Chapter 2
Piezoelectric Materials

Abstract After some historical remarks the field equations for piezoelectric materials are presented for the 3D and the 2D case. Furthermore, the boundary value problems in bounded and unbounded cracked domains are formulated.

2.1 Short Historical Overview

In the middle of eighteenth century Carolus Linnaeus and Franz Aepinus first observed that certain materials, such as crystals and some ceramics, generate electric charges in case of a temperature change. Both René Just Haüy and Antoine César Becquerel subsequently attempted to investigate the phenomena further but were unsuccessful. Piezoelectricity as a research field in crystal physics was initiated by the brothers Jacques Curie (1856–1941) and Pierre Curie (1859–1906) with their studies, [4, 5]. They discovered an unusual characteristic of certain crystalline minerals as tourmaline, quartz, topaz, cane sugar and Rochelle salt. It was found that tension and compression generated voltages of opposite polarity and proportional to the applied load. This was called by Hankel [13] the piezoelectric effect. The at first discovered direct piezoelectric effect is shown schematically in Fig. 2.1a, b. The word piezoelectricity comes from Greek and means electricity resulting from pressure (Piezo means pressure in Greek). In the year following the discovery of the direct effect, Lippman [22] predicted the existence of the converse effect basing on fundamental thermodynamic principles. Before the end of 1881 the brothers Curies confirmed experimentally the existence of the converse effect. They showed that if one of the voltage-generating crystals was exposed to an electric field it lengthened or shortened according to the polarity of the field, and in proportion to its strength, see Fig. 2.2.

The study of piezoelectricity remained something of a laboratory curiosity for the years until the World War I. In this period it is worth to mention the textbook on

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