An algorithm to compute the electro-elastic fields for layers of unrestricted anisotropy, Konrad Bojar, Industrial Research Institute for Automation and Measurements, Warsaw, Poland
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We present an algorithm to compute the Green's function and the coupled electro-elastostatic fields in a 2D piezoelectric layer of unrestricted anisotropy and containing a distribution of straight line defects. Currently only three types of boundary conditions for the layer are accepted by the algorithm: mechanically uncoupled boundaries, clamped boundaries, one boundary clamped and one boundary mechanically uncoupled. In addition, it is assumed that the layer is adjoined to dielectric subspaces of known dielectric permittivities. The algorithm presented computes the result using the inverse Fourier transform. It is well-known that the Fourier amplitudes of the Green's function and the corresponding electro-elastostatic fields for a single defect in a medium of any anisotropy class may contain essential singularities at $k=0$. For example, for clamped boundaries there are poles of order 1 for any symmetry class [1], for mixed boundary conditions there are no singularities irrespective of possible anisotropy [1], and for a layer of cubic symmetry with uncoupled boundaries there are poles of order 1, 2, and 3 [2]. Other boundary conditions have been investigated in [1], but the results obtained there contain some errors and cannot be implemented until the formulas are corrected. The poles mentioned above exclude direct application of simple quadratures or the IFFT (the inverse FFT).

The first step of the algorithm is to calculate constants $c$ for all poles of the form $c/k^n$, $n = 1, 2, 3$. Once all such constants are known, the singularities are removed from the amplitudes by a simple subtraction. The singular part of the solution which corresponds to the subtracted term does not need to be computed; it was shown in [2, 3] that although the Green's function diverges polynomially when $x \to \infty$ (far from the defects), the electro-elastostatic fields exhibit a regular behavior at infinity if and only if all forces and force moments are equilibrated.

The second step of the algorithm is to compute the IFFT of the remainder of the above subtraction. Given the desired precision, the appropriate sampling frequency is calculated using the analytical estimate of the Filon-type quadrature error [4]. The remainder is sampled at the chosen sampling frequency and fed into the IFFT function (e.g. from the FFTW library). The same remainder is sampled at the chosen sampling frequency and fed...