

Report on the memoir with title
**“Caracterizacion micromecanica de compuestos con condiciones
de contacto imperfecto”**

presented by
Juan Carlos Lopez-Realpozo
for the grade of “Doctor en Ciencias Matematicas”
to the University of Havana, Cuba.

Author of report: Gerard A. Maugin, Ph.D., D.Sc., dr hc mult.,
Emeritus, Institut Jean Le Rond d’Alembert,
Université Pierre et Marie Curie – Paris-6, Paris, France

Mr Lopez-Realpozo presents a memoir devoted to the modelling and characterization of composites with imperfect contact conditions at interfaces. This he does in a rather short memoir while we note that Mr Lopez-Realpozo has also contributed a large number of already published papers and presentations at conferences.

The motivation of the work and its place in the general landscape of research in the mechanics of composites and their homogenization are clearly stated in a long introduction and a first chapter that offer a nice and complete perusal of the existing approaches in this branch of continuum mechanics and applied mathematics. In particular, basing on really observed cases, the Introduction shows the necessity to consider interface conditions that are more involved than perfect ones, especially in composites with embedded fibers, and that of considering unit cells of appropriate shapes (square, hexagonal, parallelogram), what is duly implemented in the memoir.

Chapter One introduces the reader to the required basic equations for the theory. These are the equations of the linear theory of piezoelectricity. Classes 6mm and monoclinic 2 are the preferred symmetries. Concerning the composite structure, the choice of the shape of the basic periodic cell and the concomitant selection of the representative volume element (for short, ERV in Spanish) in view of the application of some homogenization procedure are fundamental. Equally important is a statement of the contact conditions in the composite. In most works only perfect mechanical contact and usual transmission conditions for electric properties are considered. But the author innovates by considering imperfect contact conditions both for mechanical and electrical quantities (cf. equations (1.15) and (1.17)). These are of the spring-type for mechanics and a similar generalization for electric properties. The first type was already considered in other works by the group of authors around Professor Reinaldo Rodriguez-Ramos. The whole electro-mechanical problem then reduces to the set of equations given in equations (1.24).

Chapter Two is central to the development of the thesis. First the author clearly explains the adopted homogenization technique. It is the method of asymptotic homogenization (for short MHA in Spanish) as initially developed in France and Russia. This method requires solving “basic” problems over the ERV, the so-called “local problems”. This is here applied to the case of imperfect contact between phases and plane and antiplane problems. Following

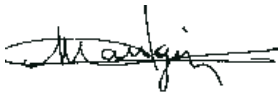
previous works in Russia (Pobedria) and in the group of the Havana, the author treats these local problems by means of the technique of complex variables (Goursat, Kolosov, Muskhlisvili). This is rather technical and the author was right in giving the details in attached Appendices. After a lot of algebra this leads to the expressions of the effective coefficients for the composites with various elementary cells.

Chapter Three is very rich in numerical results given in the form of many tables depending on the coefficient of imperfect contact and the type of basic cells, for real material components. Results are appropriately compared to those available and obtained by finite-element method or a mixed MHA-FEM method. This chapter is rich in comments and comparisons with many works. These comparisons show the efficacy of the method adopted by the author. The conclusions enunciated in the “Conclusions and recommendations” go in this direction, with which the undersigned fully agrees.

The whole presented work fits well in the general scientific production of the Cuban group around Professor Reinaldo Rodriguez-Ramos. It improves on it by enlarging its scope and bringing in new results of great interest on the application side.

With its clarity, thoroughness, accuracy in description of methods and results, and an obvious proof of the dexterity in the required mathematics, this memoir presents all excellent properties to justify the grant of the title of “Doctor en Ciencias Matematicas” to Mr Lopez-Realpozo. I strongly recommend him for this well deserved title.

Paris, May 20, 2012.

A handwritten signature in black ink, appearing to read 'Maugin', with a horizontal line drawn through it.

Gerard A. Maugin,
Paris, France.
E-mail: gerard.maugin@upmc.fr