Rugate filters in nanoporous anodic alumina for photonic applications: fabrication, design and analysis

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Abstract

Optical properties of nanoporous anodic alumina (NAA) are interesting in many photonic applications of this nanomaterial. Such optical properties can be modified in several ways [1] and applications such as optical biosensing have already been demonstrated [2]. One possible optical function is the rugate filter: a multilayer structure with continuous variation of refractive index along the pore. It can be produced in a quasi-galvanostatic regime with a sinusoidal perturbation of the current and leads to structures with a sharp stop band around the design wavelength. One advantage of such structures is the possibility to overlap several sinusoidal profiles resulting in several tunable stop bands in the same structure. This features permit to envision other applications such as colorimetric sensing or barcode labeling.

In this work, we present a complete study of the design parameters for sinusoidal-anodization rugate filters made of NAA. The complex porous structures obtained by the electrochemical anodization of aluminum present a set of unique optical properties, by the galvanostatic control of the anodization that provides an accurate control of the porosity and growth rate of the alumina. Our study establishes the principles for understanding the effect of the fabrication parameters (current amplitude, offset current, period length and number of periods) on the optical properties of the sinusoidal rugate filters. The obtained results reveal that the transmission and reflection spectrum of the rugate filters can be precisely tuned in the UV, visible and IR range by adjusting the different fabrication parameters (Figure 1).

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References

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Figures

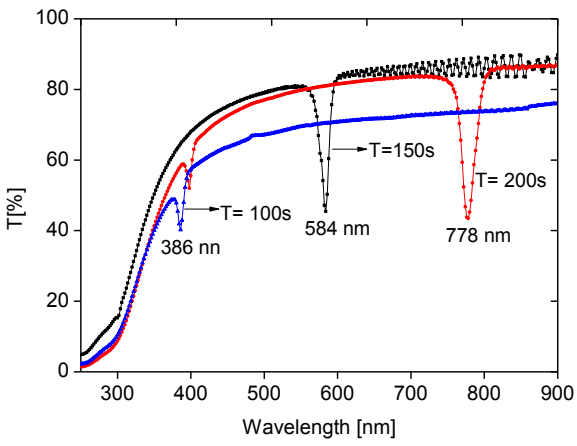

Figure 1. Transmission spectra of NAA sinusoidal rugate filters with different period lengths (T=100, 150 and 200 s).