COMSOL CONFERENCE
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Structured Ultrasonic Metasurfaces

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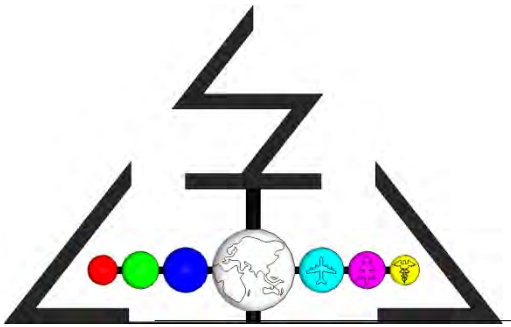

ATOAST

- We Provide Multiphysics Engineering Design Solutions
- Growing with Simulation based engineering Design
- Driven by Material Unity Vision
- We are the first COMSOL Certified Consultant from India
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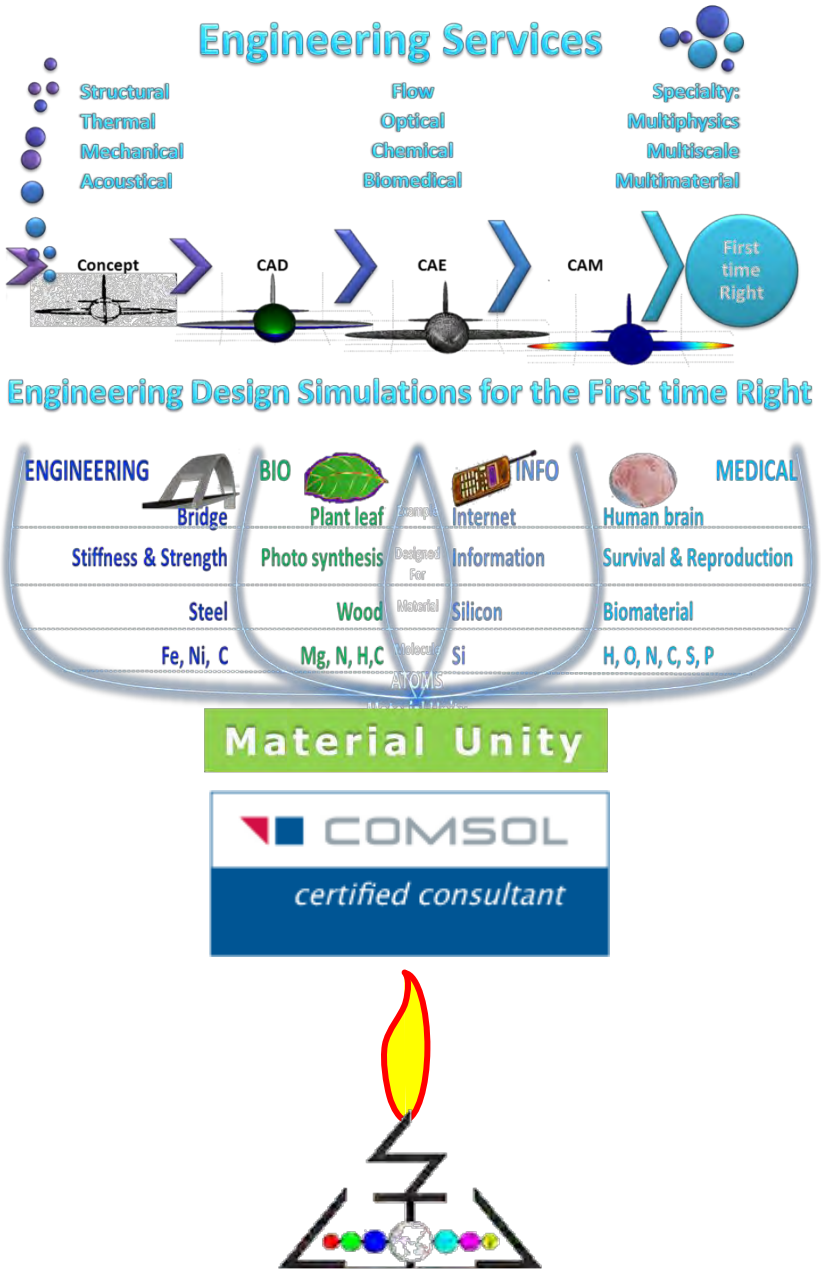
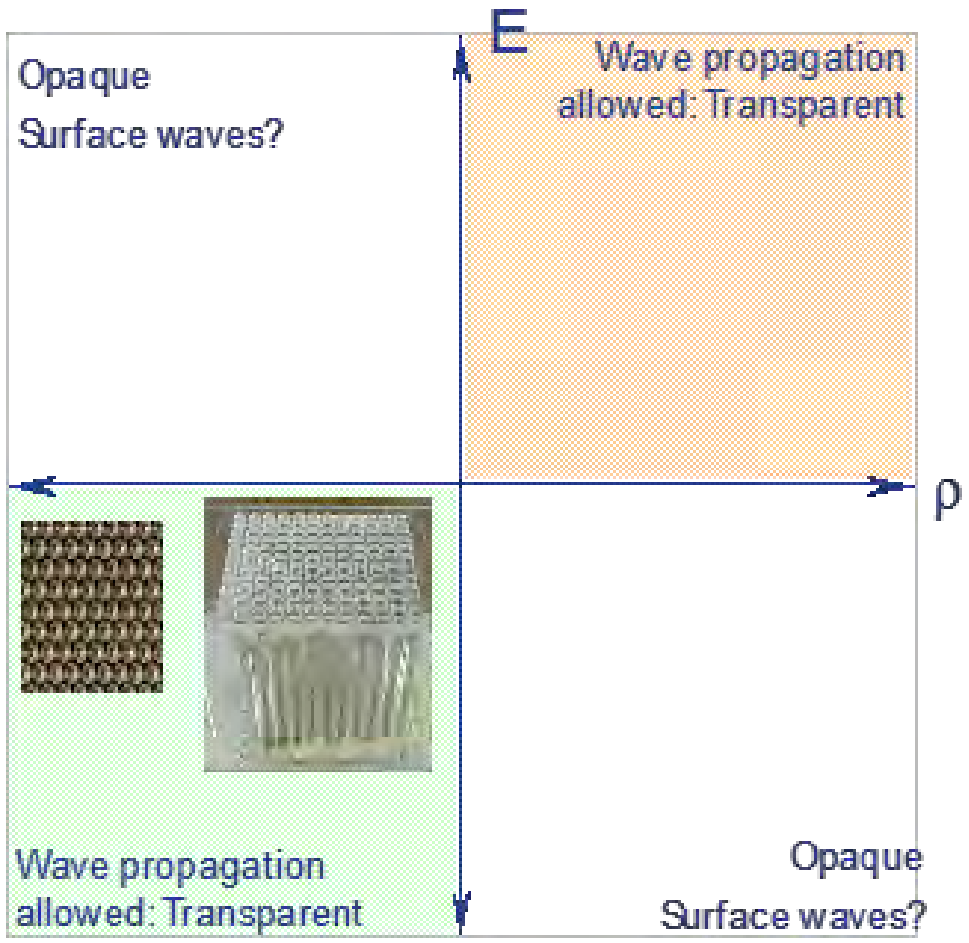


Structured Ultrasonic Metasurfaces

- Ultrasonic Metamaterials
- Nature inspired interface
- Industrial Applications
- COMSOL implementation
- Results and discussion

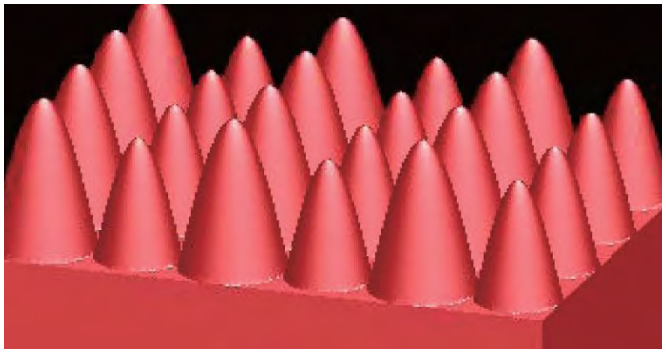
Ultrasonic Metamaterials

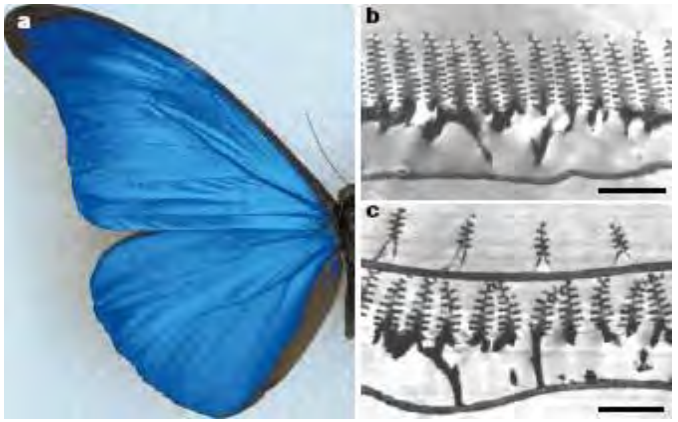
- Metamaterials with unusual properties.
- Acoustic Metamaterials
- Meta surfaces
  - 100% Transmission
  - 100% Reflection

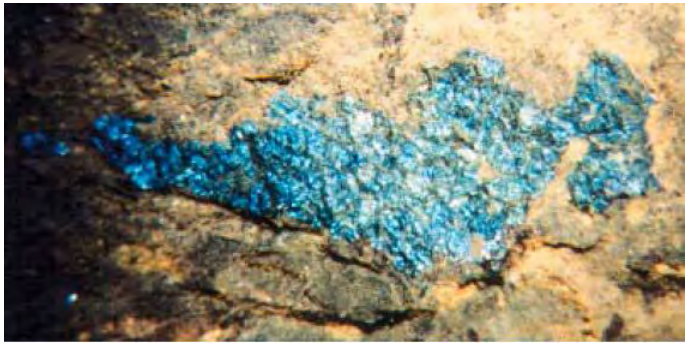


Nature inspired interfaces

- Motheye
- Butterfly
- Sharkskin
- Nature perfected the art of interface engineering for maximizing performance.







Applications

- Ultrasound scanning
- Therauptic ultrasound

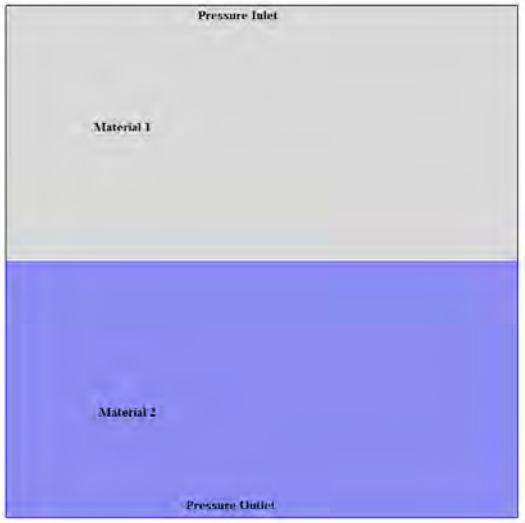
- NDE inspection
- Acoustic barriers

- Drag reduction
- Dry adhesion,
- Self-cleaning,
- Drug Therapy…..

COMSOL Implementation

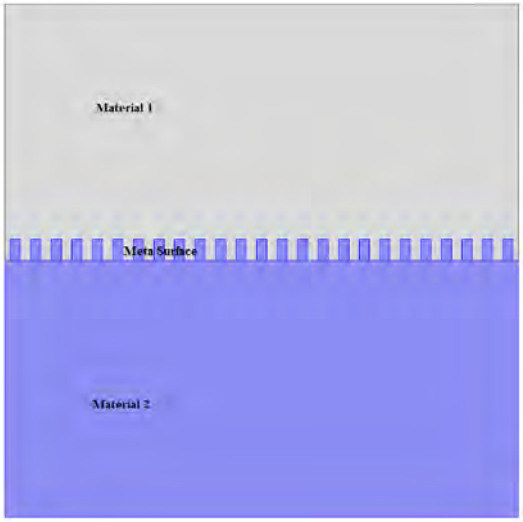
- Wave propagation
- Helmholtz equation

$$\frac{1}{\rho_0 c_s^2}\frac{\partial^2 p}{\partial t^2} + \nabla \cdot \left(-\frac{1}{\rho_0}(\nabla p - \mathbf{q})\right) = Q$$



- Transmission coefficient
-
-

$$T_c = \frac{P_{out}}{P_{in}} \qquad P_{in} = \int_{\partial\Omega} \frac{p_0^2}{2\rho c_s} dA \qquad P_{out} = \int_{\partial\Omega} \frac{|p_c|^2}{2\rho c_s} dA$$

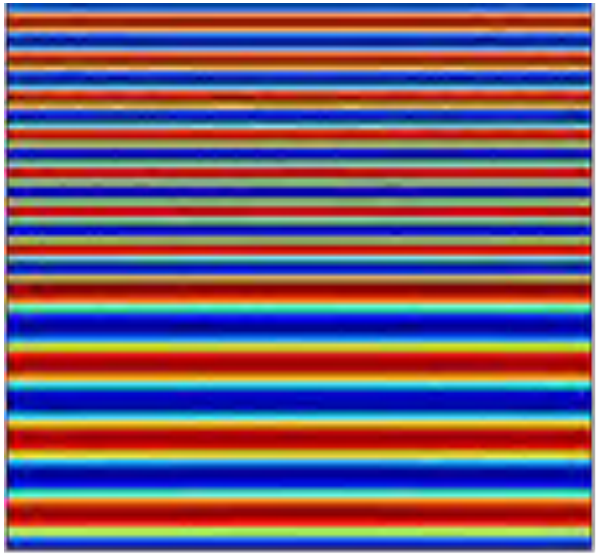


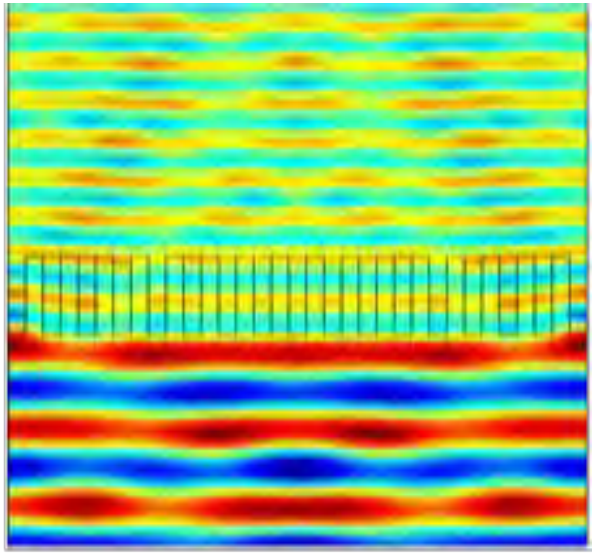
- Tc from impedance

$$T_c = 1 - \left[\frac{Z_2 - Z_1}{Z_2 + Z_1}\right]^2$$

Results

- Pressure Distribution
- Ultrasonic wave propagation between two medium with
- a typical non engineered interface between two medium,
- an engineered and structured metasurfaces interface.

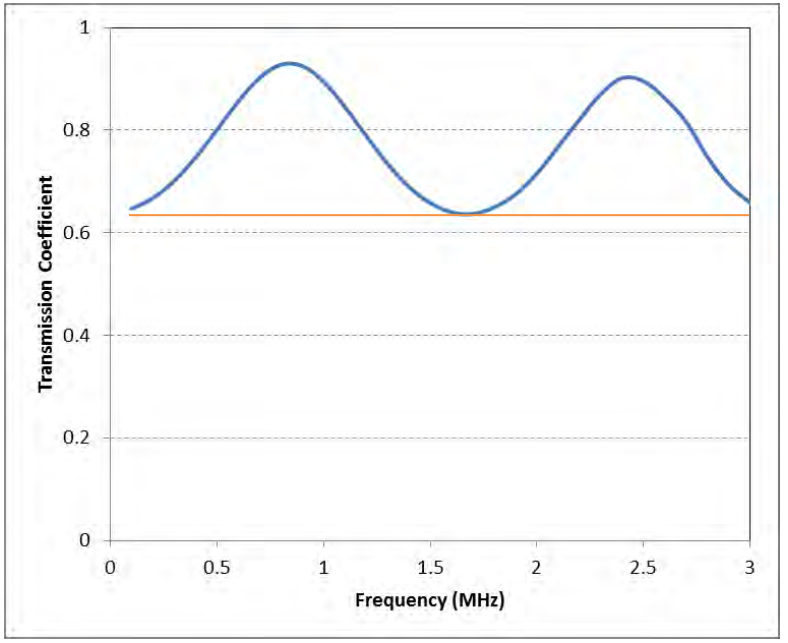


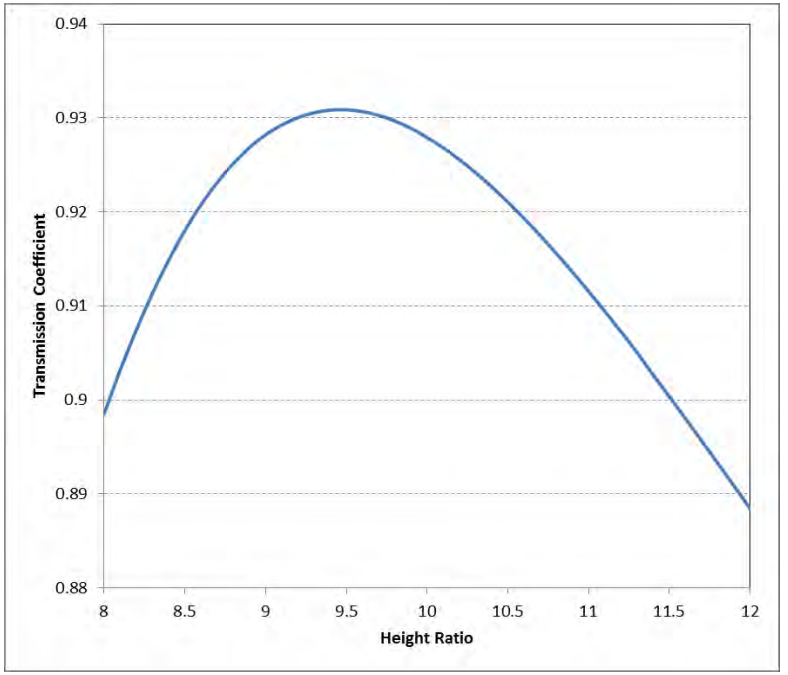


Results

- **Transmission coefficient of water polymer interface as a function of frequency**
  - 64% to 93%

- **Transmission coefficients as function of engineered interface feature height.**





Conclusions

- The standard interface shows a transmission coefficient of 0.64 for water polymer interface.
- The engineered interface shows as high as 0.93.
- The increase in transmission coefficient can be exploited for improvement in ultrasonic medical and industrial imaging applications.