Research proposal for PhD Students / CSC-UTT Grants

Subject: Nano-multi-facets element applied in the field of photonics.

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Beam shaping with incoherent light source is important in different fields of photonics. Various kinds of optical elements have been proposed to reshape the incoherent light. Diffractive Optical Elements (DOE) are currently designed to reshape monochromatic and coherent light, but only few results have been reported for incoherent light. Lightpipe system is mainly used in the micro display and creates uniform light on the output plan. In the areas of solar energy, non-imaging Fresnel lens have been designed mainly for solar concentrators. Freeform optics for beam shaping involves a series of complex calculations and optimization methods linked to differential equations. But the fabrication of the surface profile of the free-form is still very complicated and expensive. For lighting and illumination, some solutions are also possible with faceted structures. But the overall geometrical structure is rotational symmetric, and arbitrary irradiance distribution has not been reported yet. In another domain, Weyrich et al. create the idea of microfacet height field by series of algorithms to obtain a custom reflectance [1]. We have proposed another approach based on geometrical optics to allow a faceted structure to allow an arbitrary irradiance map. The current structure has the geometrical dimensions of the facets large with respect to the wavelength [2]. The principle is based on either reflection on small mirrors or refraction through a prism array redirecting the incident light. The idea is known to realize and work on smaller facets, in order to propose very small components for beam shaping of incoherent light. Using either smaller facets or reducing the scale with effective medium theory, the request is to use another electromagnetic model solver [3,4]. The goal of the thesis work is to develop rigorous electromagnetic developments inspired from angular spectrum method or new other finite element method to calculate the irradiance map at small distance or far distance of the component. The application will be in the field of white light LED beam shaping or femtosecond laser.

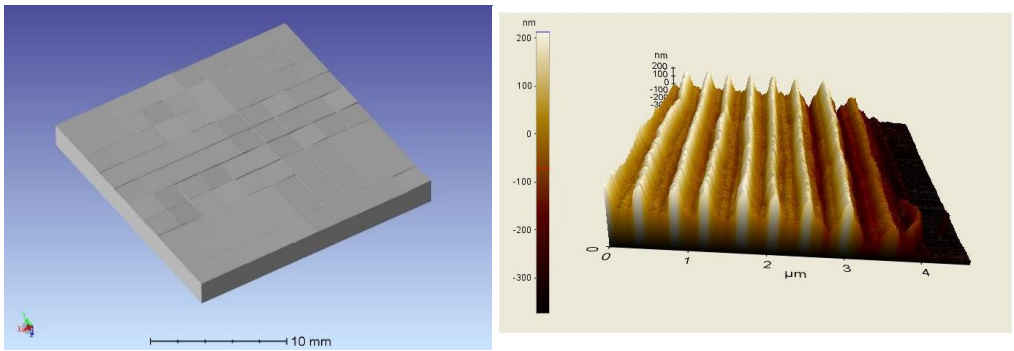

Figure 1 : (Left) Example of the faceted structure designed with Zemax [2]. (Right) Example of a effective medium structure realized by a sub-wavelength grating and measured by AFM. This structure was realized in a previous PhD work in Strasbourg University [4]. A facet structure can be replaced by this type of effective medium.

Références :

[1] T. Weyrich, P. Peers, W. Matusik, and S. Rusinkiewicz, “Fabricating microgeometry for custom surface reflectance,” ACM Transactions on Graphics (Proc. SIGGRAPH) **28**, 321-326 (2009).
[2] **L. Liu, T. Engel, M. Flury**, "Simulation and Optimization of Faceted Structure for Illumination", Proceeding of SPIE, Vol. 9889, 2016, p. 98891A
[3] D. Kuang, R. Charriere, N. Matsapey, **M. Flury**, J. Faucheu, P. Chavel, Optics Express, 2015, 23(4), p. 4506-4516.
[4] V. Raulot, P. Gérard, B. Serio, **M. Flury**, and al., Optics Express, 2010, 18(17), p. 17974-17982.