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Enhancing photocatalysts on anodic aluminum oxide by surface pretreatments

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Numerous applications, from catalysis to batteries, and filtration to gas sensors, make use of anodic aluminum oxide (AAO) as a low cost, simply prepared high surface area material. Many of these applications depend on the chemical composition of the AAO template. Because AAO is produced in an acidic solution it includes impurities originating from that solution as well as oxygen vacancies. Hedrich et al. investigated how surface treatments can purify (AAO) templates and showed how removing contaminants and defects from the AAO can enhance the performance of photocatalysts it supports.

The researchers prepared AAO templates with 30 µm deep, 25 nm wide pores and subjected them to different post-anodization treatments: thermal annealing, immersion in water (H_2O), hydrogen peroxide (H_2O_2), or phosphoric acid (H_3PO_4). These modified templates then underwent atomic layer deposition (ALD) in an Arradiance GEMStar™ system of either TiO_2, a stable photocatalyst, or Fe_2O_3, a chemically less stable one. They used methylene blue dye degradation under UV-visible light to gauge photocatalytic performance and employed X-ray photoelectron spectroscopy (XPS) to assess changes in surface chemistry.

The TiO_2-coated templates showed consistent photocatalytic performance regardless of treatment, confirming TiO_2's resilience. However, Fe_2O_3-coated samples only maintained stability when the underlying AAO received H_2O_2 or H_3PO_4 treatment. Untreated AAO led to declining performance, likely due to interactions between Fe_2O_3 and residual contaminants in the AAO surface. XPS confirmed that both H_2O_2 and H_3PO_4 treatments reduced surface-bound impurities and promoted stable surface groups, thereby enhancing the stability of deposited photocatalysts.

The findings demonstrate that chemically stabilizing AAO templates before coating improves the reliability of less stable photocatalysts. This work provides a valuable guide for future studies using AAO as a platform for evaluating emerging photocatalytic materials.

Arradiance enables ALD on very high aspect ratio structures with a versatile system with detailed recipe control. For more information on Arradiance Technology, GEMStar™ ALD Systems or Foundry Services, please contact Arradiance.

[1] *Impact of surface treatments on the photocatalytic performance of anodic aluminum oxide templates,* ***Scientific Reports. 2025****, 15, 15030* https://doi.org/10.1038/s41598-025-98635-3