



Underwater Defense Technology

June 26 2018





Innovations in Piezoelectric Materials for Improved Sonar Design





- Piezo Ceramics are used in a variety of industries for their unique properties
- The act of sending and receiving acoustic signals is useful for:
 - Oil & Gas
 - Pipeline monitoring & pigging
 - Commercial Fishing
 - Fish Conservation
 - Defense



Innovations in Piezo Materials

- What we will be focusing on today:
 - PZT
 - Hard
 - Soft
 - Lead Titanate
 - PMN-PT (single crystal)



Tradeoffs between Hard & Soft PZT

Hard	Property	Soft
↓	piezoelectric d constants	↑
↓	dielectric constant	↑
↓	dielectric loss	↑
↓	hysteresis	↑
↑	mechanical Q	↓
↓	coupling factor	↑
↓	resistivity	↑
↑	coercive field	↓
↓	elastic compliance	↑
↑	aging effects	↓



Hard PZT Navy Type I, III

Tonpilz



Barrel Stave

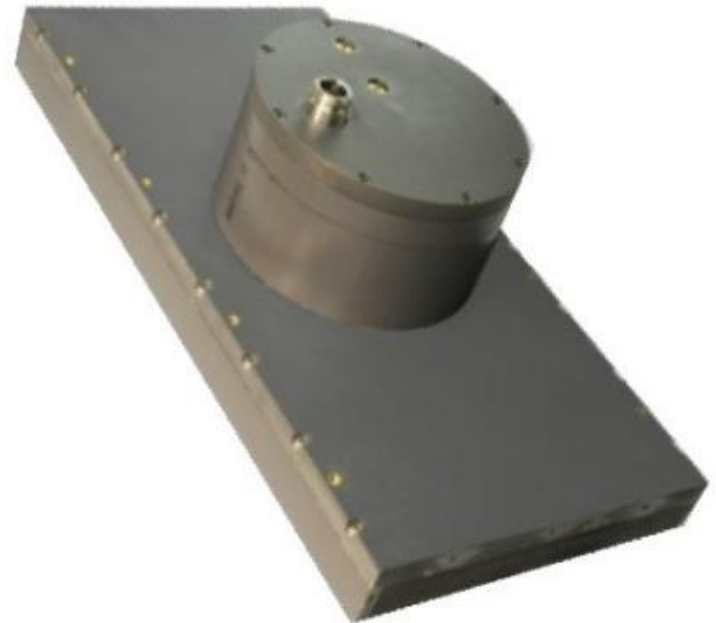


Soft PZT Navy Type II, V

**End Capped Tube
Hydrophone**



Hydrophone Array



Lead Titanate

In specific applications of high ringing, PT can eliminate the need for backing material

- ↓ ringing
- ↓ design complexity
- ↑ cost





PMN-PT Single Crystal

↑ Performance (5X)

↓ # elements

↑ Bandwidth of
Transducers

↓ Form Factor

So why isn't everyone using this?



PMN-PT Single Crystal

↓ Operating Temp (90C vs 190C for Navy VI)

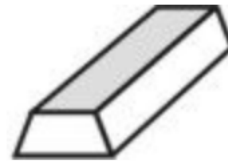
↓ Coercive Field

↑ Cost

- Barrier to entry for ceramic manufacturers
- Supply base



Navy Type				
I	II	III	V	VI
PZT4	PZT5	PZT8	PZT5J	PZT5H



Lead Titanate

BM300





Thank you!

Questions? Email me

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