

# (SD2018-040) High Yield Fabrication of Sharp Vertically Aligned Nanowire Arrays for Intracellular Recordings and Applications Thereof

Tech ID: 33333 / UC Case 2021-Z08-1

## ABSTRACT

Engineers from UC San Diego have disclosed a new patent-pending technology (SHARP, VERTICALLY ALIGNED NANOWIRE ELECTRODE ARRAYS, HIGH-YIELD FABRICATION AND INTRACELLULAR RECORDING) that minimizes the electrode size to an intracellular probe, and is scalable to integrate multiple channels at one platform and overcomes the previous disadvantages such as invasiveness and insensitivity. This newly disclosed improved technology reduces the number of steps and the number of metal layers used to increase the biocompatibility and device yield, as compared to an earlier disclosure for NEAs that were fabricated using a different process.

## TECHNOLOGY DESCRIPTION

**Background.** In biological and clinical research, patch-clamp is the gold-standard and most widely used and efficient technique to probe the dynamic potential fluctuations and ion-gate current exchanges in excitable cells. However, patch-clamp is quite invasive and doesn't meet the needs to scale to large densities, long term, and intracellular electrophysiological intervention. And while microelectrode arrays (MEAs) enable long-term recordings from networks of neurons, they measure extracellular potentials and therefore lack the sensitivity to subthreshold potential oscillations that are important features for drug screening.

Intracellular access with high spatiotemporal resolution can enhance the understanding of how neurons or cardiomyocytes regulate and orchestrate network activity and how this activity can be affected with pharmacology or other interventional modalities. Nanoscale devices often employ electroporation to transiently permeate the cell membrane and record intracellular potentials, which tend to decrease rapidly with time.

Researchers from UC San Diego have invented an innovative scalable, vertical, ultrasharp nanowire arrays that are individually addressable to enable long-term, native recordings of intracellular potentials. One reports electrophysiological recordings that are indicative of intracellular access from 3D tissue-like networks of neurons and cardiomyocytes across recording days and that do not decrease to extracellular amplitudes for the duration of the recording of several minutes.

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## OTHER INFORMATION

### KEYWORDS

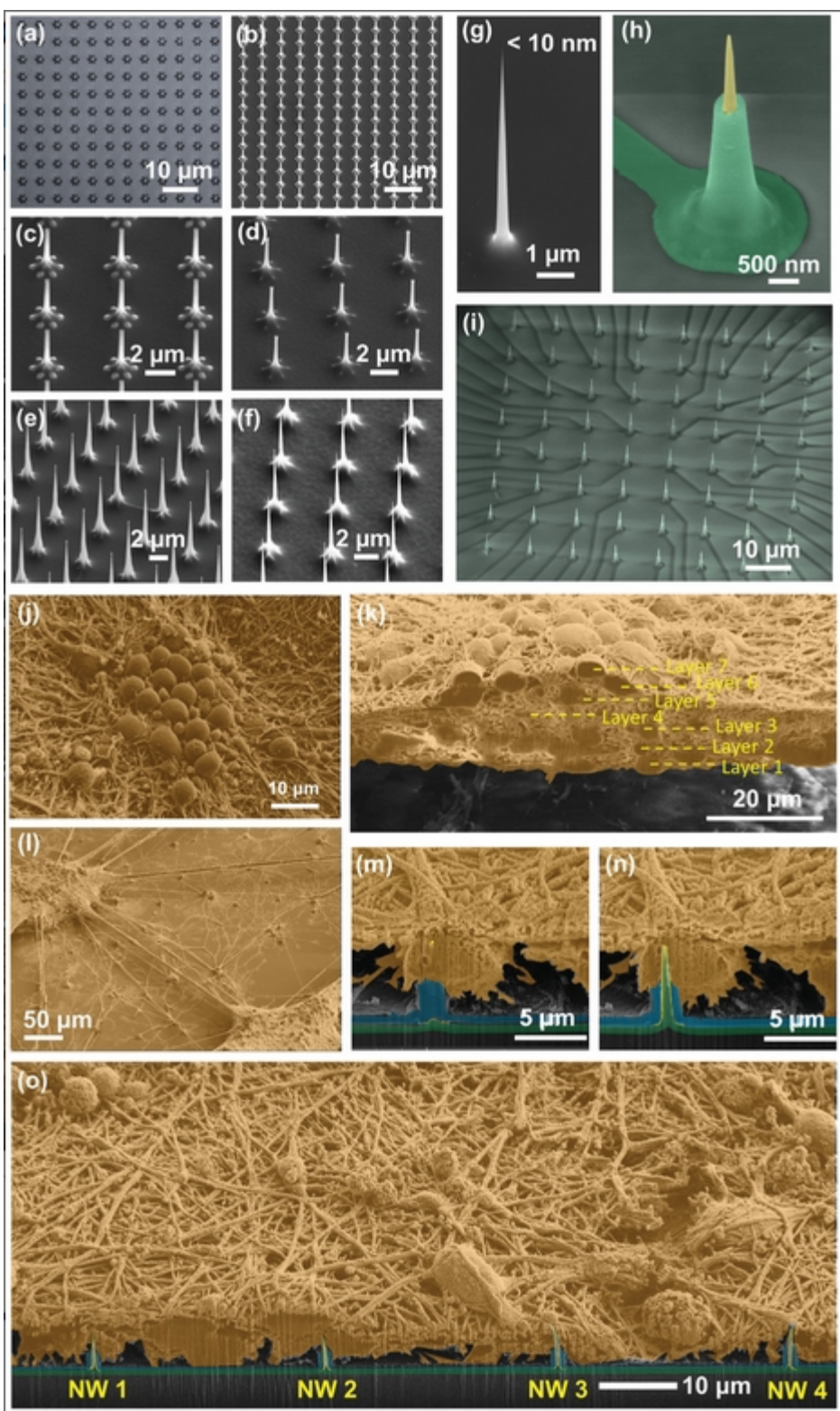
cardiomyocytes, culture, intracellular, nanowires, neurons, tissues

### CATEGORIZED AS

- ▶ **Imaging**
  - ▶ Medical
- ▶ **Medical**
  - ▶ Research Tools
  - ▶ Screening
- ▶ **Sensors & Instrumentation**
  - ▶ Biosensors

### RELATED CASES

2021-Z08-1



## APPLICATIONS

The applications of this technology are mostly in drug screening for neurodegenerative and neuropsychiatric diseases, heart and muscle disease. The devices have broad applications in any type of penetrating devices including but not limited to biological tissue, skin, etc. Additional applications include biosensing, field-emission devices, scaffolding platforms, etc.

## ADVANTAGES

These new high density vertical NEAs offer minimal invasiveness, high yield, high robustness, high aspect ratio, lower impedance, high sensitivity, biocompatibility, high density, and individual addressability. This invention is a novel fabrication process for the development of high yield nanowire electrode arrays (NEAs) with ultra-sharp tips to measure intracellular potentials from excitable cells. The nanowire arrays may find other applications in field-emission devices, light and particle detectors, etc.

This technology offers multiple intracellular measurements per a single cell or intracellular measurements from a large network of excitable cells. The invention provides for improved yield, high robustness, lower impedance, high density, increased sensitivity, high aspect ratio, individual addressability, minimum invasion

and biocompatibility, thus enabling longitudinal measurements of cell potential's and ionic currents important for drug screening.

#### STATE OF DEVELOPMENT

The cited paper below details the findings that are validated with cross-sectional microscopy, pharmacology, and electrical interventions. The experiments and simulations demonstrate that the individual electrical addressability of nanowires is necessary for high-fidelity intracellular electrophysiological recordings. This study advances the understanding of and control over high-quality multichannel intracellular recordings and paves the way toward predictive, high-throughput, and low-cost electrophysiological drug screening platforms.

#### INTELLECTUAL PROPERTY INFO

#### RELATED MATERIALS

► Liu, R., Lee, J., Tchoe, Y., Pre, D., Bourhis, A. M., D'Antonio-Chronowska, A., Robin, G., Lee, S. H., Ro, Y. G., Vatsyayan, R., Tonsfeldt, K. J., Hossain, L. A., Phipps, M. L., Yoo, J., Nogan, J., Martinez, J. S., Frazer, K. A., Bang, A. G., Dayeh, S. A., Ultra-Sharp Nanowire Arrays Natively Permeate, Record, and Stimulate Intracellular Activity in Neuronal and Cardiac Networks. *Adv. Funct. Mater.* 2022, 32, 2108378. - 06/11/2021

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