1 1 ADMINISTRATIVE DATA

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2 2 DIRECTION OF WORK

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3 TITLE

RELIABILITY OF INTELLIGENT NANO-MATERIALS FOR BIOMEDICAL APPLICATION.
APPLICATION: PATCH FOR DIFFUSION OF MEDICINES AGAINST CANCER

4 SUBJECT

4.1 BACKGROUND

Nanomaterials introduce a new way of designing materials, manufacturing them and integrating them into products. This new approach is based on the control of the structure of materials at the nanoscale. All materials are potentially concerned, and all manufacturing sectors should benefit from significant innovations and technological advances. Many applications affecting the general public are already available (tires, sun creams, microchips, etc.). The estimates unanimously predict a strong growth and widespread diffusion of nanomaterials applications in the coming years, which is expected to accelerate as mass markets are affected.

4.2 RESEARCH AIMS

Designing and evaluating the performance of these microsystems such as nanomaterials requires robust and reliable modeling tools. Thus, the present research work aims at the modeling, deterministic and stochastic, of nanomaterials for a use implanted on the human body.

The purpose of the thesis is to integrate in the modeling and optimization steps of a nanomaterial a process of dependability that integrates reliability, maintainability, availability and security.

Taking into account the manufacturing and design uncertainties and the conditions of use of a nanomaterial form the main axis of the developments to be carried out. Optimization-based approaches based on meta-heuristics (genetic algorithms, ant colony, etc.) or hybridized will be used to improve the design of nanomaterials considered from a geometric or topological point of view. A study of opportunities is to be made on the nature of the methods to be used (intrusive or non-intrusive).

A second axis will be to consider a distributed set of nanomaterials and to study the characteristics of such a system, especially in terms of reliability. A study should be undertaken to optimize the structure of such a system to ensure the expected objectives while ensuring satisfactory availability. Meta-heuristic or dedicated type approaches will be favored in this work. The application of this work will be in the medical field and more particularly patches implanted on the skin in order to disseminate the drug.

The goal is to develop three-dimensional physico-probabilistic numerical models of the performance of a nanomaterial in the medical field by taking into account the influence of uncertainties of design, manufacturing and operational parameters. Particular attention will be given to modeling the main function of this type of nanomaterial. Of course here it is about the distribution of the right dose, at the right time and in the right place.

Task 1: Dimensioning of a nanomaterial in the biomedical field
Development of a parametric model of a nanomaterial in the biomedical field

Task 2: Phenomenological Analysis
It is a question of detailing the different sources of influence on the performance of a nanomaterial (usable methods: tree of causes, global modeling, ...)

Task 3: Study of sources of uncertainty in a nanomaterial
Develop a database on the sources of uncertainties and available knowledge (component manufacturers, publications, ...). Then, propose the adapted theoretical modelizations (Probabilists, stochastic, meta-heuristic,).

Task 4: Three-dimensional numerical modeling of a nanomaterial in its operating environment and in its life cycle
Develop a digital model (s) (at different scales) of a nanomaterial. This step must provide behavior modeling in a context without uncertainty and results in the presence of uncertain phenomena.

Task 5: Integrating the effects of uncertainties
The effects of uncertainties must be integrated into a physico-probabilistic approach using SFEM (stochastic Finite Element Method) approaches.

Task 6: Sensitivity analysis on the effects of uncertainties
This study will integrate a sensitivity analysis on the effects of uncertainties. It will propose confidence intervals on the effects of uncertainties on the performance of a nanomaterial.

Key words: nanomaterial, Dependability, reliability, optimization

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