Thesis title: Development of broadband and monochromatic optical monitoring strategies for sputtering and evaporation depositions

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Optical interference filters offer a very broad range of optical functions for the control of the spectral properties of light. With the last 15-year improvement of both the design techniques and the manufacturing systems, the complexity of filters has dramatically increased. In particular, the combination of stable deposition processes and in-situ optical monitoring has allowed fabricating high performances filters that can be composed with several hundreds of layers. The filters structures are then no longer periodic and can exhibit a very broad range of thicknesses ranging from a few nanometers to a few hundreds of nanometer for filers in visible and near-IR range.

To precisely control the thickness of each layer, there are, as of today, two classes of optical monitoring techniques: monochromatic and broadband optical monitoring. The first one relies on an in-situ measurement of the transmitted (or reflected) intensity at a single wavelength and, in this case, the choice of the proper wavelength is a critical criterion that will affect the precision of the control. The second one relies on an in-situ measurement of the transmitted (or reflected) intensity over a broad spectral range and, in this case, the choice of the proper stopping condition is a critical criterion that will affect the precision of the control.

In this thesis, we propose to explore the combination of both monochromatic and broadband optical monitoring techniques. These developments will be done in collaboration between the Thin Film Research Team at institut Fresnel in Marseille, France (https://www.fresnel.fr/spip/spip.php?article1487) and Bühler company (R&D department of Bühler/Leybold Optics in Alzenau, Germany (https://www.buhlergroup.com/global/en/process-technologies/high-vacuum-thin-film-coating/about-buehler-leybold-optics.htm). The developments will be done on Bühler HELIOS and SYRUSpro machines (Plasma Assisted Reactive Magnetron Sputtering and electron beam desposition) and with a brand new broadband optical monitoring system under development at Bühler. The thesis will thus consist in developing and experimentally implementing new monitoring techniques.

The candidate is then expected to spend most of his time at institut Fresnel with some shorts stays at Bühler. The candidate must have a Master in Science with good knowledge in optics, programming and if possible in optical thin films.

References:

M. Vignaux, F. Lemarchand, T. Begou, C. Grèzes-Besset and J. Lumeau, "Semi-automated method for the determination of the all-optical monitoring strategy of complex thin-film filters", Optics Express 27(9), 12373-12390 (2019).
J. Zideluns, F. Lemarchand, D. Arhilger, H. Hagedorn and J. Lumeau, "Automated optical monitoring wavelength selection for thin-film filters", Optics Express 29(21), 33398-33413 (2021).