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NEWS AND OPINIONS

Researchers merge tissue with nanoelectronics

Cordelia Sealy

Researchers from Harvard University, Children's Hospital Boston, and Massachusetts Institute of Technology have created that stalwart of science fiction, 'cyborg' materials by merging functional nanoscale electronics with engineered biological tissue [B. Tian, et al., Nat. Mater. 11 (2012) 986].

The approach hinges on a macroporous, flexible, free-standing nanowire nanoelectronic scaffold — or nanoES developed by Charles M. Lieber of Harvard and Daniel S. Kohane of Children's Hospital Boston and their teams. It is produced by incorporating silicon nanowire-based electronic devices into macroporous, biocompatible 'mesh-like' polymer scaffolds.

The mesh-like networks are porous enough to allow the researchers to introduce heart and nerve cells, which penetrate the scaffold and grow into three-dimensional hybrid nanoelectronic-tissue structures. The viability and activity of the tissue grown in the scaffolds appears to be unaffected by the presence of the embedded nanoscale network (Fig. 1).

''The work... is quite revolutionary in that it demonstrates a seamless merging of electronics with cells/tissue in three-dimensions in a manner that literally begins to blur the distinction between electronics and living systems for the first time,'' says Lieber.

The idea itself is quite simple, he says, in that making the electronic component of the system in a form analogous to the extracellular matrix gets around the problem of how to seamlessly integrate electronics with biomaterials and tissue.

The engineered tissues embedded with nanowire electronics enable the detection and measurement of electric signals generated by the cells in response to cardio- or neuro-stimulating drugs. The researchers also constructed blood vessels where the embedded devices can detect pH changes, which may be indicative of inflammation or ischemia, for example.

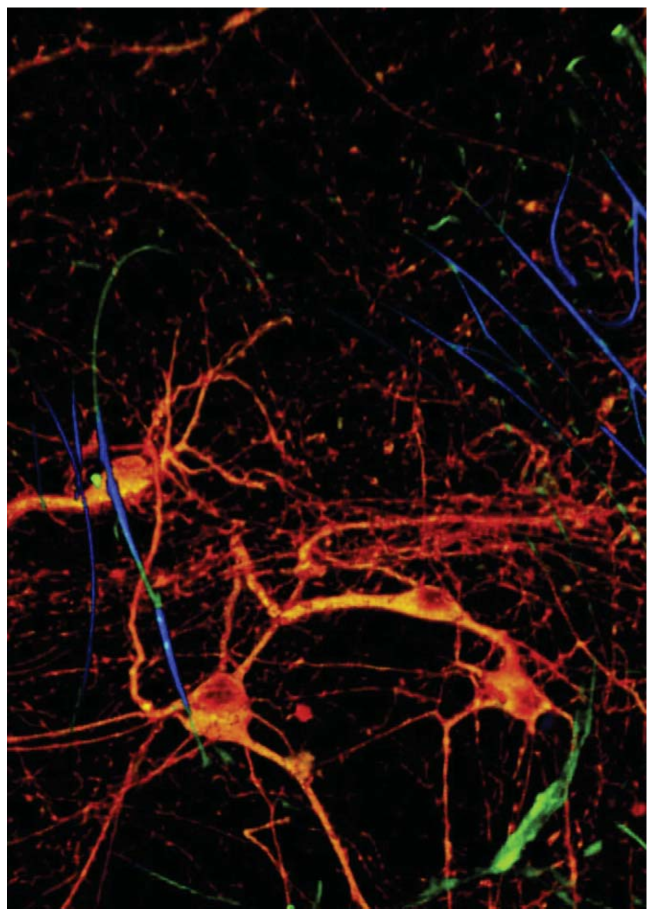

Figure 1 Confocal fluorescence micrograph of three-dimensional nanoES/neural tissue with neurons stained red, nanoelectronic network of same size as axons and dendrites stained blue/green.
Courtesy of Charles M. Lieber, Harvard University.

''We believe this work can be transformative in opening up a huge number of opportunities from basic research through what one previously might of thought of as science fiction in terms of 'cyborg tissue','' Lieber told Nano Today.

The researchers speculate that modifying the nanoES with growth determinants could tune cell interactions with the scaffold, while nanoscale stimulators could also be incorporated into the structure to provide electrical and mechanical stimulation of the cell culture.

''In short term, it can be used for the development of new three-dimensional tissue based platforms for real-time *in vitro* drug screening/testing,'' says Lieber. ''On a longer time scale... partial replacement of damaged tissues or organs [could be possible].''

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Map points to stable nanostructured metals

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Nanostructured metals promise outstanding strength but in practice have turned out to be brittle and unstable. The cause is the large number of grain boundaries, which lead to instability and, at higher temperatures, coarsening, where the subgrains merge with each other to increase in size.

Many approaches have been tried to stabilize nanocrystalline metals, primarily through alloying to introduce

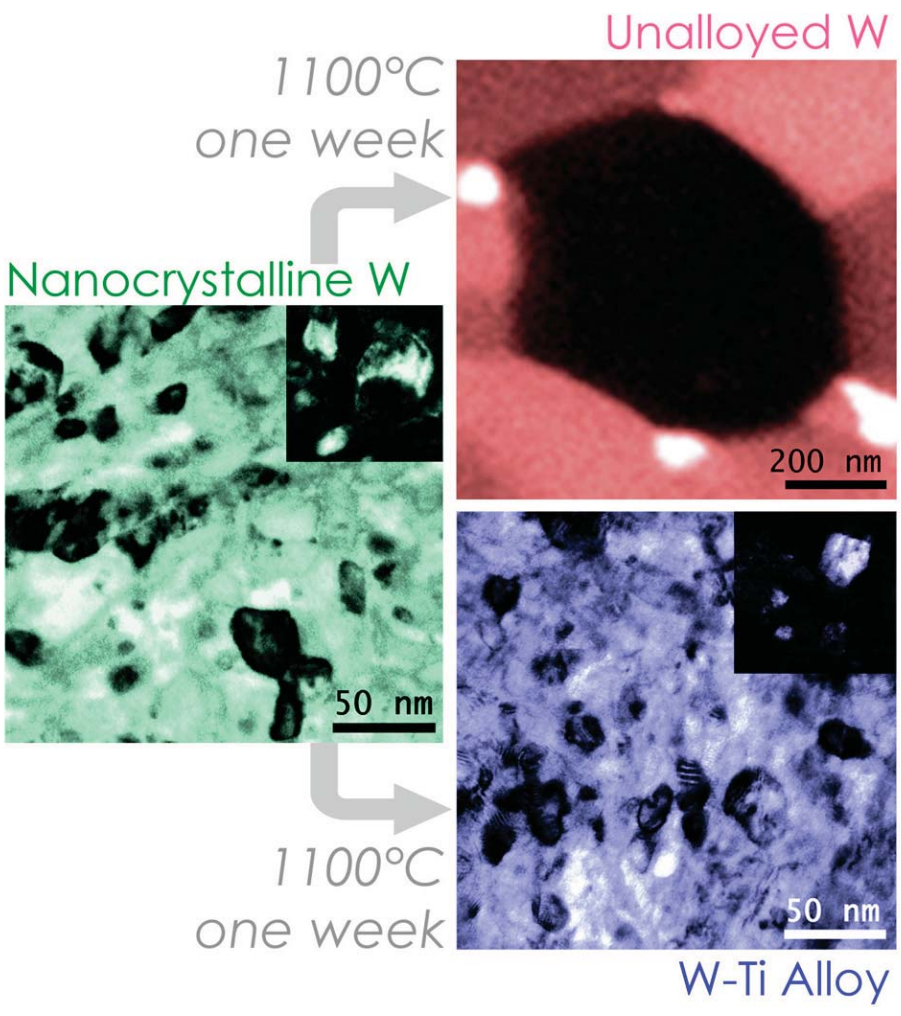

Figure 1 Stabilizing nanocrystalline metals via alloying: after one week at 1100 °C, nanocrystalline W loses its nanoscale grain structure and coarsens to the micrometer scale. By alloying with Ti, W can retain the nanocrystalline grain size under the same conditions.
Courtesy of Tongjai Chookajorn, Heather A. Murdoch, Christopher A. Schuh.