

研究課題目名

集積化マイクロ/ナノワイヤーデバイスのセンサ応用

Sensor applications of integrated micro/nanowire devices

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研究目的・目標

本研究は、シリコンワイヤーに代表される半導体1次元デバイスの集積化の開発と、そのセンサ応用に取り組むものである。シリコンワイヤーの集積化には触媒を利用したVapor-liquid-solid (VLS)結晶成長法を用いる。触媒金属を選択形成することにより、ワイヤーの位置・直径を厳密に制御できる。センサエレメントにこのように1次元の半導体ワイヤー形状を用いることで

- ① 高い表面積対体積率を持つオプティカル/ケミカルセンサデバイス
- ② 高いアスペクト比構造によるフィジカルセンサデバイス、
- ③ 生体組織内の各種計測を実現する刺入型バイオセンサデバイス
- ④ また、CMOS一体化によるワイヤーセンサ集積化チップシステム

が提案できる。このように従来の技術では形成が困難であった3次元的なワイヤーデバイスを提案することで、新しいセンサチップを実現可能であると考えられる。



研究内容

“Nano” wire sensors

- Optical sensors,
- Physical sensors,
- Biological sensors,
- Chemical sensors etc.

“Micro” wire sensors

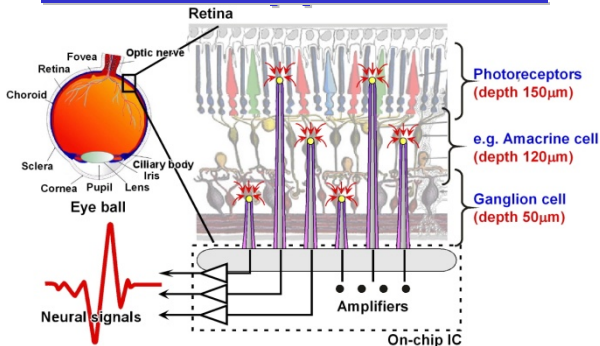
Advantages

Vertically-aligned micro/nano wires on silicon substrate

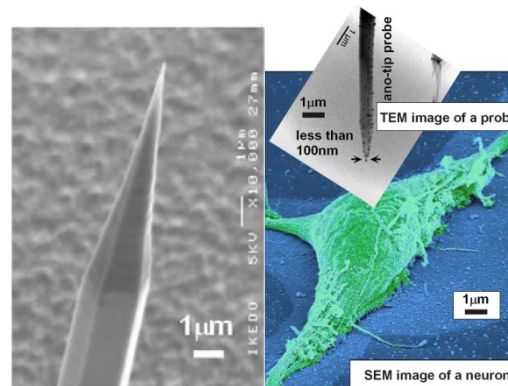
Controllable diameter (nano-scale to micron-scale) and length (1 μ m to >1mm)

CMOS compatibility for on-chip microelectronics

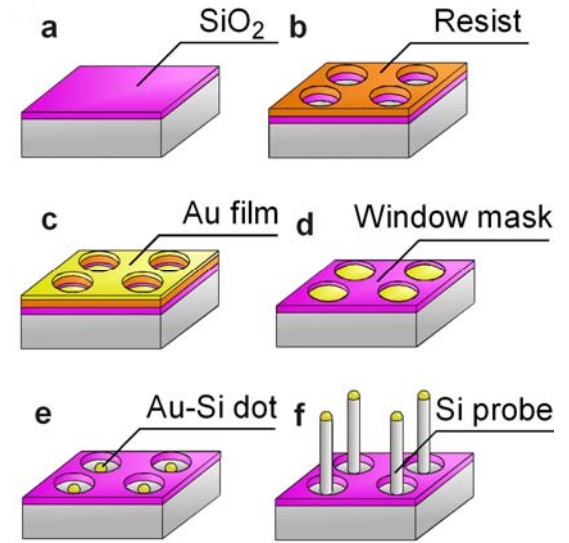
Sensor applications



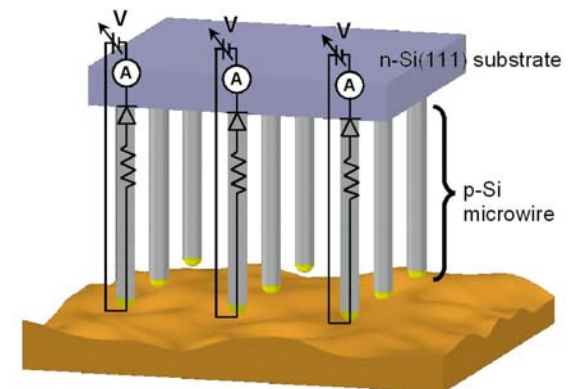
Multi-length bio-probe array



Nanoprobe sensor array



Integration of micro/nano wire array
(Selective vapor-liquid-solid growth)



Out-of-plane force sensor array

Summary (2009')

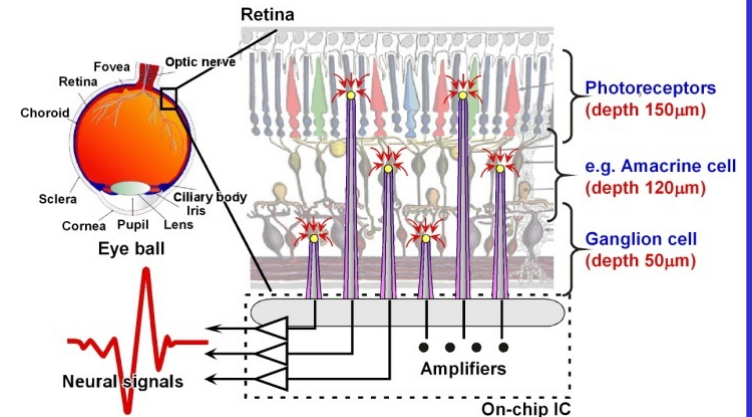
Multilength neuroprobe arrays

- ✓ Device design and fabrication completed
- ✓ Microwires integrated (Length=50, 100 μ m)
- ✓ Electrical, mechanical characterizations for applications to neural recording

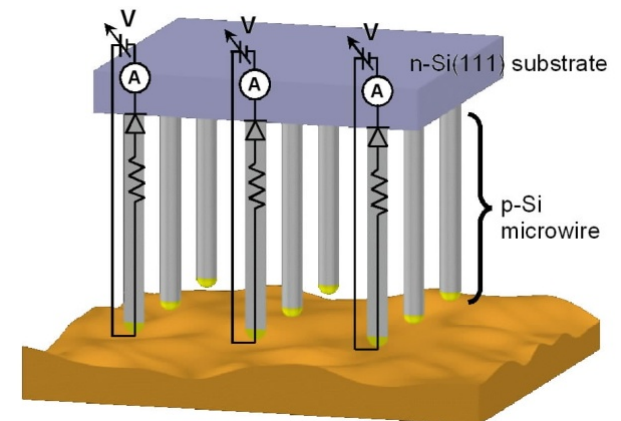
Out-of-plane micro force sensor arrays

- ✓ Device design and fabrication completed
- ✓ Sensor probe arrays integrated (Length=30 μ m)
- ✓ Stress-induced resistance change investigated

Multilength neuroprobe arrays



Out-of-plane micro force sensor array



Acknowledgements

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Published papers

- 1) A. Ikedo, T. Kawashima, T. Kawano, and M. Ishida, "Vertically aligned silicon microwire arrays of various lengths by repeated selective vapor-liquid-solid growth of n-type silicon/n-type silicon." Applied Physics Letters, Vol. 95, No. 3, 033502, July 2009.
[\[Also selected as cover image article\]](#)
- 2) T. Kawano*, A. Ikedo*, T. Kawashima, K. Sawada and M. Ishida (* equally contributed first authors), "Vertically aligned various lengths doped-silicon microwire arrays by repeated selective vapor-liquid-solid growth." IEEE Micro Electro Mechanical Systems (IEEE-MEMS) Conference 2009, Sorrento, Italy, January 2009.
- 3) A. Ikedo, T. Kawano and M. Ishida, "Out-of-plane microwire force sensor arrays with embedded p-n diodes by selective vapor-liquid-solid growth." 15th International Conference on Solid-State Sensors, Actuators and Microsystems (Transducer Colorado, USA, June 2009.

[\[We won one of four Outstanding Paper Awards at Transducers'09\]](#)

