Title: Caracterización micromecánica de compuestos con condiciones de contacto imperfecto en la interfase (Micromechanical characterization of composites with imperfect contact conditions at the interface)

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Summary

This thesis is concerned with piezoelectric periodic composite materials with imperfect mechanical and electrical contacts. Assuming a periodic parallelogram cell, the two scales Asymptotic Homogenization Method (AHM) is used for deriving the local problems (formulae (2.14)-(2.18) page 53-54) and effective coefficients (Appendix A, page 122,124). These problems are solved using the method of complex variables in terms of two harmonic functions and the complex potentials are related to the displacement and stress components by means of the classical formulae of Kolosov-Muskhelishvili.

Composites with different arrangement of the cells (parallelogram or rectangular) periodic cells exhibit more general anisotropic behavior than squares or hexagonal periodic cells (see Table 12, page 85). For instance, composites with i) cell in parallelogram form have 13 elastic, 8 piezoelectric and 4 dielectric coefficients different from zero; ii) cell in rectangular form contains 9, 3, 3 elastic, piezoelectric and dielectric coefficients different of zero respectively.

The imperfect mechanical and electrical contacts have an effect on the performance of the composites as summarized in Table 15 page 90. The mechanical imperfect parameter affects the elastic and piezoelectric effective coefficients in-plane and out-plane problems, whereas the electrical imperfect parameter influences the piezoelectric and dielectric coefficients for out-of-plane problems.

As a particular case, from the expressions derived by AHM we can obtain results derived by other authors for periodic squares and hexagonal cells. We take perfect contact

condition, as a limiting case, when the imperfect mechanical and electrical parameters approach infinity.

A methodology for dealing with the local problems, its soluction and the effective coefficients is proposed. Computational programs for obtaining numerical results and comparisons with theorical and experimental models are developed.

The thesis is divided in Introduction, three chapters, conclusions, recommendations, references and two appendixes. The introduction presents the state of the art, the motivation, the objectives and the list of main contributions published so far in journals and conference proceeding. The first chapter is devoted to general concepts and basic equations related to piezoelectric materials, a description of parallelogram cell, and an explanation on different types of contact at the interface of composites is given. In the second chapter, the two scales of AHM is used for finding the solution to nine local problems. The analytical expressions of the effective coefficients involving imperfect contact (mechanical and electrical) between the constituents of the composite are obtained. The third chapter is related to the presentation and analysis of the numerical results derived by AHM. Validations, comparisons and interpretations of the results are performed. Finally, conclusions, recommendations, references and two appendixes with the principal expressions related to the solution of the local problems and all analytical expressions of the average coefficients are given.

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