Engineering of Nanoporous Anodic Alumina as a Versatile Platform for Biomedical Applications

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Nanoporous anodic alumina (NAA) is a nanostructured material suitable for developing complex and cost-effective biomedical applications like selective molecular separation, chemical/biological sensing, cell adhesion and culture, and drug delivery [1-2].

NAA is obtained by the electrochemical etching of aluminum and presents a self-ordered hexagonal pore distribution of parallel cylindrical nanopores with diameters between 10 and 300 nm [1-2]. Its geometric characteristics such as diameter, length and separation distance is controlled by the anodization conditions (voltage and time of anodization, temperature, and electrolyte) [3-4].

Chemical resistance, thermal stability, and intrinsic photoluminescence are some of the outstanding properties of NAA [5]. Its highly effective surface area (hundreds of m^2/cm^3) makes of NAA an interesting platform for sensing and loading and releasing of active agents.

In this abstract we present the use of NAA for developing advanced drug delivery systems and complex gated materials for biosensing applications [6]. In these systems, the NAA nanopores are used as nanocontainers of drugs or molecules that are released in a controlled way under selective external conditions. NAA is also engineered to produce one-dimensional photonic crystals (1D-PC) with an enhanced optical response. Low-cost NAA 1D-PC biosensors were developed for the detection of substances of interest for the health and the environment like bacteria, proteins or drugs.

NAA also can be applied for reproducing 3D cellular microenvironments and understanding the complex cellular interactions and behaviors. The effect of the geometry and functionalization of NAA on cell adhesion and morphology of human aortic endothelial cells is investigated.

Finally, we propose NAA for the production of particles for biological applications. We present the successful fabrication, characterization, and functionalization of NAA particles [7]. We evaluate the simplified process of linking a protein/antibody to the NAA particles and demonstrate their biocompatibility by analyzing the cell viability and cytotoxicity.

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References

[1] J. Ferré-Borrull, J. Pallarès, G. Macías, L.F. Marsal, Materials 7, 5225 (2014).

[2] M. Porta-i-Batalla, E. Xifré-Pérez, C. Eckstein, et al., Nanomaterials 7, 227, (2017)

[3] A Santos, P Formentín, et al., J. Electroanal. Chem. 655, 73 (2011).

[4] A Santos, L Vojkuvka, M Alba, VS Balderrama, et al., Physica Status Solidi (a) 209, 2045 (2012)

[5] L. Vojkuvkas, A. Santos, et al., Surf. Coat. Technol. 206, 2115 (2012).

[6] T Kumeria, A Santos, MM Rahman, J Ferré-Borrull et al. ACS Photonics 1, 1298 (2014).

[7] E. Xifre-Perez, S. Guaita-Esteruelas, et al, ACS Appl. Mater. Interfaces, 7 (2015) 18600.

Figures

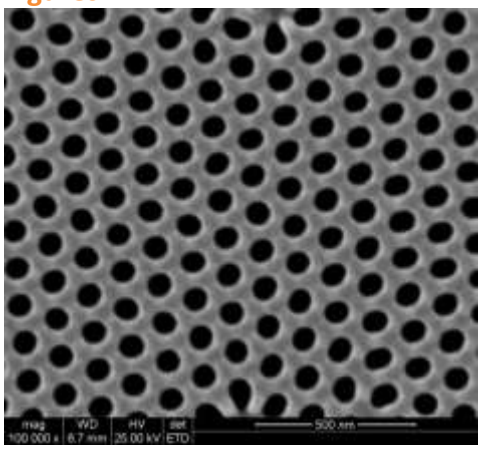

Figure 1. Top view of nanoporous anodic alumina.