(Invited)

Progress in the fabrication of complex optical coatings

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The field of interference optical coatings made of dielectric multilayer has constantly progressed since their start seven decades ago [1]. Iterative and matrix approaches were introduced early for facilitating the calculation of spectral properties such as reflectance or transmittance for a given multilayer stack. However, the mathematical complexity of the inverse problem led to several decades of research on improved design techniques. This problem was partly solved with the introduction of the numerical optimization of coatings [2], the inverse Fourier transform method [3], and the needle method [4].

Recent challenging problems have forced refinements in the design and fabrication of coatings. Improvements in the manufacturing strategy, including subdivision of layers and reoptimization of the remaining layers were introduced [5]. In the present work, the sources of errors when fabricating complex filters are reviewed. We will see that new devices lead to specific challenges; for example:

- Coatings for wide ranges of incidence angles ask for the use of more than two materials, and may be very demanding as regard to the control of the refractive indices [6].
- Corrective filters (of which an “architectural” example is shown in Fig. 1) and new PBS [7] demand precision of less than 0.5 nm per layer;
- Optical coatings on facets, which have to accommodate non planar incidence waves [8];
- Dielectric quantum microcavity structures for new luminescent devices, which can be very sensitive to the dispersion of the phase change on internal reflections in the mirrors.

In addition, we will see how uniformity can become a critical parameter, and how to improve it to a desired level. Some recent improvements in the manufacturing of coatings, such as the introduction of ion milling (Fig. 2) [9], will be reviewed. The measurements precision will be identified as one of the most limiting factor for the manufacture of optical coatings [10].

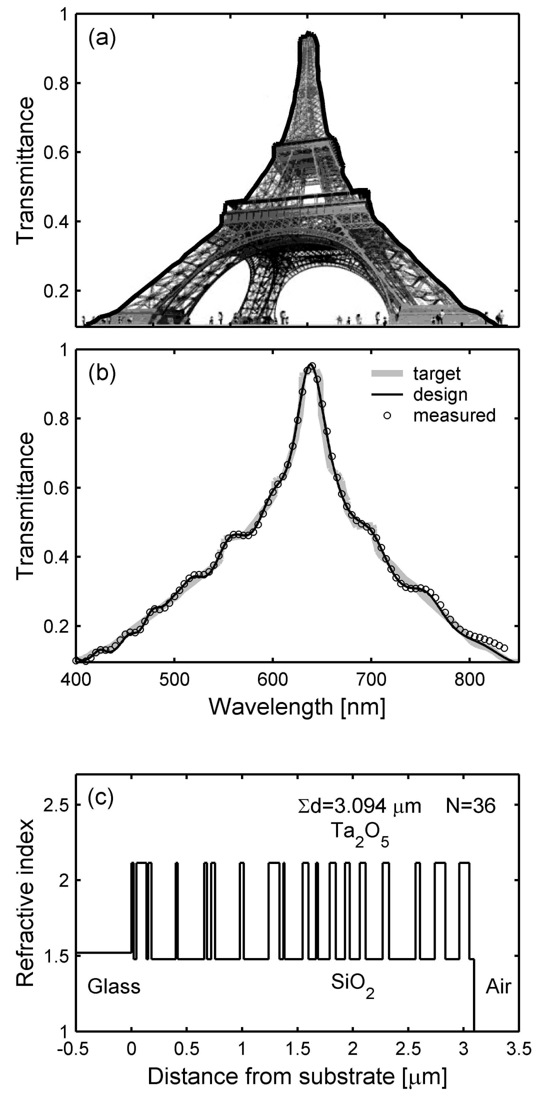

Fig. 1 The profile of the Eiffel Tower considered as a transmittance target for a thin-film optical filter: (a) definition of the target, (b) comparison of the target with calculated and measured spectra, (c) design considered.

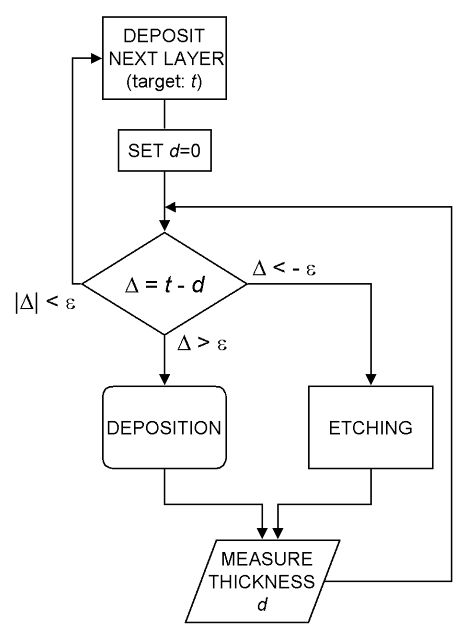

Fig. 2 Introduction of etching as a tool for precisely control the thickness of individual layers during the fabrication of complex optical coatings.

References

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