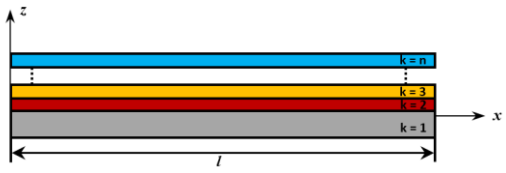
Development of a methodology for measuring the elastic constants of anisotropic coatings using impulse excitation technique

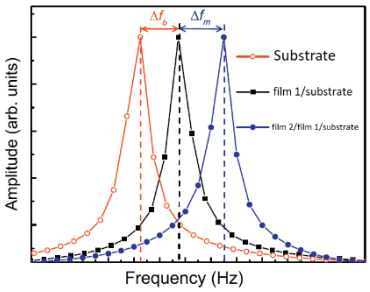
New processes for obtaining advanced materials, in the form of coatings, are developing more and more to meet the socio-economic and the environmental needs. Coatings, as protective layers, improve the surface properties of a material. For example, in biomedical, elastic properties are must to be considered for the good insertion of the prostheses into the bone tissues. Thus, the deposit of Micro metric and/or Nano metric layers to obtain gradient functional materials is a promising approach for achieving impedance matching or reduction of stress concentrations on structures, such as prostheses or implants.

The project is part of the developments of Impulse Excitation Technique (IET) measuring constants of elasticity of thin layers [1, 2]. The IET is based on the analysis of vibrational frequencies created by an impact on a specimen. In this project, deposition will be developed using low-pressure process: PVD (Physical Vapor Deposition); and the parameters influencing the elasticity of the coatings will be identified. In the literature and for a designed anisotropic coating, no technique is available to go back to the values of the elastic constants of each layer and stack. This difficulty motivates the researcher to innovate methods and characterizations. What the project proposes is developing an inverse method using a multilayer model and the global analysis of vibration modes obtained by IET.

The methodology being used is a multi-scale approach to correlate the microstructural state of the coating and its resulting properties. The objectives that will be achieved rely on the development of IET measurement technique for mono and multi anisotropic coatings, by understanding the link between the parameters of elaboration, the physical-chemical properties, the microstructures and the elastic constants of the materials.

Keywords: Coatings, Elastic constants, Anisotropy, Multilayers, Impulse Excitation Technique, PVD.





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[1] M.F. Slim, A. Alhussein, F. Sanchette, B. Guelorget, M. François, A new enhanced formulation to determine Young's and shear moduli of thin films by means of Impulse Excitation Technique, Thin solid films, 2017.

[2] M.F. Slim, A. Alhussein, A. Billard, F. Sanchette, M. François, On the determination of Young's modulus of thin films with Impulse Excitation Technique, Journal of Materials Research, 2016.