

# MULTI-SCALES MORPHOLOGICAL PROPERTIES AND PREDICTION OF DIELECTRIC BEHAVIOR OF NANOCOMPOSITES

**Maxime MOREAUD**

*Centre de Morphologie Mathématique, Ecole des Mines de Paris*

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## Abstract

Carbon-Black nanocomposites are obtained by dispersing a carbon black charge in a matrix. Due to the conditions of mixing, the arrangement of the charge usually presents some heterogeneity at different scales. In order to predict the effective properties of such composites (like the dielectric permittivity or the elastic moduli), it is necessary to know the properties of the two components (charge and matrix), and their spatial distribution. To fulfil this project, we developed a general methodology in several steps: the morphology is summarized by multi-scale random models accounting for the heterogeneous distribution of aggregates. The identification of the model is made from image analysis of thin slices. In a second step, 3D simulations of the model are generated to estimate the percolation threshold of nanocomposites (including carbon black or carbon nanotubes charges), and to predict the effective dielectric permittivity by numerical homogenization. Small scale statistical fluctuations of the permittivity are used to assess the notion of RVE (Representative Volume Element). This morphological approach is a first step towards the optimization of the effective dielectric properties of nanocomposites.

The approach was applied to two kinds of materials for aeronautics used by EADS.

A study of the morphology of catalysts with cerine nanoparticules embedded in a silica network is also performed. The aim is to understand and to improve the manufacture process of this kind of materials.



### Collaboration :

Délégation Générale pour l'Armement  
European Aeronautic Defence and Space Company  
Centre de Morphologie Mathématique, Ecole des Mines de Paris  
Centre des Matériaux, Ecole des Mines de Paris

### Jury :

Rapporteur : **François CARMONA** (chercheur permanent, Centre de Recherche Paul Pascal, C.N.R.S. UPR 8641)

Rapporteur : **Karam SAB** (directeur du Laboratoire Analyse des Matériaux et Identification, E.N.P.C.)

Examineur : **Gérard-Pascal PIAU** (ingénieur, E.A.D.S. C.C.R.)

Examineur : **Alain PRIOU** (professeur des universités, Université Paris 10)

Directeur de thèse : **Dominique JEULIN** (professeur des universités, Centre de Morphologie Mathématique, Ecole des Mines de Paris)

Directeur de thèse : **Alain THOREL** (maître de recherche, Centre des Matériaux U.M.R. C.N.R.S. 7633, Ecole des Mines de Paris)