Cell Separation and Manipulation by magnetic field in the presence of functionalised magnetic nanowires

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ABSTRACT

In this paper we investigate the possibility of using magnetic nanowires in cell separation and manipulation [1,2]. Ni, Co/Cr and Co/Fe nanowires made by electrochemical deposition in anodic aluminum oxide (AAO) templates. The combination between nanowires and different cells such as MC3T3 mouse fibroblasts, UMR-106 has been shown. There, cell viability with all the three kinds (Ni, Co/Cr and Co/Fe) of nanowires after combination was monitored. Magnetic cell separations were carried out following standardized conditions have achieved 75% purity and 75% yield.
Moreover, we were also successful in aligning the nanowires with cells in a 0.1 T uniform magnetic field. There, the axial of the magnetic nanowires internalised into cells can be aligned to the field direction with uniform magnetic field.
Therefore, a cell-nanowire interaction and living study will be addressed in the future in order to understand the intrinsic mechanisms responsible for cell internalization and alignment.

Keywords: Magnetic nanowires, cell manipulation, cell separation, nanowires.

MATERIALS AND METHODS

Ni, Co/Cr and Co/Fe nanowires with 200 nm in diameter and 40 µm in length were fabricated using electrochemical deposition in anodic aluminum oxide templates. Their magnetic properties were measured in a vibrating sample magnetometer (VSM) or a superconducting quantum inference device (SQUID) as shown in Figure 1a,b,c respectively. Cells were incubated with the magnetic nanowires at least over night before the separation test [3]. The cell separation equipment was made by two aligned permanent magnets with surface magnetic field of 0.3 T (Fig. 2). The nanowires alignment tests were carried out in a uniform magnetic field of 0.1 T for 1 hr, 24 hrs or 48 hrs [3] (Fig. 3).

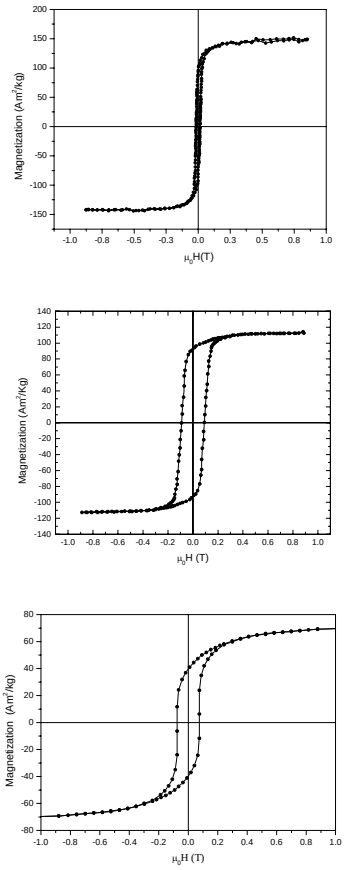

Fig. 1. Magnetic hysteresis curves. *(from left)* A) Ni, B) CoCr, and C) CoFe Nanowires

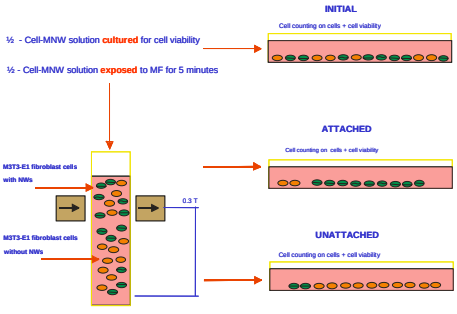

Fig. 2. Cell separation experimental setup

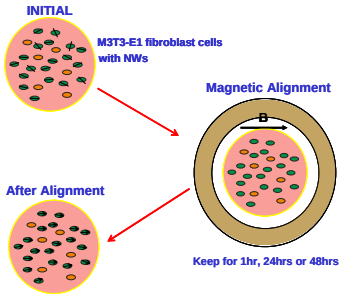

Fig. 3. Nanowires alignment experimental setup

RESULTS AND CONCLUSIONS

Cell viability with all the three kinds (Ni, Co/Cr and Co/Fe) of nanowires has been shown**.**

Cell separation purity and yield as high as 75% have been achieved by using Ni nanowires as shown in Figure 4.
Then, the axial of the magnetic nanowires internalised into cells can be aligned to the field direction with uniform magnetic field of 0.1 T as shown in Figure 5.

Future work is focused on surface coating and seeking better dispersion of the nanowires over the cell systems.

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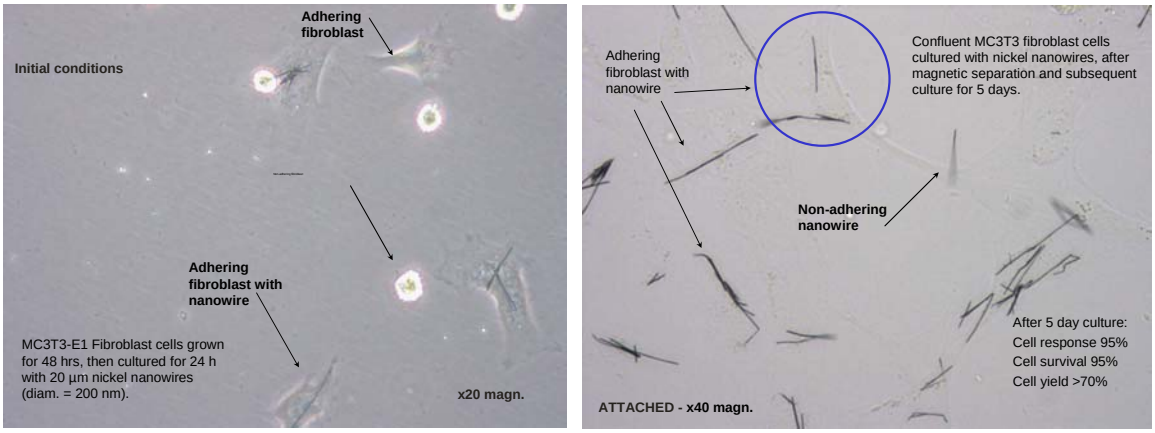
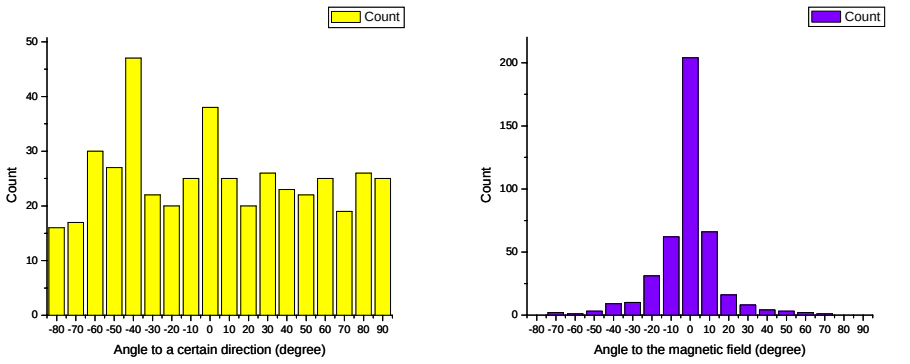


Fig. 4. Cell Separation: *(from left)* before and after magnetic exposure



After alignment (Data extracted out of 422 nanowires from 14 images

Before alignment (Data extracted out of 453 nanowires from 34 images

Fig. 5. Cell alignment: *(from left)* before and after magnetic field exposure