

## 2: Basic Physical Principles of Ultrasound / Yale Fisher, MD

### Transcript

For this second short lesson, we're going to be talking about two of the principles that are basic to the physical principles of contact ultrasound - really involves all ultrasonography. And it involves two phenomena.

The first is a Piezoelectric phenomenon, which is really a phenomenon where crystals or materials can be bent and will send electricity, and if you put electricity into them they will bend.

This Piezoelectric phenomenon, which has been around for a long time, was originally discovered in quartz. Bending small wafers of quartz would generate an electrical phenomenon and if you put electricity into it, you could bend these small wafers.

Without understanding that, you really can't go on in the basic idea of contact ultrasonography because it is this movement that allows the transducer to work. You are basically transducing electricity into sound and then sound back into electricity. And that is how all the devices work.

The second principle is very important. It is called acoustic impedance and all materials have one. It means how difficult it is for sound to get through something, how much the material can impede the movement of sound and basically comes down to how close the molecules are, one to another.

So acoustic impedance can be figured out with a very long mathematical formula. I choose to use just the speed of sound times the density of the material to give you a number. If two materials are next to each other, with a different acoustic impedance in each one, the reflection that occurs at the interface between one material and the other really determines how much echo comes back.

So if you are using something like water and steel, for example, there will be a great difference between the two, and a very large echo at the interface. But the same would occur with water and air because, again, there would be a great acoustic impedance mismatch.

And we talk about acoustic impedance mismatch throughout diagnostic ophthalmic ultrasonography. That is really what you are reading.

All the images that you see on the screen are really a result of these two phenomenon: Piezoelectric phenomenon and the acoustic impedance mismatch of tissues.