Structured Ultrasonic Metasurfaces

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ATOA Scientific Technologies Pvt Ltd
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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
• Therapeutic 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

\[
T_c = \frac{P_{out}}{P_{in}}
\]

- \( T_c \) 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.