Surface functionalization is generally used to add new physical properties to bulk material, allowing for numerous applications (self-cleaning surfaces, haptics, friction). Those new physical properties, induced by different industrial processes, typically arise from a change in such surface properties as material nature or morphology. However, the modification of surface properties will also impact the visual appearance of such surface, and the strong impact can be critical in some applications.

The link between surface morphology and optical properties has been studied for a long time. Nowadays, the optical properties of smooth (or weakly rough) surfaces are mastered. Yet, dealing with rough and highly rough surfaces remains a not so easy task. Two kinds of approaches allow for theoretical description of the light scattering from rough surface: geometrical optics and physical optics. In all, there are several different groups of models, varying in the ranges of applicability, amount of computational time and the facility of comparison with macroscopic optical experimental data. In order to test the limitations of those models, their predictions must be confronted to experimental data on rough surfaces with large set of statistical parameters (roughness and correlation length etc.).

We have developed at SVI a flexible fabrication process (nano-imprint [1]), allowing the production of patterned surfaces with controlled features at different scales (from nanometric to micrometric). With this process we are able to: (a) realize samples with the same topography but made of different materials (refractive index can be varied from 1.2 to 1.6), and (b) slightly modify a surface topography by different technics (addition of micro-roughness or surface smoothing).

On the other side, with numerous facilities available at SGR and SVI, we are able to perform a complete morphological and optical study of rough surfaces. The surface topography can thereby be characterized at the nanometric scale with an Atomic Force Microscope, and at the micrometric scale with contact profilometer or an optical profilometer (based on confocal microscopy), as presented on Fig.1. Then, the optical characterization can be realized with simple setups as glossmeter or hazemeter for quick evaluation of integral optical properties (gloss and haze), and also with more complex facilities like goniospectrophotometer, see Fig.2 (distribution of scattered light in 3D) and spectrophotometer (spectral properties of diffused light).
This internship aims for the morphologic and optical characterizations of rough surfaces and for their interpretation. To this end, several tasks will be assigned to the intern:

- Morphological and optical characterizations of a unique large panel of rough surfaces with different statistical parameters.
- Numerical treatment of the experimental data with the existing Python codes (statistical parameters of surface morphology, analysis of the light scattering in 3D; candidate can participate in the development of the user interface for these codes).
- Qualitative analysis of experimental results (links between experimental optical and morphological properties)
- Validation of the domains of applicability of theoretical models by confrontation to experimental data.

Profile required: M2 or engineer student with a background in optics with a strong taste for experimental work and basics knowledge programing in Python. Experience in signal data treatment is not obligatory but would be appreciated.

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