SPTS
An orbotech Company

CASE STUDY

Silicon Etch for Neural Probes

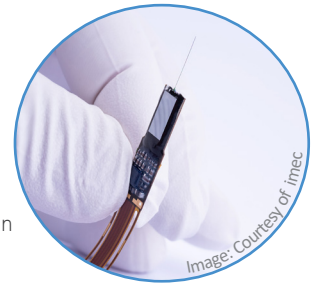
Image: Courtesy of imec

Customer

Imec is a world-leading R&D and innovation hub in nanoelectronics and digital technologies. As a trusted partner for companies, startups and academia they aim to bring together brilliant minds from all over the world in a creative and stimulating environment. **See www.imec-int.com**

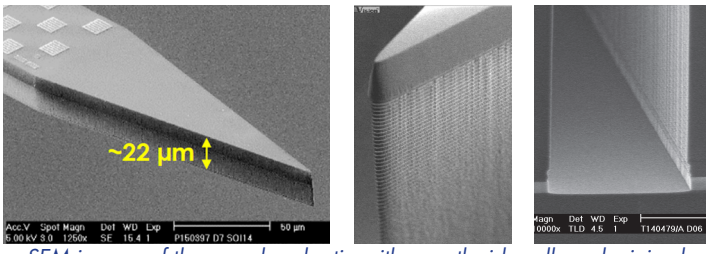
Application

Imec is a pioneer in high density minimally invasive neural probes. These integrated bio-microsystems, have 1000's of sensors, with 100's recording channels, on single or multiple silicon shanks. Imec's *Integrated Neuroprobe* technology provides unprecedented resolution for mapping brain activity across multiple brain regions. These probes are designed and fabricated on imec's advanced silicon platform, using SPTS's silicon etch.



Background

Since 2013, imec has developed *Cerebro*, *Neuroseeker* and *Neuropixels*, different embodiments of these neural probes, targeting different neural applications, all built on a common silicon CMOS platform. These are a new class of powerful neural devices that are capable of simultaneously monitoring neural activity from hundreds of different neurons within the brain. One example is the first generation of *Neuropixels* probes, with its initial results announced in 2017[1].



SEM images of the neural probe tip with smooth sidewalls and minimal notching at the Si:SiO_2 interface (Courtesy of imec)

All these probes were manufactured at imec using SPTS's silicon etch technology. Key process challenges included maintaining vertical sidewalls with precise critical dimension control at the probe tip, while also achieving good base roughness and sidewall quality. SPTS's end-point detection also enabled feature control on SOI wafers, maintaining surface quality at etch interfaces, and ensure the ability to handle fragile wafers in a production environment.

OBJECTIVE

- Etch a silicon probe 70µm wide, 22µm deep and 1cm long to oxide layer
- Create a production-worthy process route for scalable manufacturing of the Neuropixels probe

SOLUTION

- SPTS provided etch recipe to achieve desired feature dimension control and smooth sidewalls
- Claritas™ end-point to control etch process at Si:SiO_2 interface

RESULTS

- Now available to the international neuroscience research community.
- In Oct 2018, imec released the first probes for general sale, and in 2019 expects to ship 1000's of probes processed on 100's of wafers

[1] Jun, Steinmetz, Siegle, Denman, Bauza et al, "Fully Integrated Silicon Probes for High-Density Recording of Neural Activity" Nature volume 551, pages 232–236 (09 November 2017)

"SPTS's DRIE technology that underpins our silicon etch platform provides unparalleled etch quality, control and repeatability in a production environment that's required to manufacture challenging structures like the Neuropixels probe. We are extremely proud that 100's of wafers enabling 1000's of probes have already been manufactured and are being tested at research centers worldwide. We are excited by their potential to advance human knowledge and medical research" Barun Dutta, Chief Scientist, imec.

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