



## Proposition de sujet de thèse

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# Improvement of the deposition process for the manufacturing of ultra uniform thin film coatings

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### Présentation synthétique du Sujet

Based on an interference phenomenon inside the stack, the optical properties of a thin film optical coating are mainly driven by the ratio of the layer thicknesses to the illumination wavelength. As a consequence, as soon as these layer thicknesses are not strictly uniform over the whole surface of a component, one can observe local modifications of its optical response. Most often, considering that all the layers are affected by the same thickness non uniformity, this modification consists in a wavelength shift of the optical properties.

This behavior is very interesting for the manufacturing of variable filters. In that case, a band-pass filter is deposited with a large and intended thickness gradient, which results in a large shift of its centering wavelength along one direction of the component. Associated with CCD detectors, such filters can be used to build very compact spectrometers.

On the contrary the same behavior can become a major difficulty for the manufacturing of uniform band-pass filters. Indeed, a thickness non uniformity can rapidly induce a wavelength shift that exceeds the band-pass, resulting in a severe degradation of the global response of the component. As a consequence, the film thickness uniformity must be mastered with a high accuracy (roughly corresponding to the spectral resolution of the filter) over the complete surface of the component and the problem today is that the natural thickness distribution of a standard deposition machine is not enough uniform for the most demanding applications.

As an example, a thickness uniformity equal to 0.999 over 20 mm diameter can be considered as a good result, which is hardly compliant with the manufacturing over this diameter of a 1 nm band-pass filter for a centering wavelength of 1000 nm, while some applications, mainly space applications, are now demanding a similar or even higher thickness uniformity over a diameter equal to 100 mm. The main goal for this PhD thesis consists to reach this level of performance.

The thickness distribution inside a deposition chamber is given by the relative geometry between the material source and the substrate to be coated. A first approach to improve the uniformity could be to give the substrate a trajectory that fits the evaporation or sputtering pattern. A second approach could be to use just below the substrate randomly vibrating masks formed with small holes distributed with a density corresponding to the lack of uniformity. The required specific skills for this work are computation and optical metrology. Some knowledge in thin film deposition systems, vacuum and mechanical systems will be appreciated.

**KEY WORDS**: Optical interference coatings; Modelling; Optical measurements

### **Procédure de dépôt de candidature**

Envoyer CV par courrier électronique à Michel LEQUIME, Professeur à Centrale Marseille, Responsable de l'équipe Couches Minces Optiques de l'Institut FRESNEL ([michel.lequime@fresnel.fr](mailto:michel.lequime@fresnel.fr)).