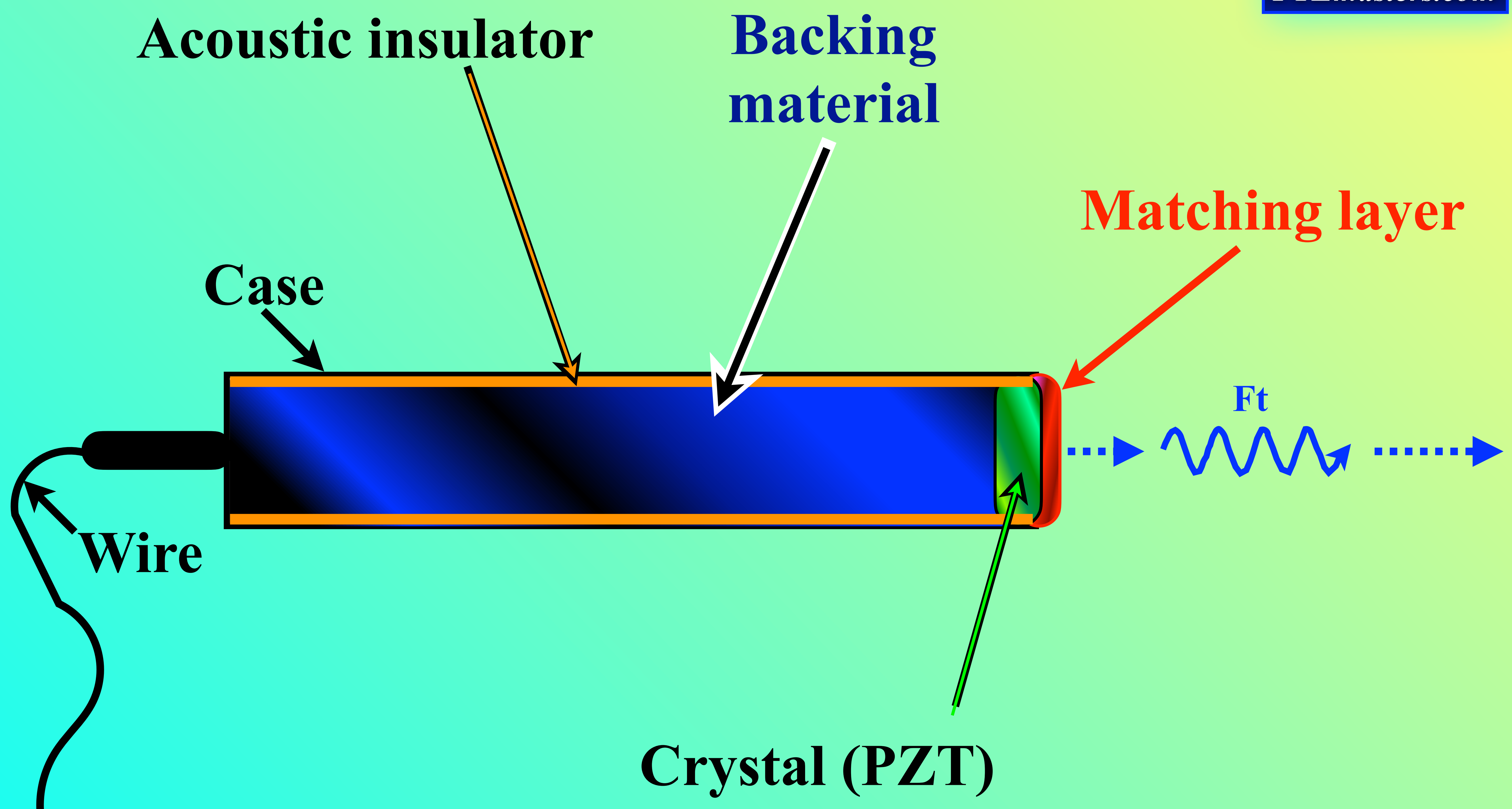


Matching Layer: 1/4 wavelength thick
Crystal : 1/2 λ thick

Understanding Ultrasound Physics by Edelman, SK, 3rd ed. Pages 117-127

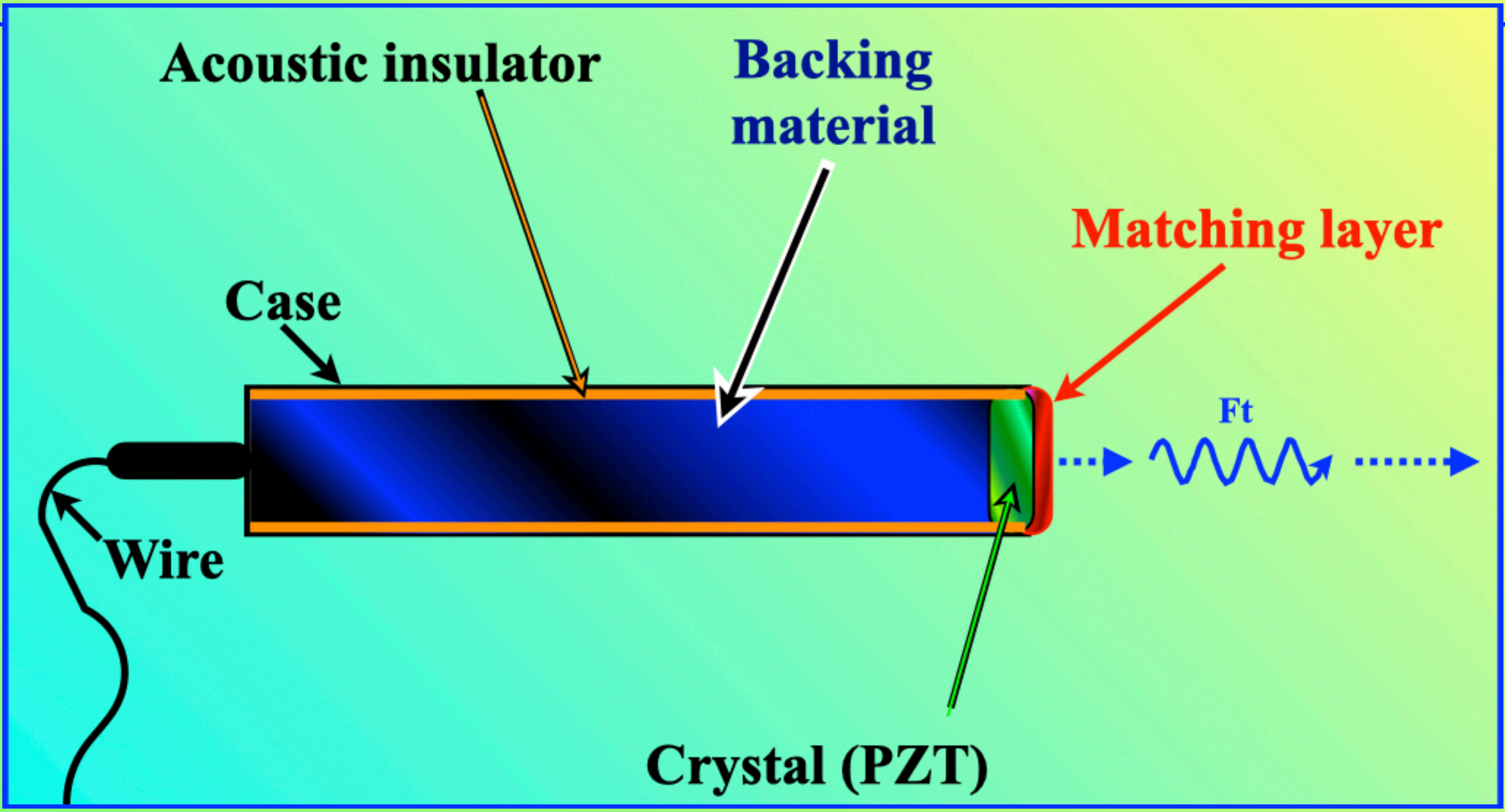
Matching layer:

The matching layer is in front of the crystal at the face of the transducer.

The matching layer has an acoustic impedance (Z) between that of the crystal (PZT) and the skin.

The matching layer facilitates sound transmission into the body (increases efficiency of sound transfer).

The optimal thickness of the matching layer is 1/4 x wavelength (λ).



Matching Layer:
Decreases reflection at Tissue -Transducer interface
1/4 wavelength thick
Acoustic impedance: PZT > Matching layer > skin

PZT = Crystal = Active element:

The piezoelectric crystal is often made of lead zirconate titanate = PZT.

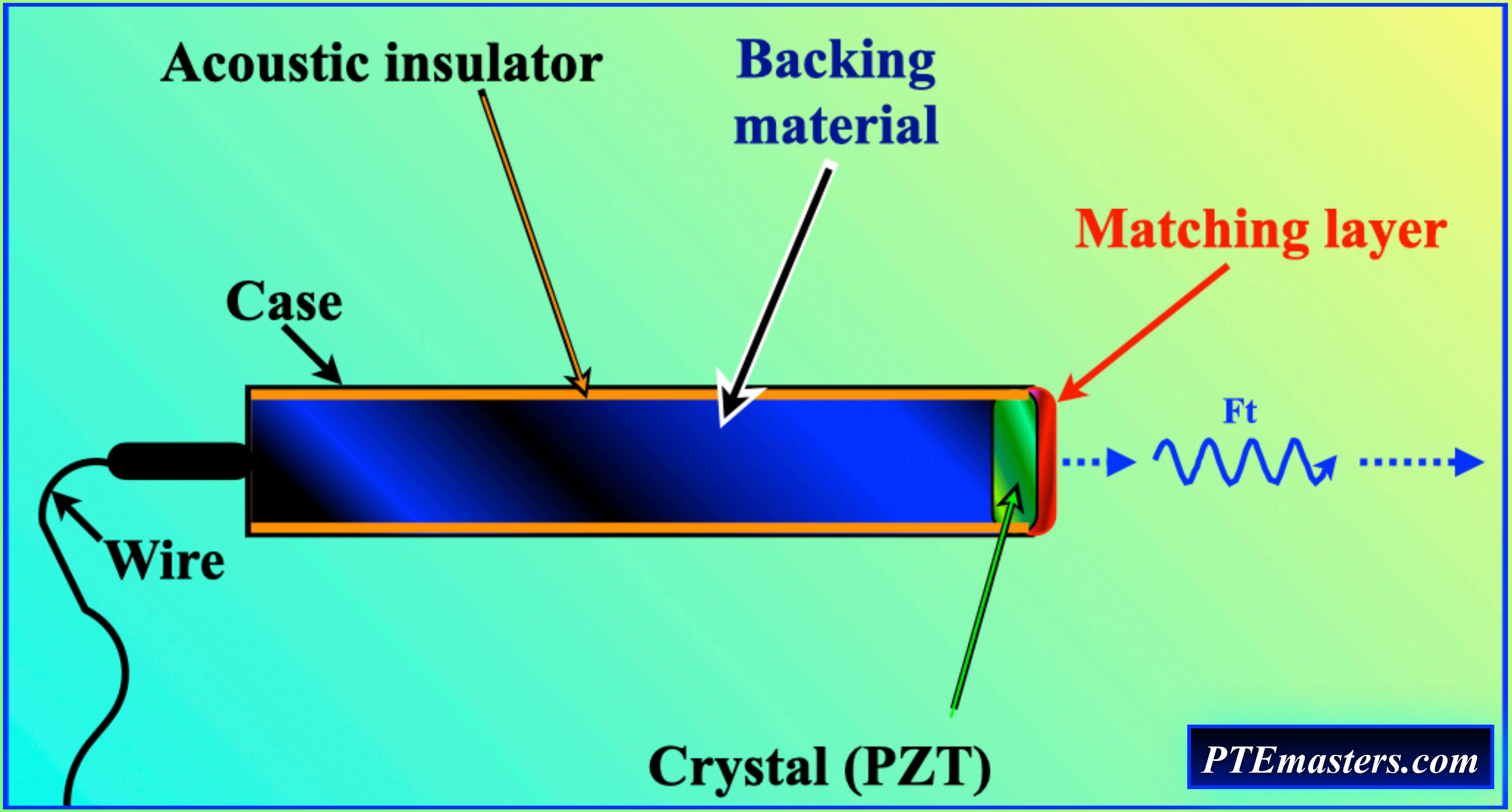
Optimal thickness of the crystal = 1/2 x wavelength (λ).

Crystal vibrates and creates ultrasound when an electrical voltage is applied.

Returning echos cause the crystal to vibrate and this creates an electrical voltage.

Reverse piezoelectric effect = conversion of electrical signal to sound.

Piezoelectric effect = conversion of sound to electrical signal.



True statements regarding the Backing material (BM) = Damping material = Damping element.

BM decreases ringing of the crystal and is also known as the damping material (damping element).

BM creates short pulses which improves spatial (axial) resolution.

BM decreases pulse duration.

BM decreases spatial pulse length thereby improving axial resolution which is ½ SPL.

BM decreases duty factor. (Duty factor = % the transducer is producing ultrasound).

BM increases bandwidth which is the difference between the highest and lowest frequency emitted by the transducer.

Sometimes composed of tungsten powder and araldite.

Decreases transducer sensitivity of the returning signals.

Decreases the quality factor = Q factor.

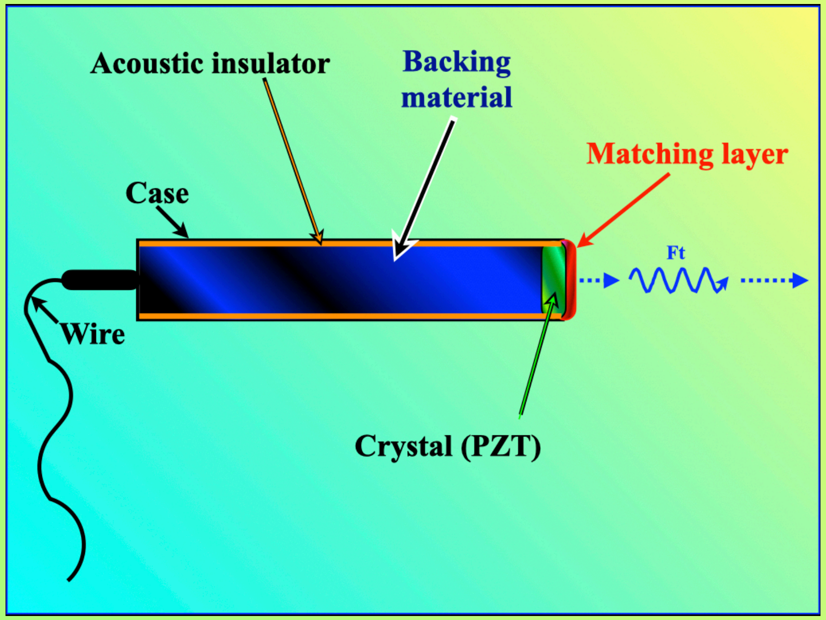
Decreases the transducer output intensity.

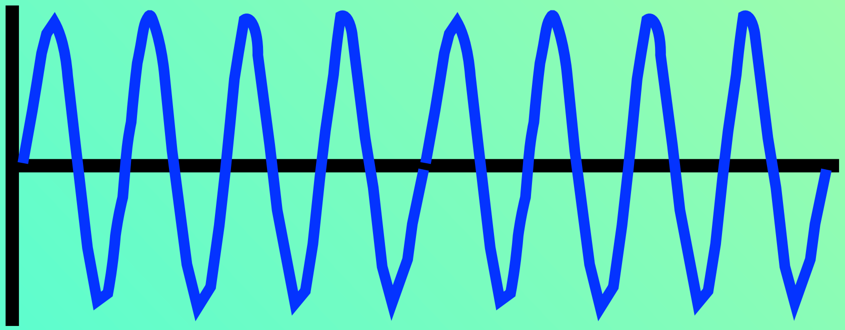
Quality factor = Q factor = resonance frequency / Bandwidth

Q factor is low for imaging transducers and high for continuous wave Doppler because continuous wave Doppler involves NO damping and dedicated CW probes have no backing material (no damping material).

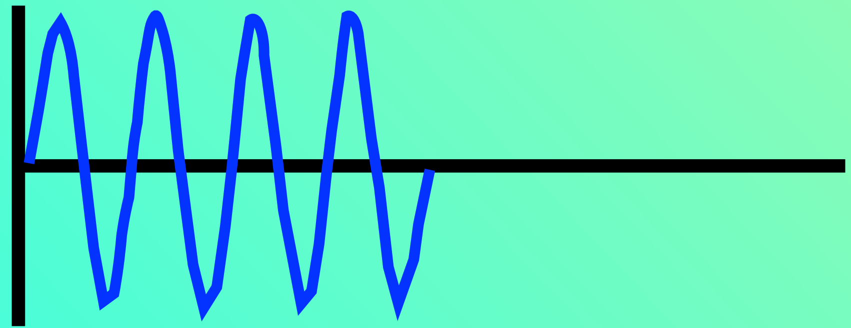
CW probes: undampened transmitted signal, narrow bandwidth, high Quality factor, higher sensitivity to returning echo signals.

Matching Layer:
Decreases reflection at Tissue -Transducer interface
1/4 wavelength thick
Acoustic impedance: PZT > Matching layer > skin

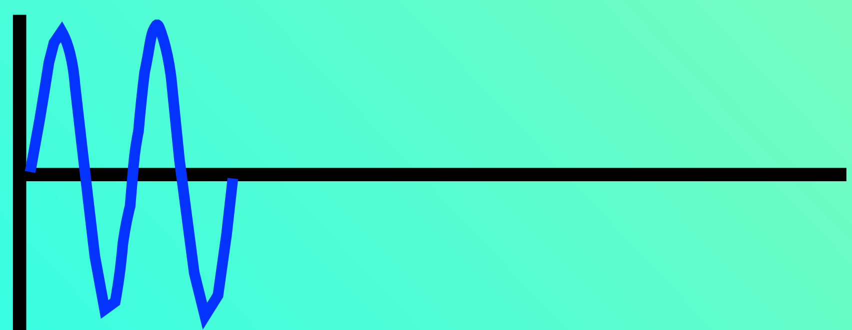




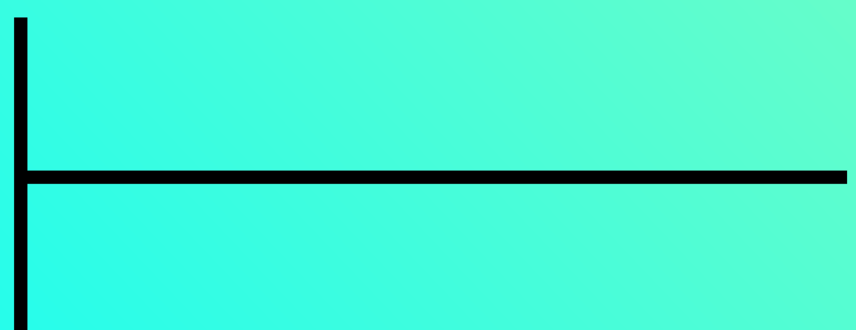
Continuous sound: Duty factor = 100%



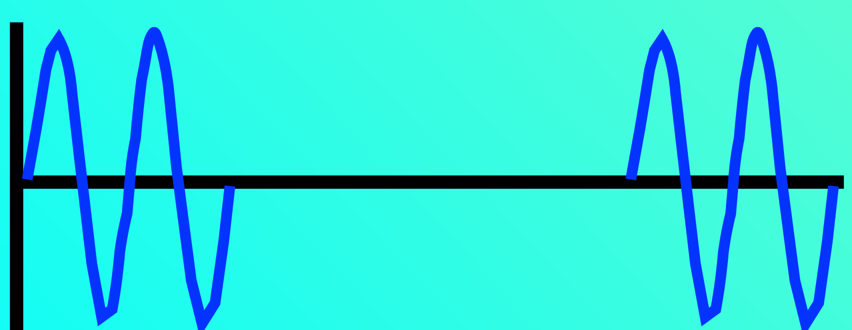
Duty factor = 50%



Duty factor = 25%



No sound. Duty factor = 0%



Duty factor = 50%

<u>Duty factor</u> is the fraction of time which an ultrasound system transmits a wave.

Understanding Ultrasound Physics by Edelman, SK, 3rd ed. Pages 117-127

Backing material = damping material decreases ringing of the crystal which shortens pulse duration and decreases duty factor.

Duty factor is the fraction of time which an ultrasound system transmits a wave.

The time required to create a pulse (time a pulse lasts) is the pulse duration.

The pulse repetition period (PRP) includes the pulse duration and the listening time = time between pulses, it is defined as the time from the start of one pulse to the start of another pulse.

The PRP includes both one transmit time and one receive time.

Duty factor can be represented mathematically as follows:

Duty factor (%) = Pulse duration / PRP x 100

The max duty factor is 1 or 100%.

This max value of 100% can only be created by continuous sound and continuous wave sound cannot generate images so duty factor for imaging systems must always be less than 100%.

<u>Shallow depth</u>: less listening time, shorter PRP, higher PRF, higher duty factor.

<u>Deeper depth</u>: more listening time, longer PRP, lower PRF, lower duty factor.

CW probes: undampened transmitted signal, narrow bandwidth, high Quality factor, higher sensitivity to returning echo signals.