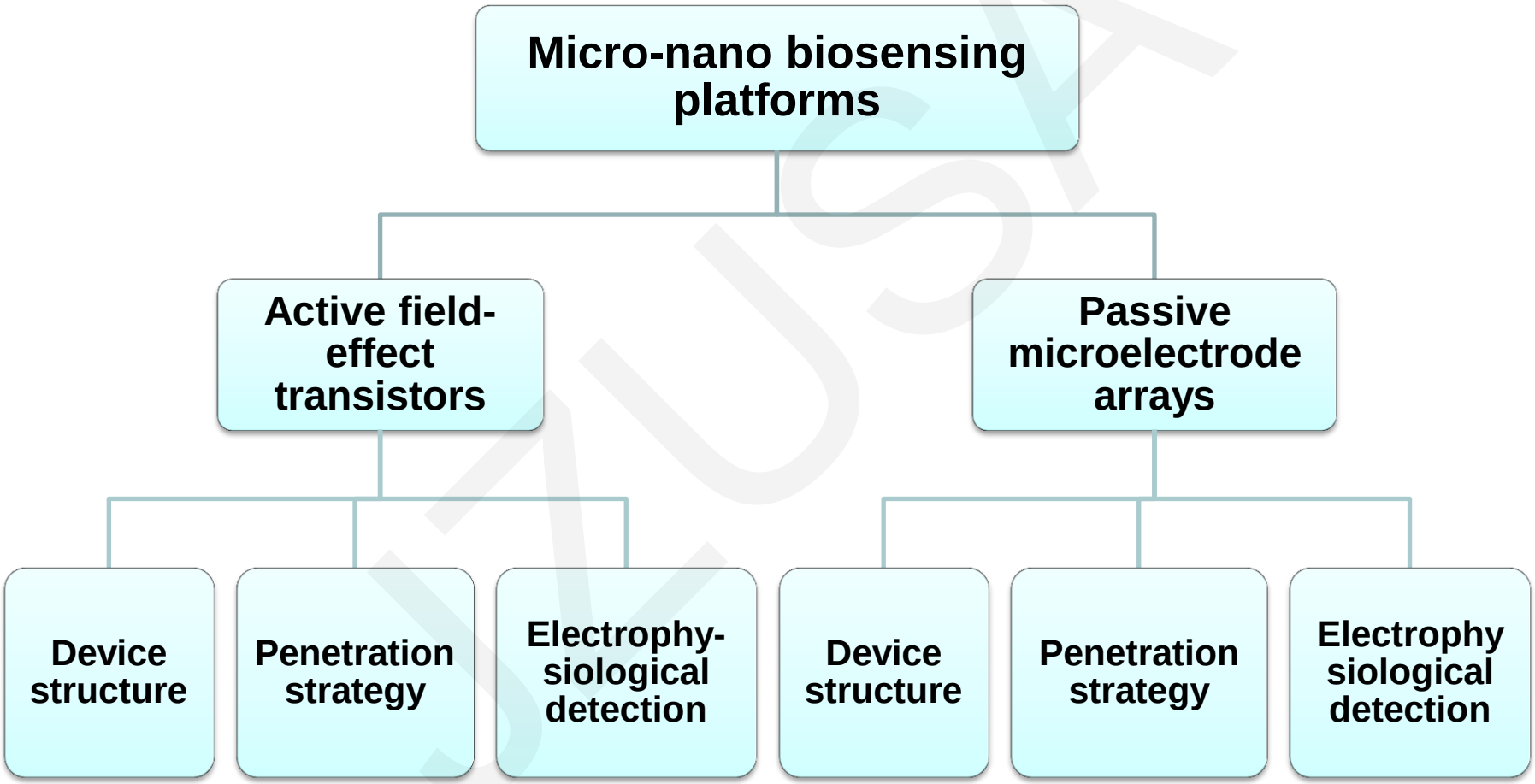
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Advances in micro-nano biosensing platforms for intracellular electrophysiology

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Intracellular electrophysiology



Active field-effect transistors

Device structure

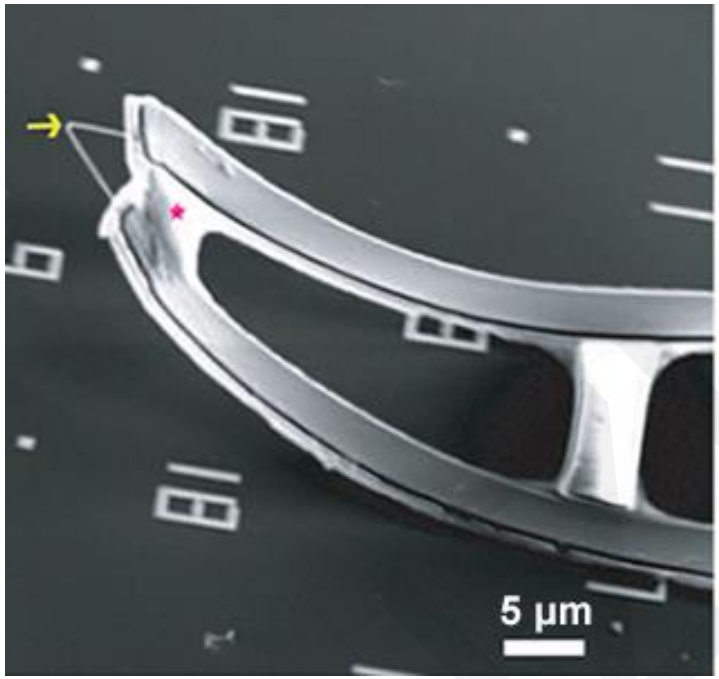


Fig. 1. Kinked silicon nanowire field-effect transistor.

Penetration strategy



Fig. 2. Transistor coated with phospholipid bilayers to fuse with cell membranes

Tian, Bozhi, et al. Science 329.5993 (2010): 830-834.

Active field-effect transistors

Electrophysiological detection

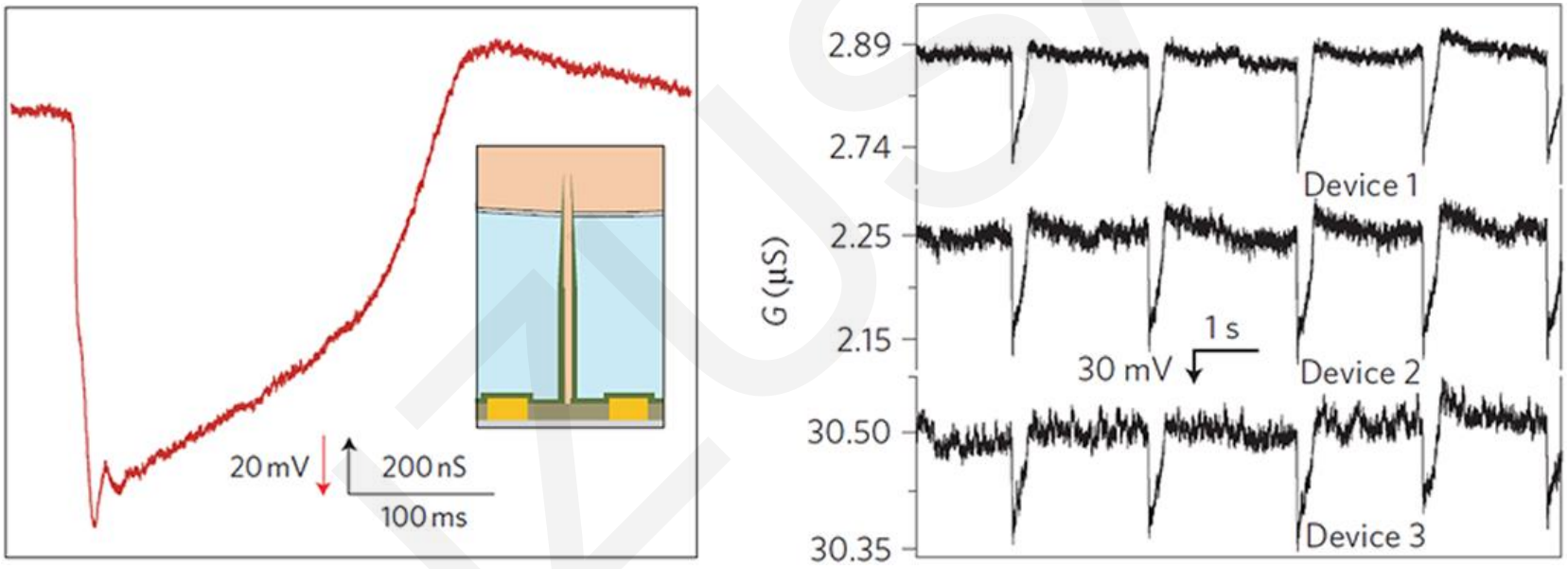


Fig. 3. Intracellular recording by a branched nanotube field-effect transistor.

Duan, Xiaojie, et al. Nature nanotechnology 7.3 (2012): 174-179.

Passive microelectrode arrays

Device structure

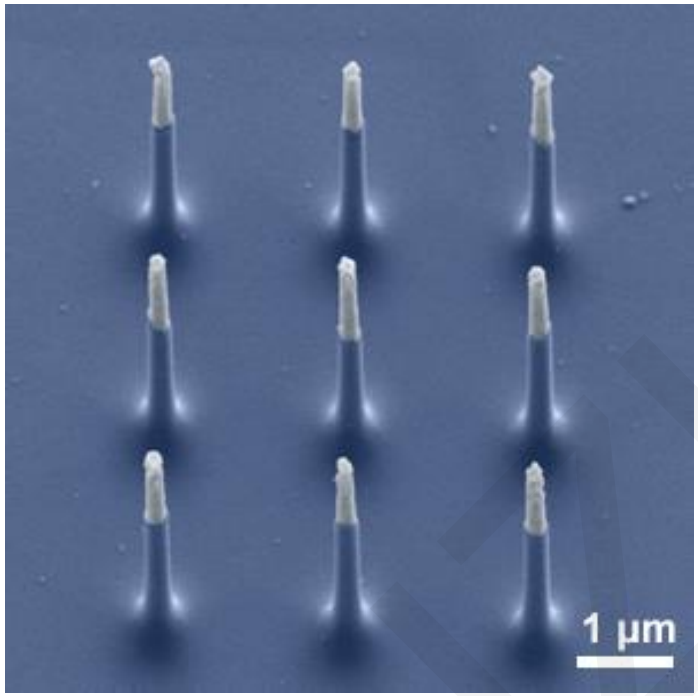


Fig. 4. Silicon nanowire electrodes.

Penetration strategy

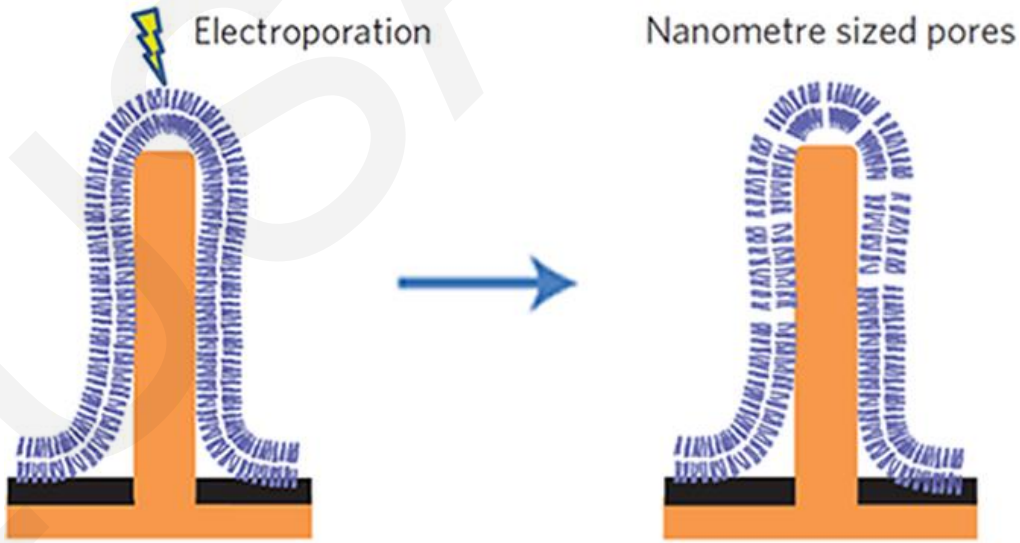


Fig. 5. Electroporation by a nanopillar electrode.

Robinson, Jacob T., et al. Nature nanotechnology 7.3 (2012): 180-184.
Xie, Chong, et al. Nature nanotechnology 7.3 (2012): 185-190.

Passive microelectrode arrays

Electrophysiological detection

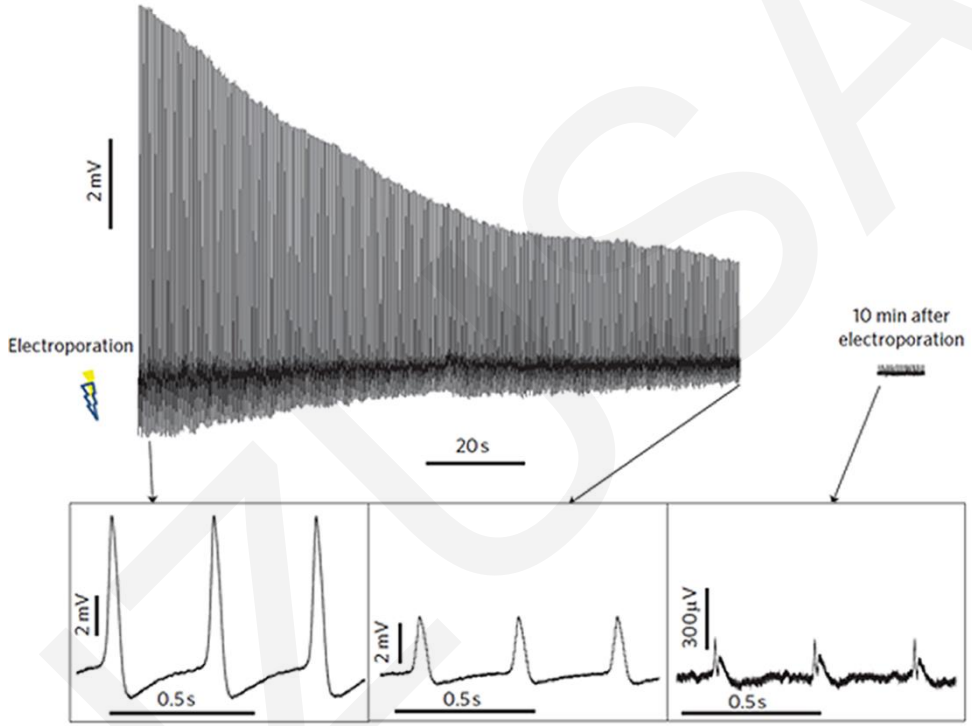


Fig. 6. Intracellular measurement of action potentials with a nanopillar electrode.

Xie, Chong, et al. Nature nanotechnology 7.3 (2012): 185-190.

Summary and perspective

- Micro-nano electronics are widely used in drug screening, disease modeling, and synapse mapping in cardiac and neural cells due to their minimally inva-sive, accurate, sensitive, stable, and multiplexing characteristics; this will provide new ideas for mechanism research and disease-treatment development for the heart and brain.
- Many challenges and development opportunities remain for the application of micro-nano sensing and control technology in intracellular recording, including but not limited to improving the quality of electrophysiological detection, developing multi-functional devices, etc. As micro-nano sensing and control technology advances, its broad adoption promises to lead to substantial breakthroughs in the biomedical field.