PhD's proposal:

Photo-induced thermal radiation in optical interferential filters

Photo-induced thermal radiation (PhTR) in optical thin films may play a key role for space, defense, security, biomedical and energy applications. Despite this context a limited number of studies can be found on this topic, unlike numerous thin film studies focused on light scattering, absorption and laser-induced damage. This has been our former motivation to start a specific research activity at Institut Fresnel devoted to PhTR in optical coatings.

The first step has consisted in the development of an exact electromagnetic model to predict the spectral, spatial and temporal behavior of PhTR in optical multilayers. This model relies on an analogy between thermal diffusion and optical propagation, together with a theory of bulk scattering in optical multilayers. Results have emphasized a number of key points:

- Thermal thin film parameters (conductivity, diffusivity) can be directly extracted from PhTR measurements, provided that the illumination pulse duration is adequately chosen
- PhTR data also allow to recover the imaginary indices of thin layers within multilayers, hence providing a major alternative to micro-calorimeters, photo-thermal deflection, cavity ring-down spectroscopy and guided-wave techniques
- Optical multilayers allow to spatially and spectrally confine the PhTR. Huge enhancements (by several decades) can be reached at specific or multiple resonances with extremely narrow bandwidths

The purpose of this PhD's proposal is to go further in this topic in order to:

- Design and build an experimental facility to measure PhTR versus direction (0°-90°), wavelength (infrared range) and time (ns scale). These data will be extremely helpful to solve a number of inverse problems for the characterization of thin film materials and optical coatings
- Elaborate numerical design techniques which would allow to reach an arbitrary shaping of PhTR spectra in direction and wavelength. Such shaping would include narrow-band and broad-band applications

Skills required:

The candidate must have a master's degree in physics or an engineering school diploma. The work to be done will present theoretical, numerical and experimental aspects to be carried out in parallel. The candidate must therefore present a certain taste for these different approaches of Physics in general and Optics in particular. Basic training in optics is desirable.

Key works: Optical metrology, optical thin films, photonics, electromagnetism, thermal radiation *Optical metrology, optical thin films, photonics, electromagnetism, thermal radiation*

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Application: Send CV, cover letter and transcripts before March 15, 2022 *to myriam.zerrad@fresnel.fr*

Book references :

- *S.M. Rytov, Yu.A. Kravtsov, V.I. Tatarskii, "Principles of Statistical Radiophysics 3: Elements of Random Fields", Springer-Verlag 1989, ISBN 13:978-3-642-72685-9*
- *Zhuomin M. Zhand, "Nano/Microscale Heat Transfer", Springer, Mechanical Engineering Series, Second Edition, 2020, ISBN 9783030450380*
- *Claude Amra, Michel Lequime, Myriam Zerrad. « Electromagnetic Optics of Thin-Film Coatings: Light Scattering, Giant Field Enhancement, and Planar Microcavities", Cambridge University Press, 2020, ISBN 9781108772372.*