Magnetic barcode nanowires for cell control and detection

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Motivation

Cell sorting and identification has been conventionally achieved using magnetic beads and fluorescence microscopy respectively. However, cell sorting is then limited by the number of spectrally resolvable fluorophores.

Electrodeposited nanowires have been demonstrated to outperform beads in purity and yield of separated cell samples. [1]

Figure 1: Scanned Barcode
thomasnet.com

The **goal** of this project is to fabricate Au-Ni multicomponent barcode nanowires for cell separation . These nanowires can be selectively functionalized to attach to different cell types so that each code would correspond to a different cell type. These barcode nanowires can then be scanned just like products at convenient stores to identify the cell type.

Reference [1]: A. Hultgren et al., "Cell manipulation using magnetic nanowires," *Journal of Applied Physics* 93, no. 10 (2003): 7554.

Nanowires

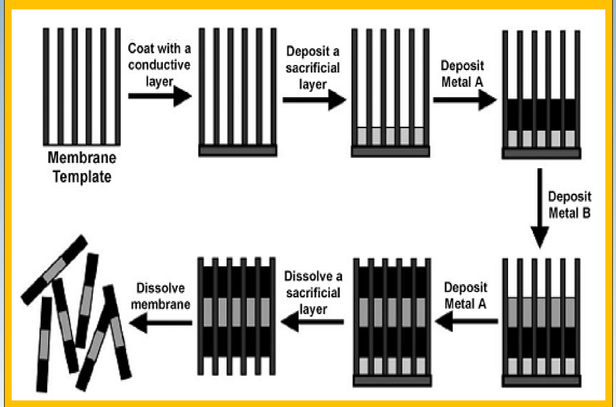
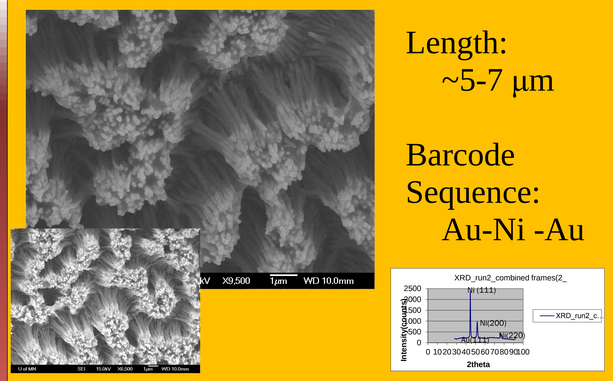


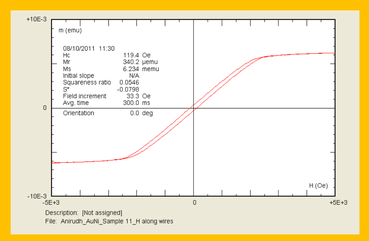
Figure 2: Template-Based Nanowire growth
Courtesy of Dr. Joseph Wang



Length:
~5-7 μm

Barcode Sequence:
Au-Ni -Au

Figure 3: SEM images of Au-Ni barcode nanowires. On the right are results from x-ray diffraction of Au-Ni nanowires in anodic alumina



V=Volume= .0062/485= 1.27*10^(-5) cm^3
No. of nanowires = N = V/(6*10E-4*pi*(50E-7)²) = 27E7 nanowires

Figure 4: M-H loop from VSM to determine number of nanowires in an array in anodic alumina

Results

Cell-NW Mixture

-Barcode Nanowires mixed with ~1.4-1.5 million osteosarcoma cells
-Incubated at 37˚C for ~24 hrs
-Apply magnetic field to cause nanowire movement
-Visualize culture under an inverted optical microscope (Nikon TE200) and observe their interactions with osteosarcoma cells when mixed.

Cell-NW Mixtures

Pre-Incubation:

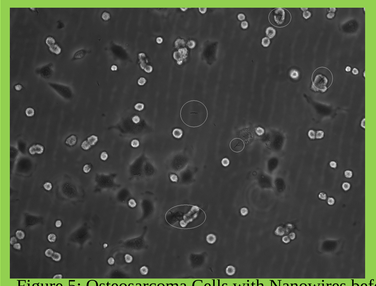


Figure 5: Osteosarcoma Cells with Nanowires before incubation

-Nanowires appear to be inside of cells
-Some tips are attached to the surface of the cells

Post-Incubation:

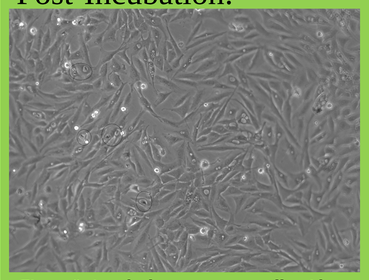


Figure 6: Attached osteosarcoma cells with nanowires

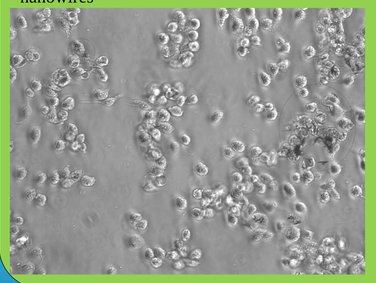


Figure 7: Unattached Osteosarcoma cells with nanowires

-Nanowires appear to be held within vesicles of cells
-Very few are attached to surface
-Magnetic field causes cells to move with nanowires

Conclusions

-Osteosarcoma cells immediately interact with the barcode nanowires by engulfing them more often than simply just attaching.
-The barcode nanowires are not cytotoxic to the cells
-Magnetic counting and identification of cells via barcode nanowires is feasible. However, more cell lines need to be tested before generalizing.

Ongoing/Future Experiments

-Efforts are currently being made to attach fibronectin-derived peptide onto gold segments of the barcode nanowires via gold-thiol chemistry.

.Magnetic separation of cells

Figure 8: Magnetic separation of cells attached to nanowires [1]

-Lengths of nanowires may affect the amount of endocytosis occuring. This relationship is still being investigated.

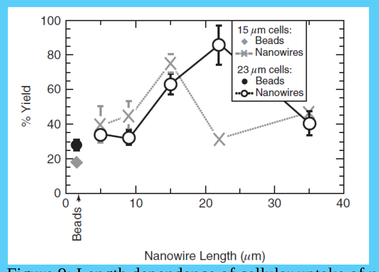


Figure 9: Length dependence of cellular uptake of nanowires [2].

Acknowlegdement

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Reference[2] Anne Hultgren et al.,*Biotechnology Progress* 21, no. 2 (January 1, 2005): 509-515.