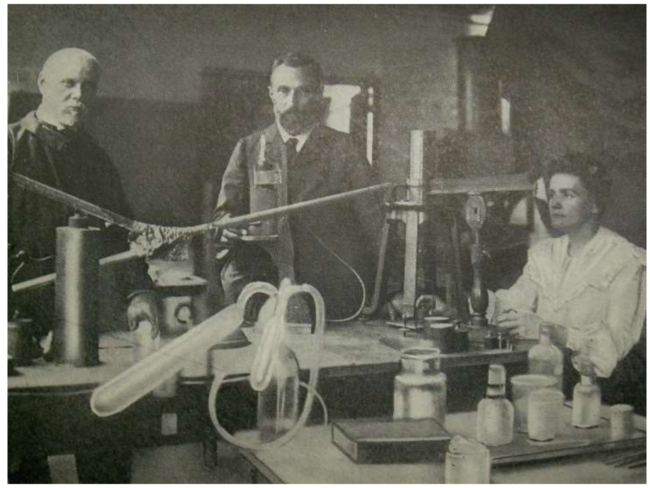
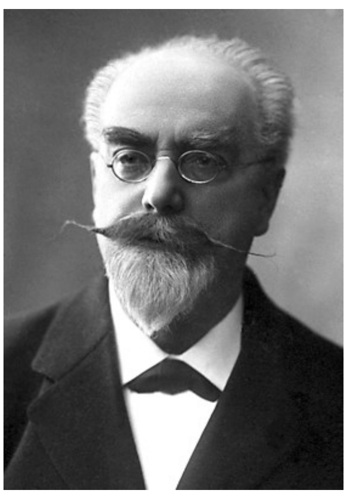
There are piezoelectric materials found in nature, and some have posed a curiosity with scientists of antiquity. One in particular is tourmaline. The photo shown here is just one manifestation of tourmaline. It presents itself in a rainbow of colors. In addition to having piezoelectric properties, it also has pyroelectric properties. That is, it develops electrical charge resulting from heating. These pyroelectric properties were the first to be noticed and characterized in early Greece.

Theophrastus of Lesbos (c. 300 B.C.) was a Greek philosopher and natural scientist who published works characterizing plants, sensations, moral characters and stones. He observed that some stones had properties of attraction, amber was one example. Another of his references was lyngurium (which modern historians believe was tourmaline). He noticed that when placed near a fire, the material caused ashes to move in its vicinity. This would happen due to the pyroelectric effect of tourmaline. It would impart ‘static cling’ to the ashes.



The brothers Pierre and Jacques Curie were studying the nature of pyroelectricity. Once they understood the properties of the crystal groups that gave rise to pyroelectricity, they theorized that application of force/pressure on certain crystals in a steady-state thermal environment should also create electrical charges at its surfaces. This event signifies the discovery and understanding of piezoelectricity. They published their findings in 1880.



Gabriel Lippmann took the work from the Curie's one step further. He realized that materials exhibiting piezoelectric properties (measuring surface charge when applying force) also deform when subjected to an electric field. This is known as the reverse piezoelectric effect. Such devises are commonly used as actuators.

Paul Langevin used this insight to pioneer early sonar systems to detect German submarines during WWI. He configured an array of quartz crystals to create the 'ping', and then sense the time delay of the reflected wave.

Woldemar Voight was a German physicist whose work published "Lehrbuch der Kristallphysick" (textbook on crystals physics) in 1910. This was a very comprehensive standard for piezoelectricity in its day. At this time, piezoelectricity was more of a curiosity, and the military/commercial applications were still on the horizon.

WWII sparked a renaissance in many technologies, including radar, mass production of penicillin, plastics, nutrition, computers and of course the atomic bomb. The library at mypiezo has on its shelves a very nice copy of Piezoelectricity (Cady, 1946) referenced below. Accompanying this volume is an original typewritten review for McGraw-Hill from Edward Arnold & Co. of London. The opening statement of this document brings it all to a focus.

"*The additional spur of a struggle for national survival presumably accounts for the many scientific and technical advances which originate with wartime activities.*

Piezoelectricity provides one example: discovered in 1880 by the brothers Curie, the phenomenon remained more or less a scientific cu[r]iosity for nearly 40 years until Langevin produced ultrasonic waves in water and detected their reflection from submerged objects."

Enter the father of modern piezoelectricity…

Walter Guyton Cady observed that quartz crystals would resonate very strongly at a specific frequency, and did not resonate at other frequencies. In 1921, he designed stable oscillator circuits from piezoelectric crystals that are still fundamental to radio communications and watches. In 1946 he published his industry-standard book "Piezoelectricity".