Controlled drug release using nanoporous anodic alumina

Julia Jiménez, Pilar Formentín, Josep M. Cantons, Lluis F. Marsal
Departament d'Enginyeria Electrònica, Elèctrica i Automàtica, Universitat Rovira i Virgili, Tarragona, Spain.
lluis.marsal@urv.cat

Nanoporous anodic alumina (NAA) has emerged as a promising material for controlled drug delivery applications due to its highly ordered pore structure and the ability to precisely tune pore dimensions [1,3]. In recent years, its versatility has also enabled applications in biosensing and diagnostics [2]. This study investigates the fabrication and characterization of monolayer and bilayer NAA structures designed to regulate the release kinetics of doxorubicin, a widely used chemotherapeutic agent known for its systemic toxicity [4].

The NAA structures were fabricated through sequential electrochemical anodization, followed by thermal treatments and pore-widening steps. Structural characterization was carried out using field emission scanning electron microscopy (FE-SEM). In vitro drug release experiments were performed in phosphate-buffered saline (PBS), and the release kinetics of doxorubicin were quantified over time via fluorescence spectrophotometry, following established methodologies for trace-level detection [4].

Our results indicate that monolayer NAA structures exhibit a faster and more pronounced initial release, whereas bilayer configurations enable a more gradual and sustained release profile. These findings are consistent with previous reports on NAA-based systems for sustained and stimuli-responsive drug delivery [1,3]. Furthermore, we observed that both the internal geometry of the samples and the experimental conditions significantly influence the release dynamics.

Overall, this work reinforces the potential of nanoporous anodic alumina as a customizable platform for advanced drug delivery applications. Future work could explore the incorporation of polymeric coatings using layer-by-layer techniques to enhance the precision of long-term release, as demonstrated in prior studies [3].

References

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Figures

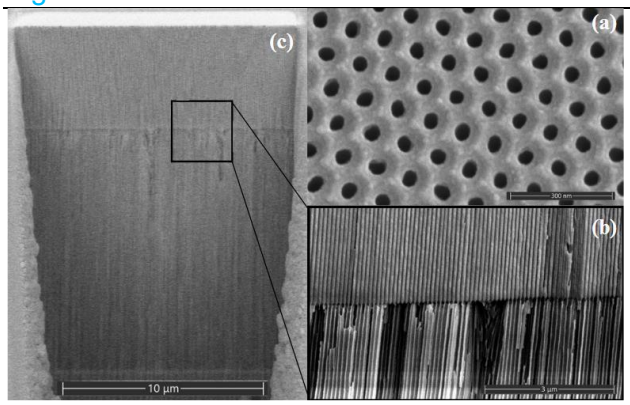

Figure 1: FESEM image of the surface (a) with a scale of 300 nm, the interface between layers (b) with a scale of 3 µm, and the cross-section (c) with a scale of 10 µm of the bilayer with a 30-minute pore-widening reaction time.

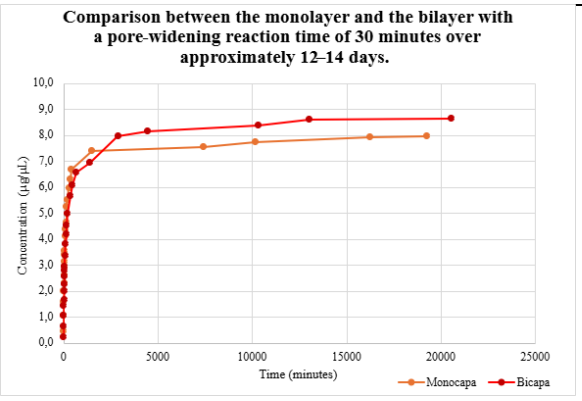

Figure 2: Graph comparing the monolayer and the bilayer with a pore-widening reaction time of 15 minutes over approximately 12–14 days.