NANO- AND MICROFABRICATED PRODUCTS FROM SELF-ORGANIZED ANODIC ALUMINA

Dmitri Routkevitch

Synkera Technologies Inc.
2021 Miller Drive, Suite B, Longmont, CO, USA, droutkevitch@synkera.com

ABSTRACT

Synkera's product development efforts are based on nano- and microstructured materials and advanced methods for their integration into functional devices (www.synkera.com). We offer two main product groups. The first is a broad group of chemical sensor products and related devices. Synkera's chemical sensors are bridging the gap between the low cost of traditional solid-state sensors and the performance of liquid electrolyte electrochemical sensors. The other group of products, which will be reviewed in this presentation, originates from a unique nano/microfabrication technology platform, which affords multiscale engineering of advanced materials and their device integration.

Keywords: nanoporous anodic alumina, templated nanofabrication, ceramic MEMS

1 TECHNOLOGY

At the core of Synkera's technology platform is the synergy of two capabilities, *templated nanofabrication* and *micromachining*, both based on nanostructured *anodic aluminum oxide (AAO)*. AAO is self-organized into a nanoscale "honeycomb", formed by uniform and parallel nanopores that are aligned perpendicular to the surface of the material (Figure 1).

Synkera's well-established capabilities to engineer nanoscale dimensions and morphology of this material span pore diameter from below 5 to over 200 nanometers and pore length from 0.1 up to 300 microns, covering the size domain of interest to nanotechnology.

Self-organized anodic alumina is an attractive host for templated deposition [1, 2], and is widely used in fabrication of high-density arrays of prepackaged nanostructures (Figure 1, left). In addition, Intrinsic anisotropic morphology and chemistry of anodic alumina enables its micromachining via a process that combines features of both bulk and surface MEMS (Figure 1, center) and offers extensive opportunities for the development of Ceramic MEMS devices.

2 PRODUCTS

This technology was successfully used to develop and produce a number of products. Unique features and performance of these products are derived from nanoscale engineering of desired materials' properties and architecture. On the other hand, our Ceramic MEMS processing provides a convenient route for integrating these materials into practical devices. Synkera's current product development efforts include:

- Nanostructured *microsensor platform* [3] for solid-state gas sensing, including metal oxide conductimetric, catalytic combustible and electrochemical types of sensors (Figure 2, details described in a related talk [4]).
- Three types of *nanotemplates* for nanomaterials research that share unique morphology of anodic alumina (pore diameter 10-100 nm), but have distinctly different pore termination (Figure 3). These nanotemplates are currently offered in both standard and custom specifications to R&D market.
- Monodisperse ceramic *membranes* for separation and filtration applications, including membrane reactors for hydrogen generation and composite membranes for hydrogen separation (Figure 4, Figure 5).
- Other *Ceramic MEMS* components and devices (Figure 6) that utilize flexible design and fabrication capabilities of the process as well as robustness of alumina ceramic in harsh operating environments.
- *BioMEMS* components, such as high surface area substrates for bioanalytical applications and biocompatible chips for tissues culturing (Figure 6).
- Integrated and non-integrated metal *nanowire arrays* for energy conversion, bioengineering, bioanalysis and other applications.

We continue to develop and expand our product portfolio, and welcome inquiries on establishing collaborative partnerships for joint application and market development.

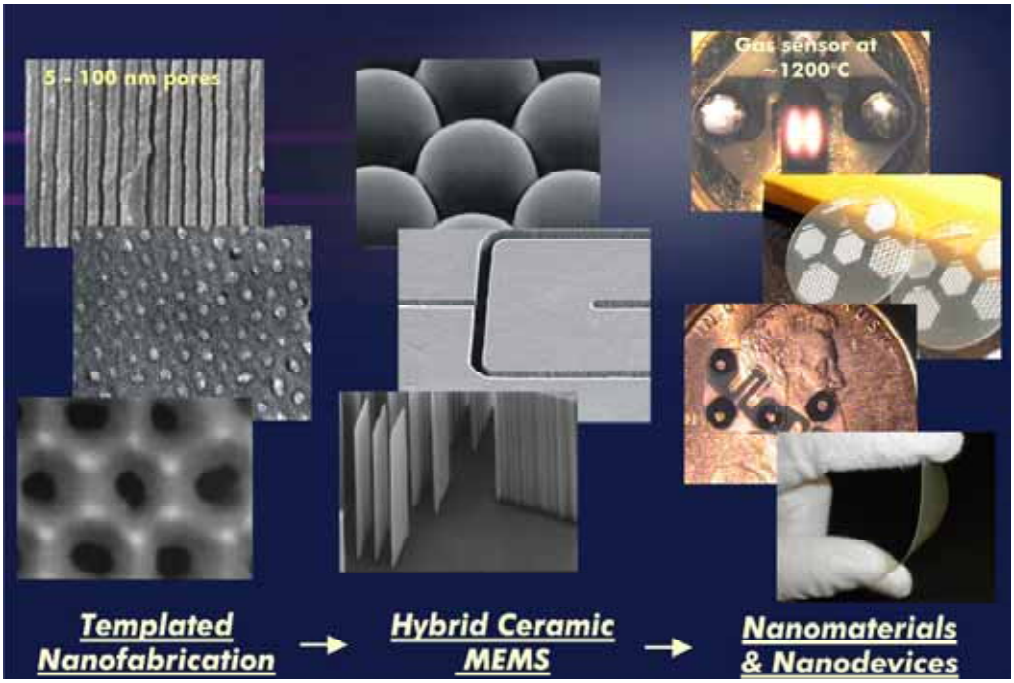

Figure 1: Synkera's nano- and microfabrication product development sequence (www.synkera.com)

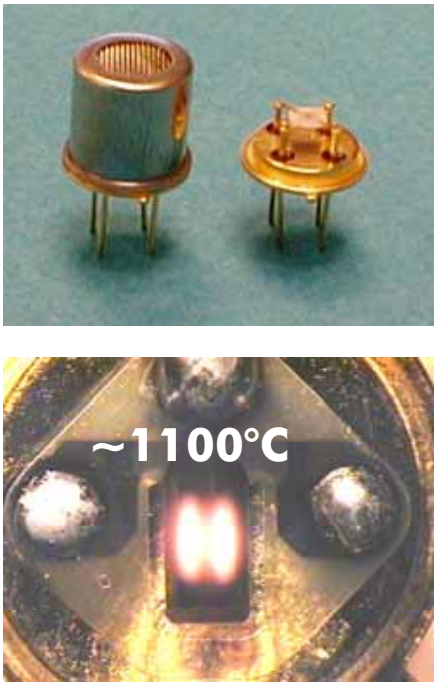

Figure 2: Synkera's packaged microsensors and microheater operating in air at ~1100°C.

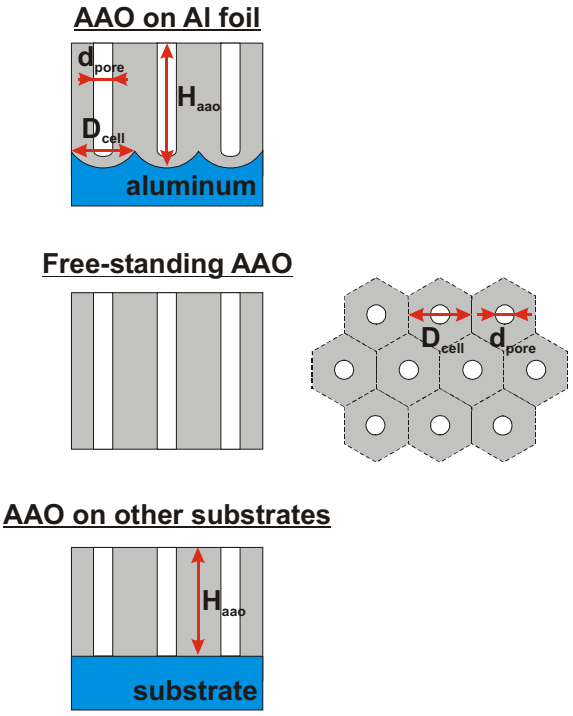

Figure 3: Three types of anodic aluminum oxide (AAO) nanotemplates offered by Synkera.

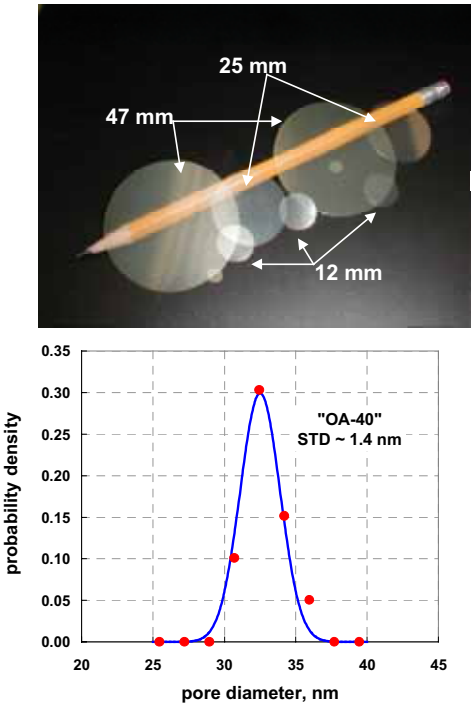

Figure 4: Synkera's monodisperse nanoporous ceramic membranes and membrane pore size distribution

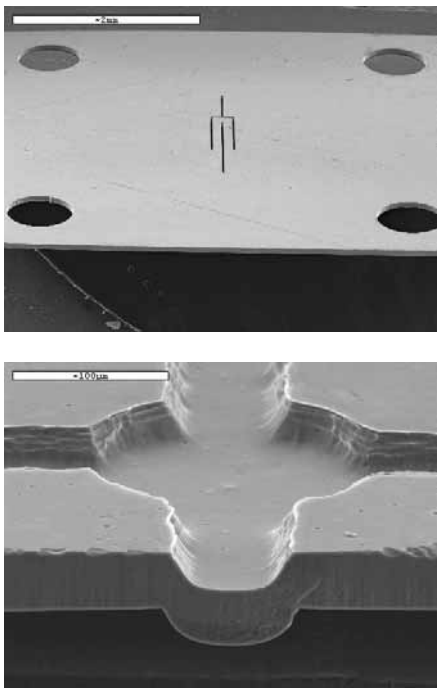

Figure 6: Examples of Synkera's Ceramic MEMS components. Top: gas microsensor substrate with thermally isolated sensing element. Bottom: micromachined chip for guided neuronal networks.

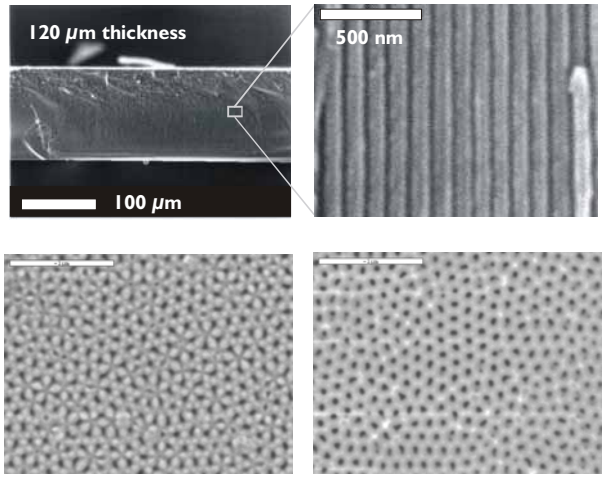

Figure 5: Scanning electron microscopy images of the cross-section and the plane view of the opposite faces of anodic alumina membranes produced at Synkera.

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