Modelling of an Innovative Directional Ultrasonic Atherosclerosis Treatment Device

with COMSOL 5.5

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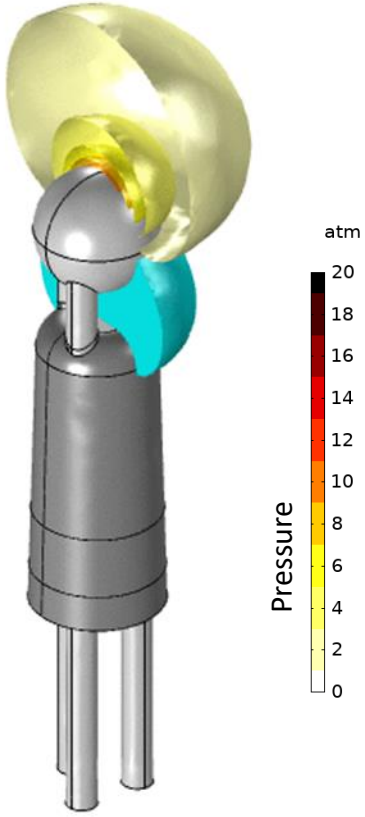
2. Designer of the device

Outline

I. Atherosclerosis
II. Acoustics
III. Cavitation
Conclusion



Area likely to increase bubble size

Our team & Our clients

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8 Members all EngD + PhD

- Extensive research background
- Complex problems
- Various fields of expertise

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- Big international compagnies
- Government laboratories

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- EU funded projects (REEcover / SHARK)
- PhD projects supervision.

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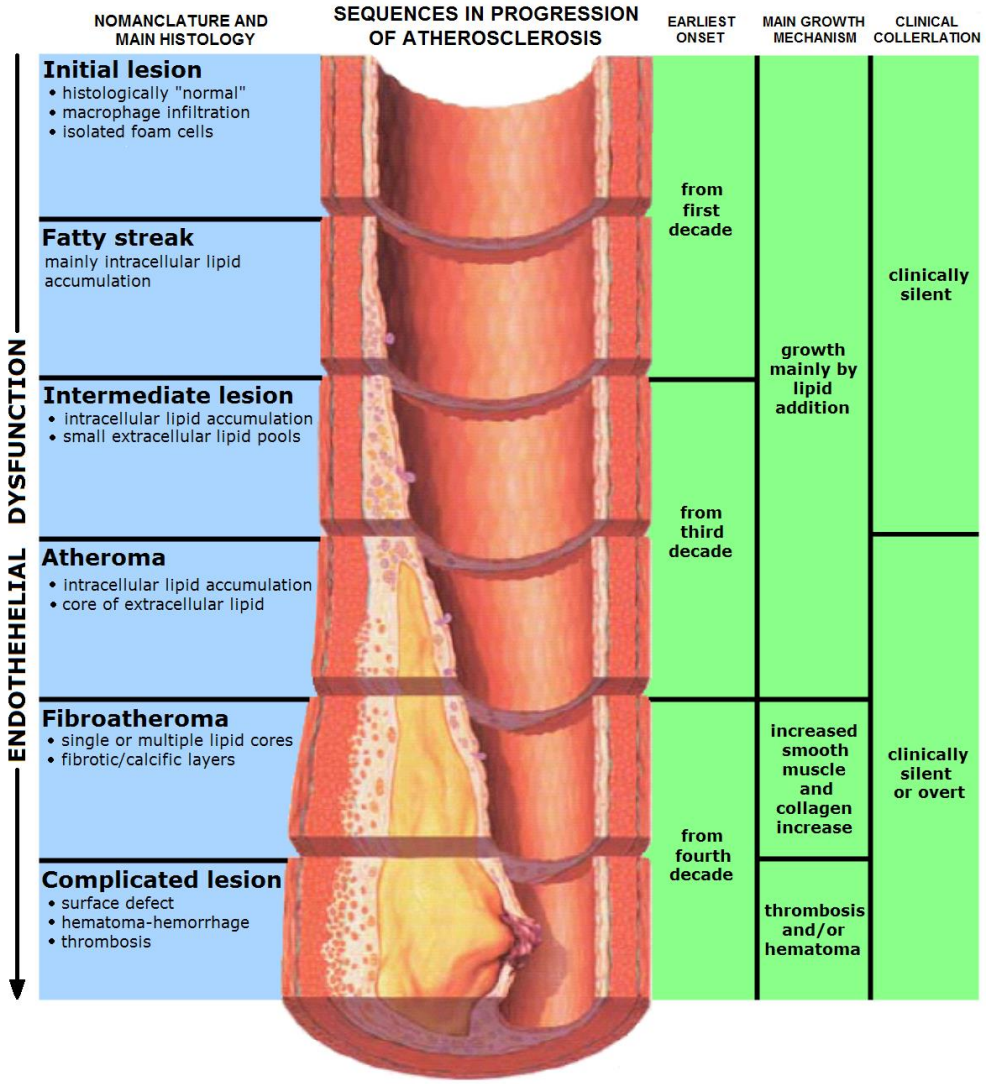
I. Atherosclerosis

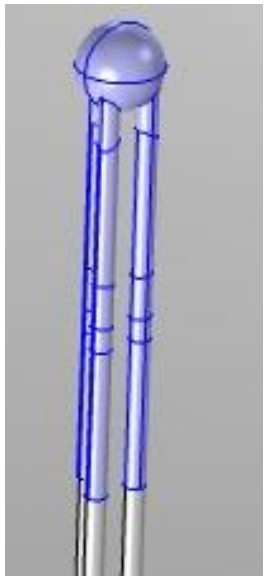
- Increasing phenomena worldwide
- Possible lethal impact
- Treatments still need improvements
- Atherosclerosis removal
  → sonotrode



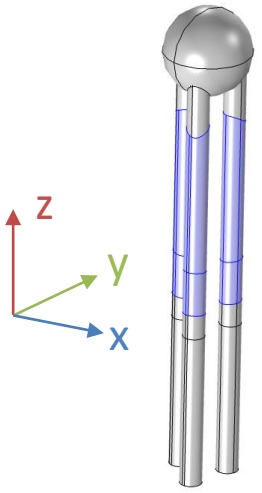
From Wikimedia Commons

II. Acoustics

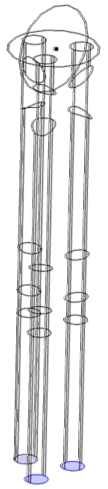
Metal sonotrode tip and wire ends



Structural mechanics domain



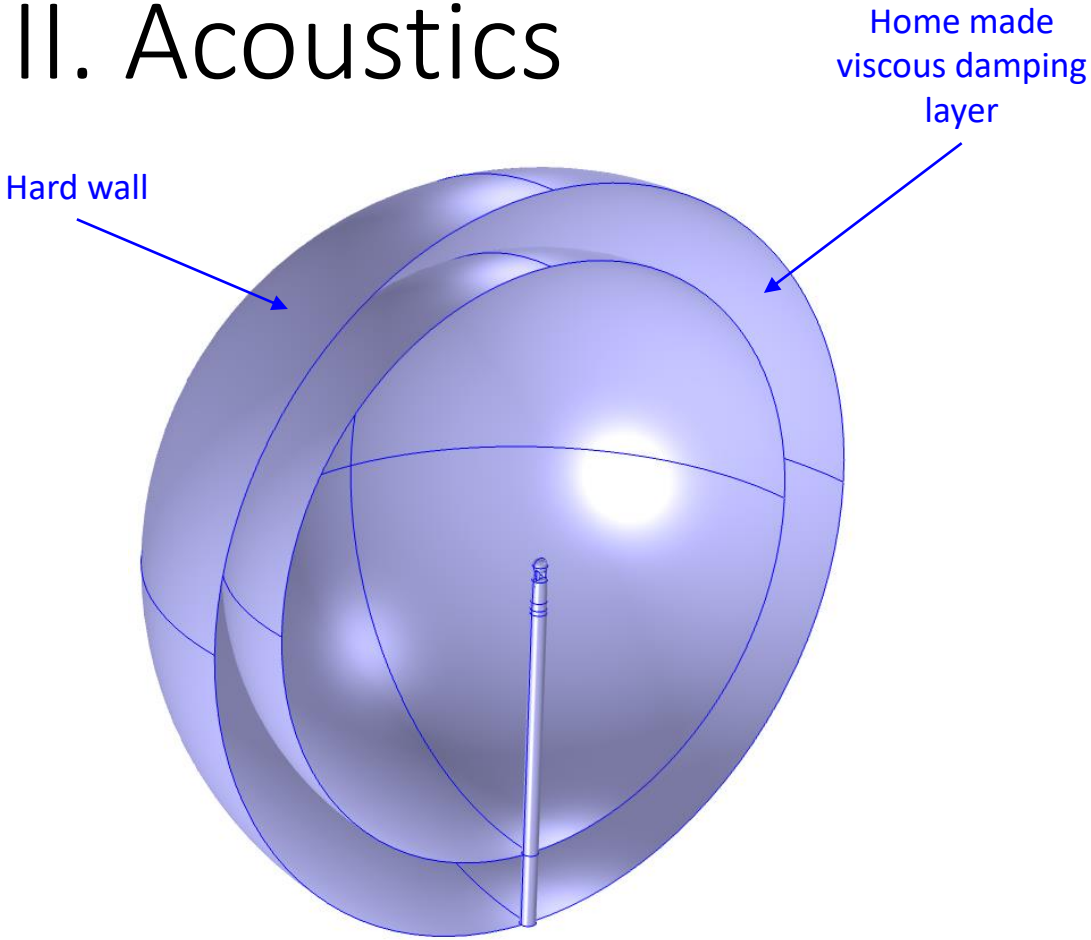
$u = 0$
$v = 0$



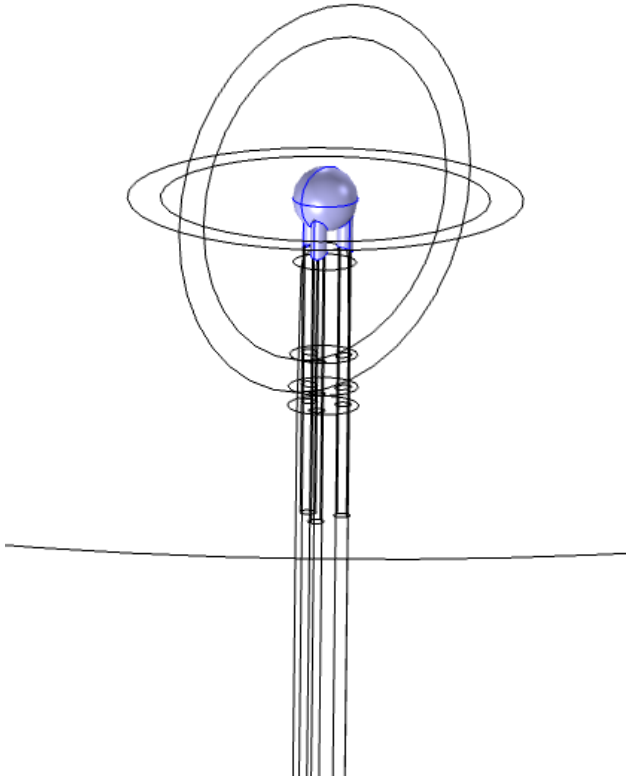
w defined depending on the wire

Boundary condition

II. Acoustics

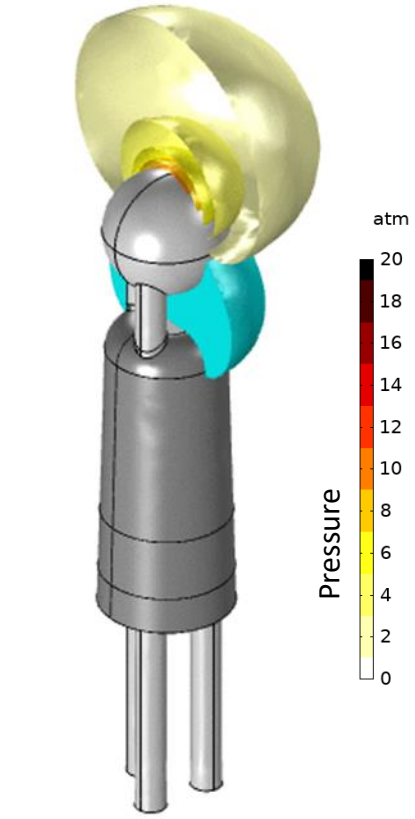


Half acoustic 3D domain

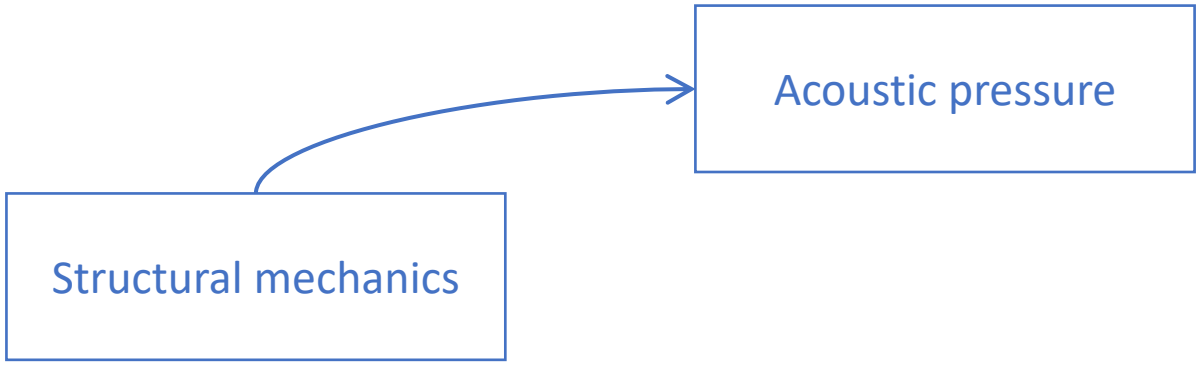


Normal acceleration boundary condition
→ coupling

II. Acoustics



Area likely to increase bubble size



Coupling description

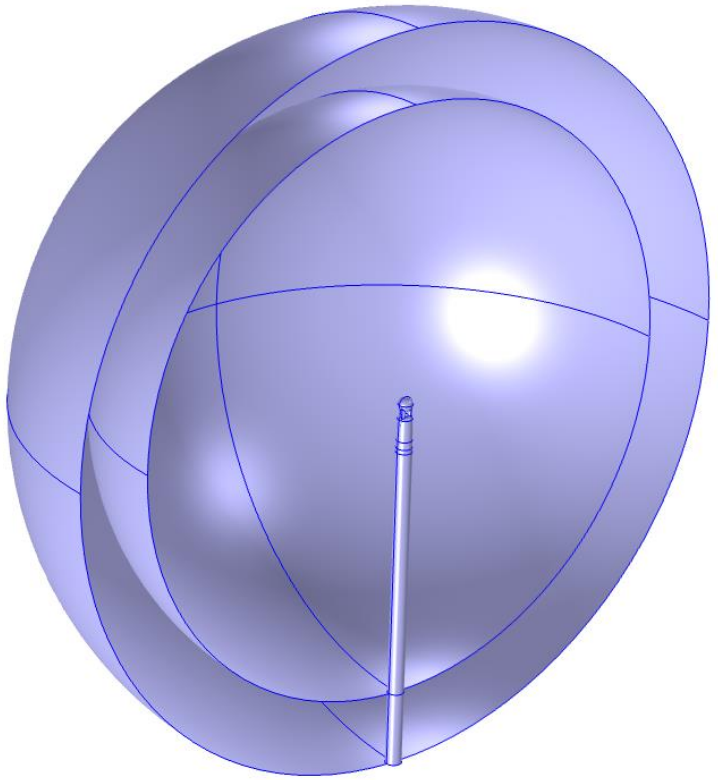
III. Cavitation

Rayleigh-Plesset equation:

$$R\ddot{R} + \frac{3}{2}\dot{R}^2 = \frac{1}{\rho_c}\left[\left(p_0 + \frac{2\sigma}{R_0}\right)\left(\frac{R_0}{R}\right)^{3k} - \frac{2\sigma}{R} - \frac{4\mu\dot{R}}{R} - p_\infty(t)\right]$$

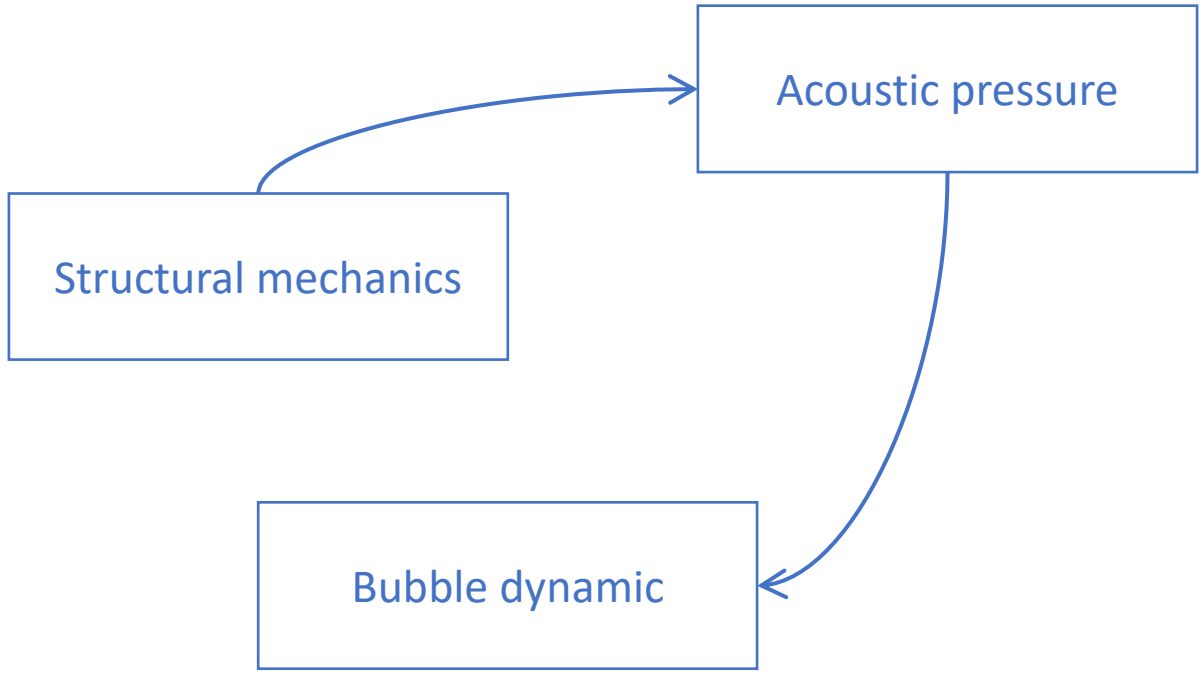
with $k = C_p/C_v$, R_0 the bubble radius under standard condition of temperature and pressure, σ the surface tension, μ the liquid viscosity, p_0 the ambient pressure and p_∞ the pressure imposed by the acoustic pressure field far from the bubble.

→ **Cavitation bubble dynamic**



Rayleigh-Plesset solving domain

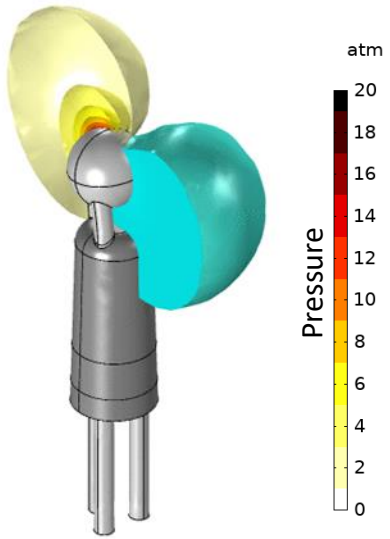
III. Cavitation



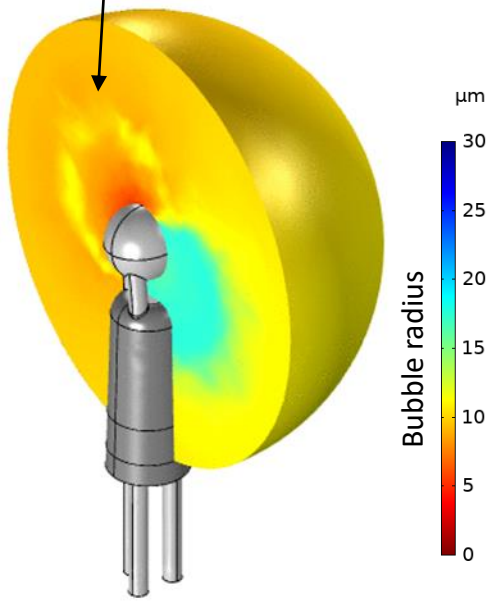
Physics coupling

III. Cavitation

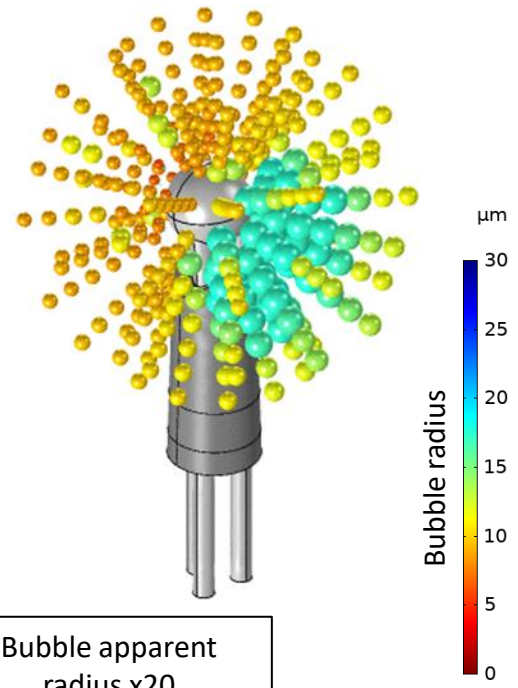
Area likely to increase bubble size



Oriented pressure field



Desired fast and localised bubble dynamic



Bubble apparent radius x20

Acoustic results

Cavitation bubble dynamic

Conclusion

Modelling of a medical device

Mechanics – acoustics – bubble dynamic couplings

Proof of concept!

Thank you for your attention

Q&A? 





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