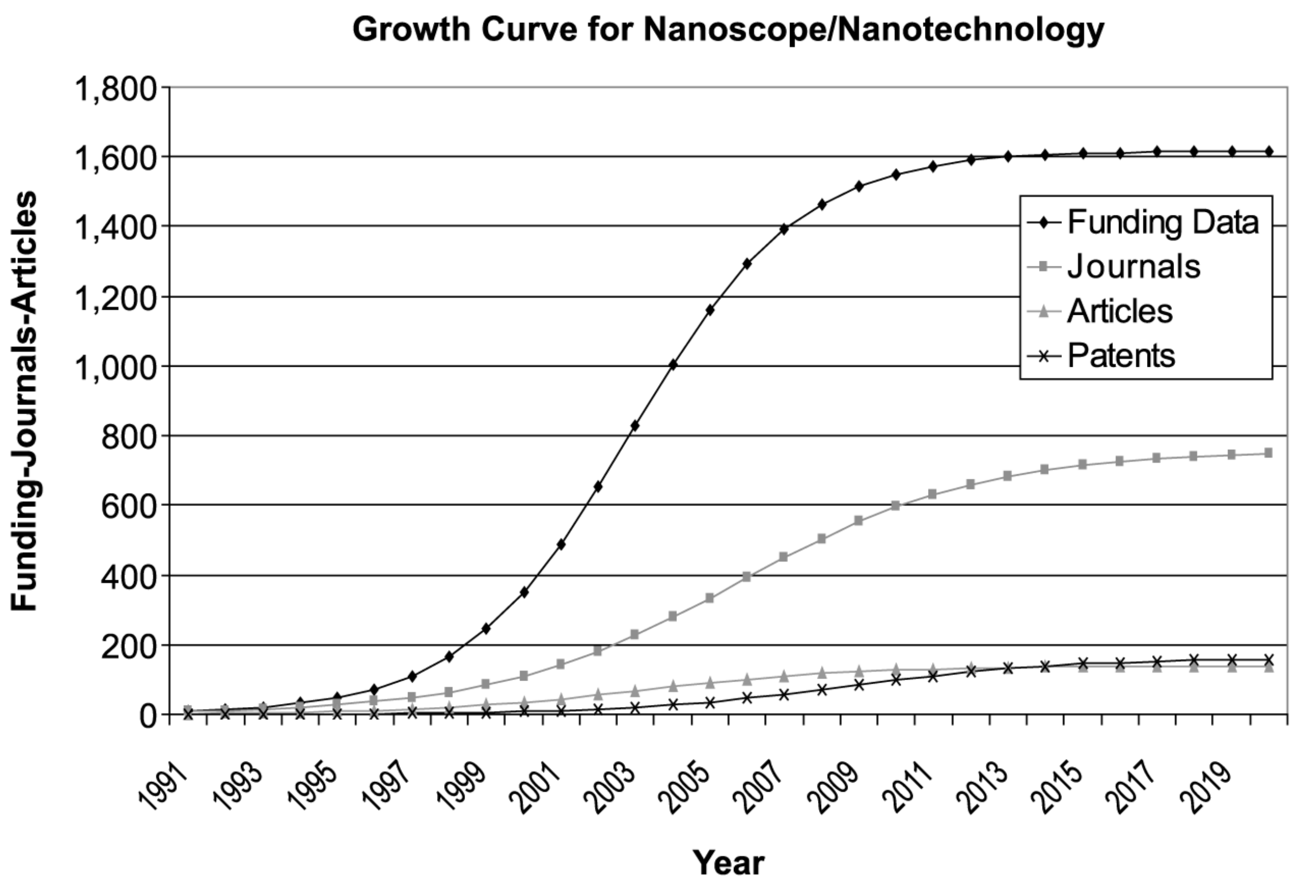
# Introduction

- Sensors are part of our everyday lives.
- Nanotechnology is used increasingly to improve their efficiency, robustness, and cost effectiveness.




***Funding in millions**

http://www.nanotechproject.org/news/archive/nanotechnology_now_used_in_nearly/

# Application:

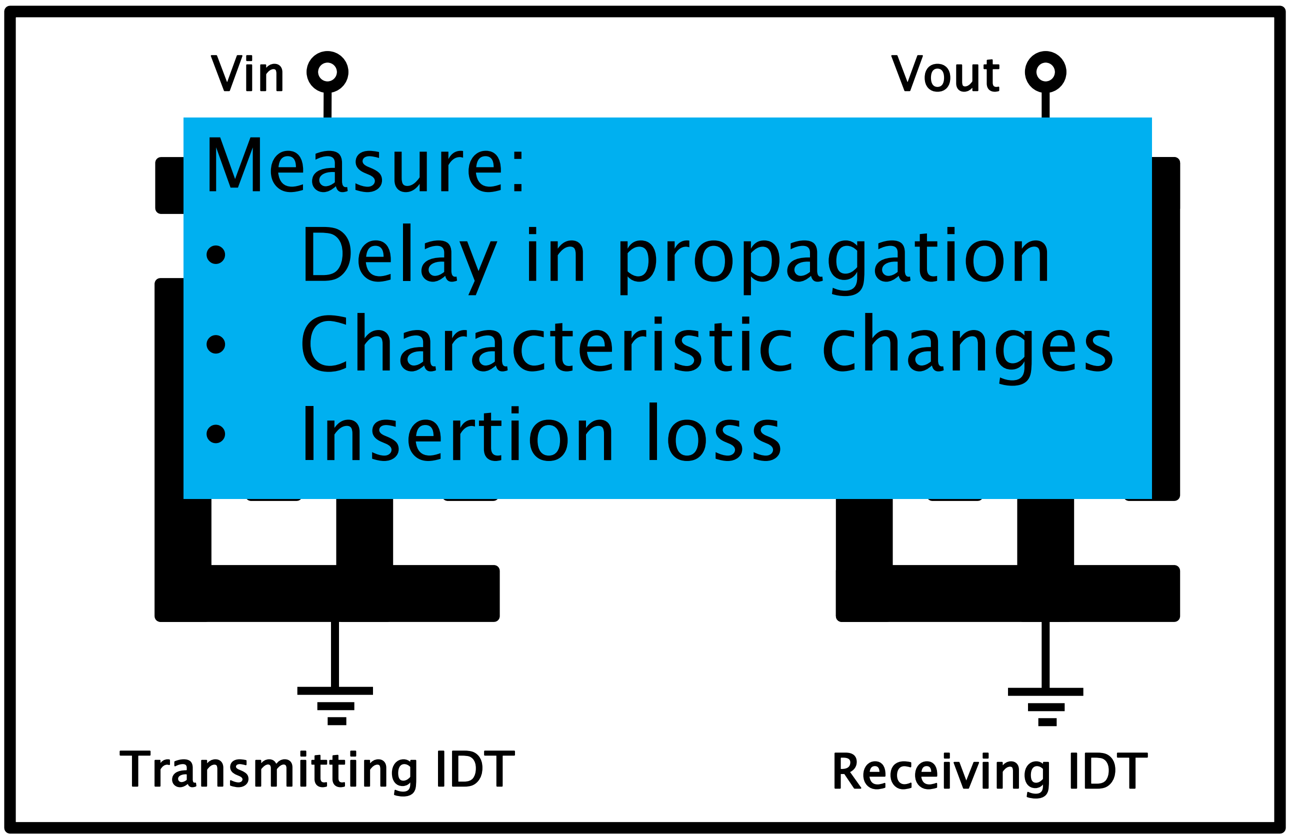
- Widely used for medical purposes: alcohol, carbon dioxide
- Also industrial: propane, hydrogen, methane

# Surface acoustic waves (SAW)

- Micro-electro-mechanical systems (MEMS).
- Made possible with the piezoelectric effect:

$$T_{ij} = c^{E}_{ijkl} S_{kl} - e_{ijk} E_k$$

$$D_i = e_{ikl} S_{kl} + \varepsilon^{S}_{ik} E_k$$




Measure:

- Delay in propagation
- Characteristic changes
- Insertion loss

- IDT determines the wavelength of the acoustic wave

$$\lambda = 2(W_e + W_{sp})$$

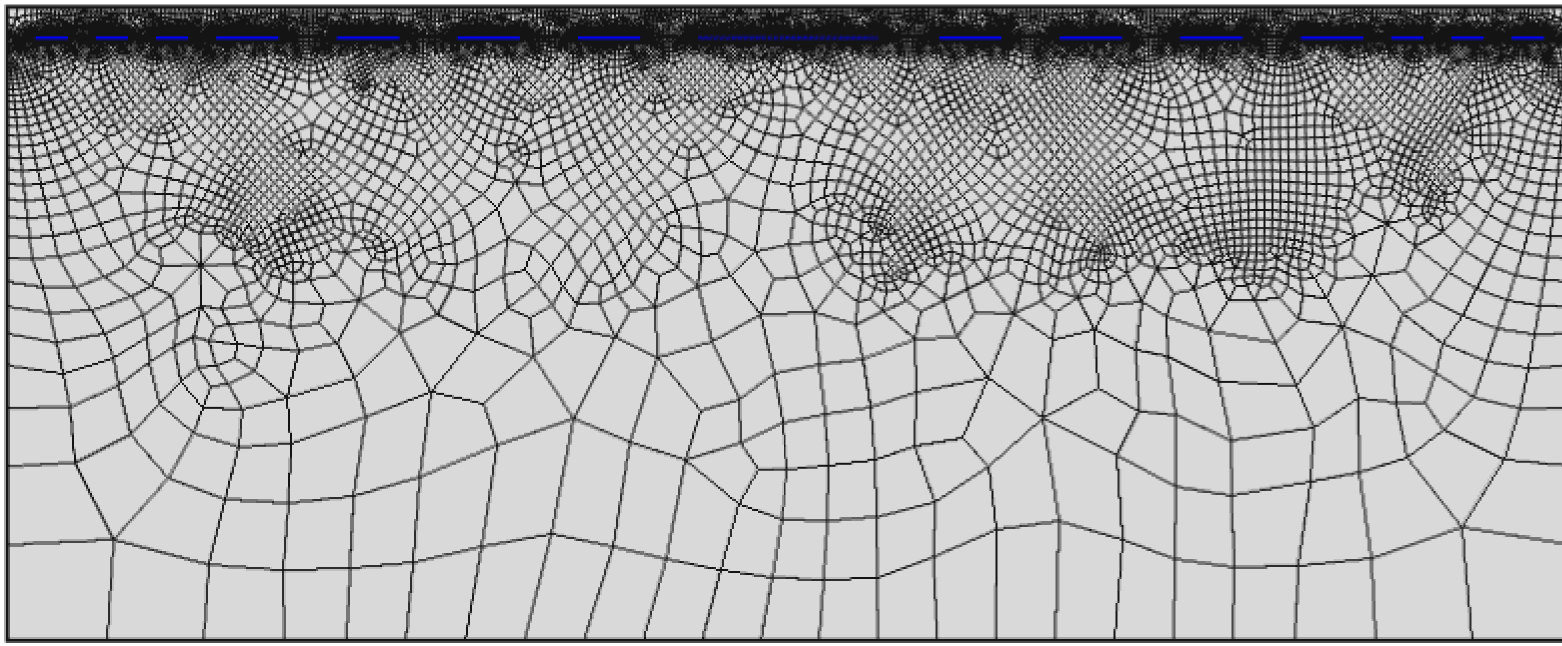
$$f_0 = \frac{v_0}{\lambda}$$

# Materials

- Add nanomaterial to the detection area to increase efficiency and sensitivity.
- The type of nanomaterial varies:
  - Gold and ZnO thin films
  - Carbon nanotubes (Single and multi)
  - Aluminium nitride
- This study focuses on ZnO nanopillars and the effect they have on the SAW device.

- For an optimised SAW device the substrate must have:
  - a large electromechanical coupling coefficient.
  - High SAW velocity
- 128YX lithium niobate has both these qualities as well as giving much less excitation of unwanted bulk waves.

# Using COMSOL



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# Design

- Electrode width and spacing → 20μm
- Wavelength of 80μm → 46.9MHz
- IDT height →200nm
- Two pairs of electrodes per IDT
- Three reflectors with width and spacing → 10μm
- Air height → 10μm
- Aluminium IDT

- ZnO nanopillars are added to the centre of the detection area as rectangular shapes with a width of 50nm.
- The height was chosen as 200nm (optimization study)

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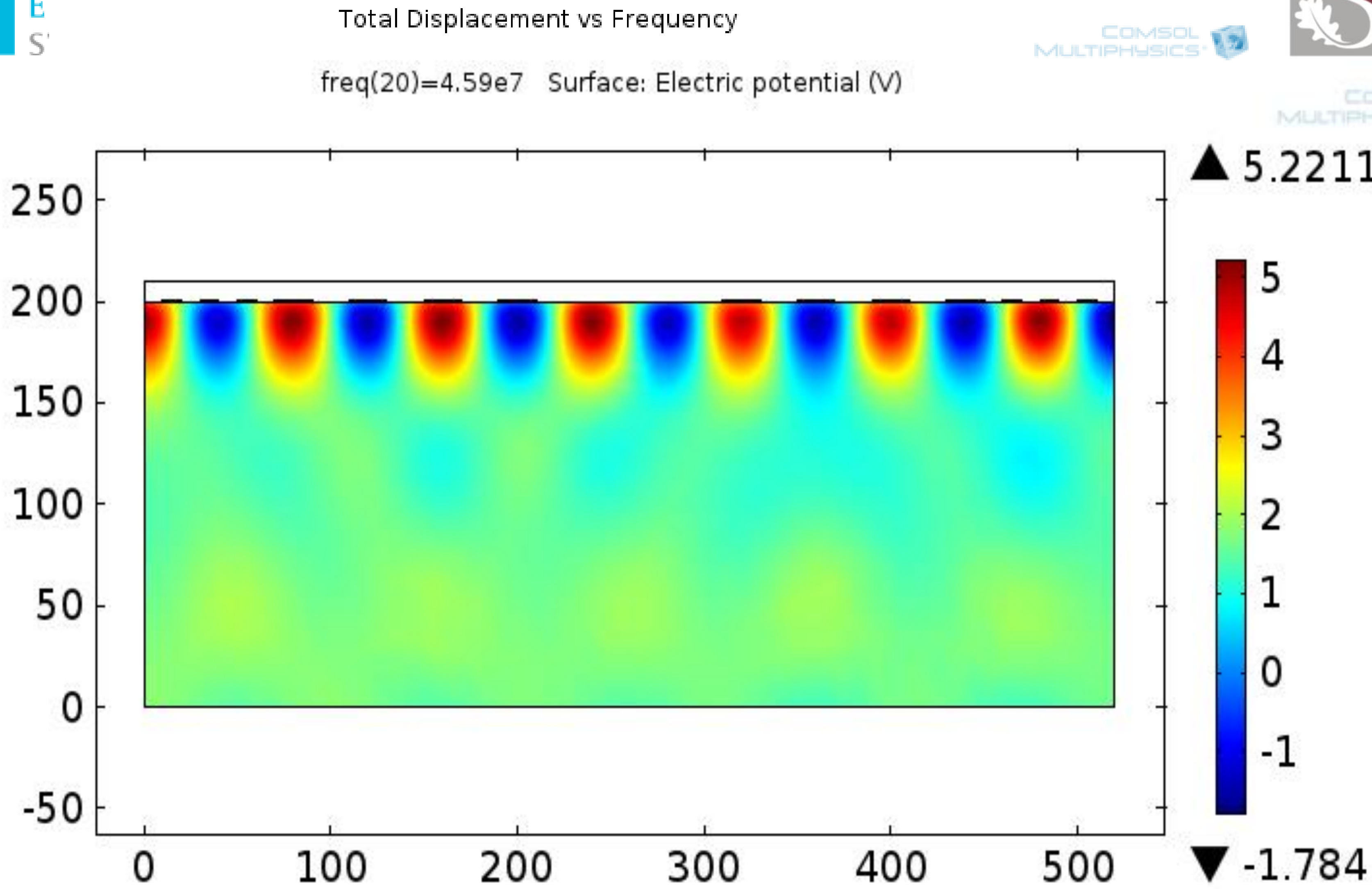
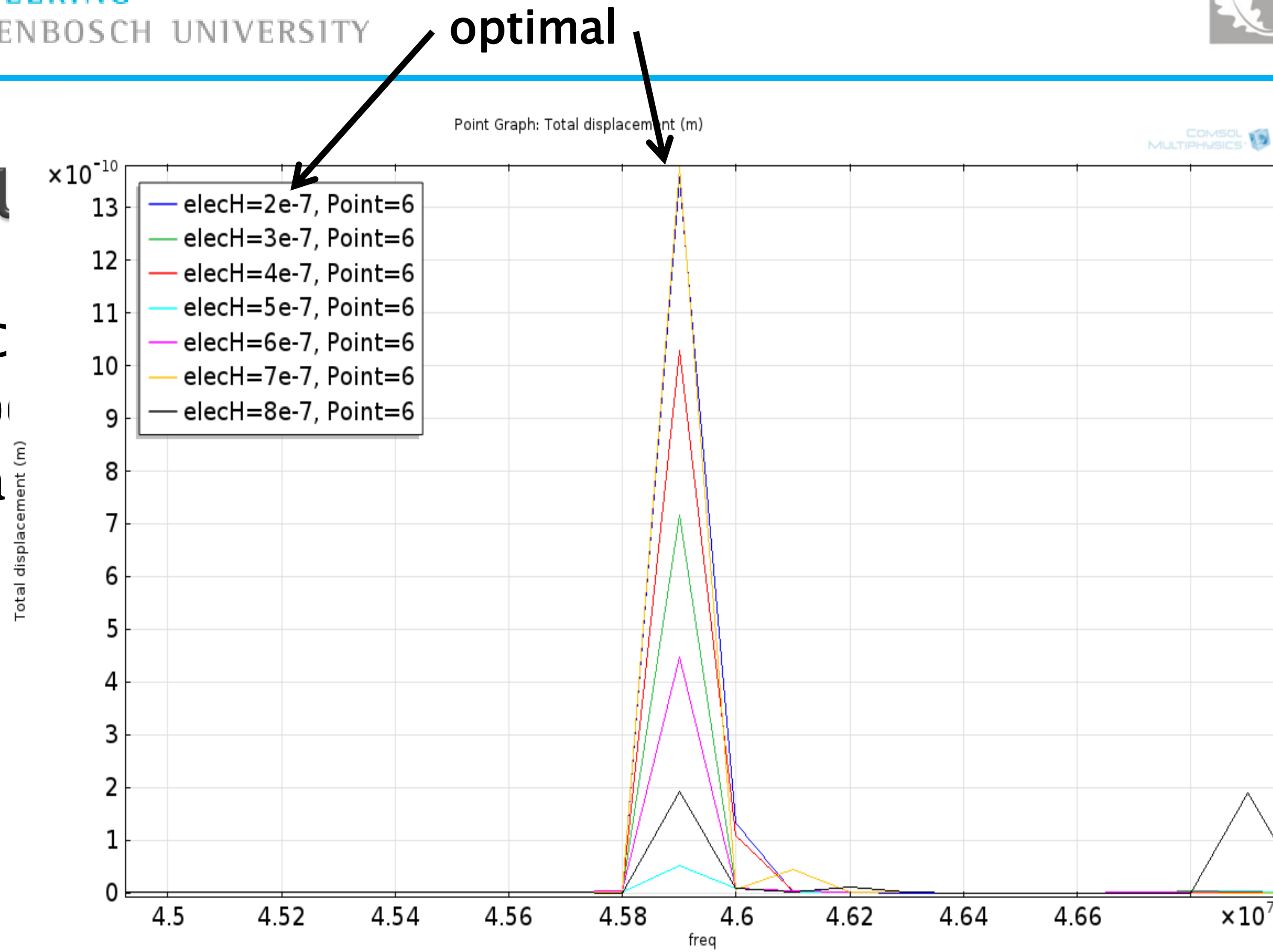


# Resu

- Elec
  - 20
  - Na
    - 1



# Conclusion

- The addition of ZnO nanopillars in the sensing area only affected the device somewhat.
- The operating frequency shifted with 1Mhz.
- The optimal height of the IDT's remained unchanged at 200nm.

# Future work

- Further analysis includes the simulation of the device in a gaseous environment.

- The study also encompasses the physical fabrication and testing of the device.

# Thank you

# Any questions?