Fabrication and Characterization of Nanoporous Alumina-Based Bilayers for Their Application in Biosensors

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Nanoporous anodic alumina (NAA) is a self-ordered material made of vertically aligned cylindrical pores arranged in a hexagonal pattern. Its chemical stability, structural flexibility, and tunable optical properties make it a strong candidate for passive biosensing applications [1-3]. By carefully adjusting the anodization process, it is possible to create bilayer structures, where each layer has different pore sizes and thicknesses. This allows for more complex optical interference behavior.

To form these bilayers, aluminum is first electropolished and anodized twice to create an ordered porous layer. The upper oxide is then removed by chemical etching, followed by a pore-widening step to modify the first layer. A final anodization creates the second layer on top, resulting in a continuous bilayer with distinct porous layers [4-5].

The structure was studied using field emission scanning electron microscopy (FESEM), confirming uniform pores and clear separation between layers (Figure 1). UV-Vis reflectance spectroscopy was used to study the optical response. A thin gold layer was added to the top surface to enhance reflectivity.

Using reflective interferometric Fourier transform spectroscopy (RIFTS), the optical behavior was analyzed, revealing three peaks corresponding to the two layers and the full structure. The presence of the gold layer significantly improved signal intensity and made it easier to distinguish individual layers.

The sensing response was tested in air, water, ethanol, and isopropanol. Each liquid caused different shifts in the optical signal (optical thickness, EOT) [6,7]. These findings confirm that bilayer NAA structures are promising as low-cost, passive optical sensors for detecting organic vapors with high sensitivity.

References

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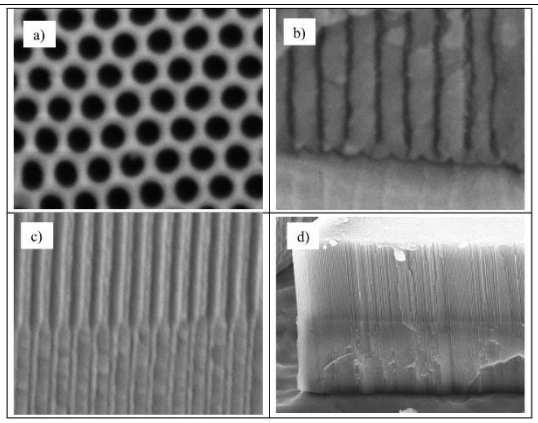

Figure 1. Top-view a) and cross-sectional b), c), d) FESEM image of a sample after a third anodization, showing a nanoporous alumina bilayer.