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Investigation of Fabry-Pérot interferences in nanoporous anodic alumina (NAA) synthesized by galvanostatic mode.

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Introduction

Nanoporous anodic alumina (NAA) has attracted great interest due to its potential applications, especially in the optical field. Fabry-Pérot interferences, observed in luminescence and reflectance investigations of the NAA films are mandatory to the define their usage as optical sensors[1,2]. In these analyzes, a parameter that has been getting attention is the effective optical thickness, EOT, which is related to the depth of the optical cavity [3], and to the refractive index [4] of NAA films. Since the EOT can be determined from the Fabry-Pérot fringes in optical spectra, it can be used as sensor response[1,2]. In this essay we determine the EOT using two optical methods in AAP samples prepared in galvanostatic regime.

Results e Discution

NAA films were synthesized by two-step galvanostatic anodisation of aluminum (Al) sheets in 0.3 mol.L^{-1} oxalic acid at 20°C and experimental conditions are described in Table 1.

Table 1: Anodisation conditions

Sample	Al. Substrate	Applied charge (C/cm^2)		Pore widening duration (s)
		1 nd Step	2 nd Step	
1	With electropolished	09,10	-	1800
2	With electropolished	09,10	-	-
3	With electropolished	40,50	09,10	1800
4	With electropolished	40,50	09,10	-
5	Without Electropolished	40,50	09,10	1800
6	Without electropolished	40,50	09,10	-

The reflectance and luminescence measurements showed the presence of interference fringes well pronounced in electropolished samples where the pore widening procedure was performed. An exception was Sample 2 which also depicts the fringes, but with a small resolution. From these results, the thickness of the NAA samples could be estimated using two different methods: (a) by the average energy difference (ΔE) of the maximum of two adjacent fringes in the spectra, and (b) by the Fast Fourier Transform (FFT) of the spectra, Figure 1. It can be seen that calculated thickness values were different depending on the used optical technique, but compatible even when estimated by different analysis method. Furthermore, the calculated error of thickness from reflectance measurements was greater than those obtained from luminescence data and it was larger when the analysis method used was the average energy difference (ΔE).

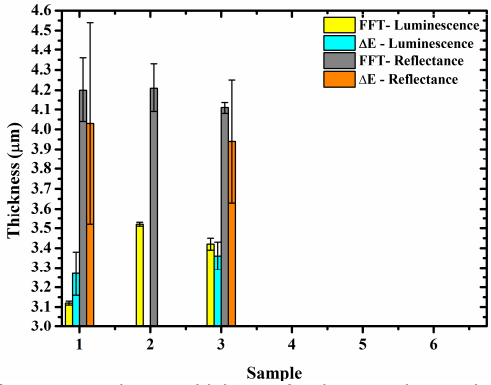

Figure 1: Estimates thickness for the samples analyzed

On the other hand, Samples 5 and 6 were anodized in the same experimental condition of Samples of 3 and 4, but without the electropolishing pre treatment and we did not detect the Fabry-Pérot interference, indicating that this behavior only appeared in electropolished samples independently from how the optical signal was obtained, if was from luminescence or from reflectance spectra.

Conclusions

Pore widening is a fundamental condition to obtain interference fringes in the optical spectra of NAA. However, the porous morphology had no significant influence on the final result of interferences. The pre-treatment of samples followed by electropolishing procedure was also necessary in order to obtain well resolved interference patterns, which can be related to the necessity of a flat surface for optimized optical responses. Regarding the calculations of samples thickness, the obtained values were different depending on the chosen method of measurement.

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