treatment of cancer."

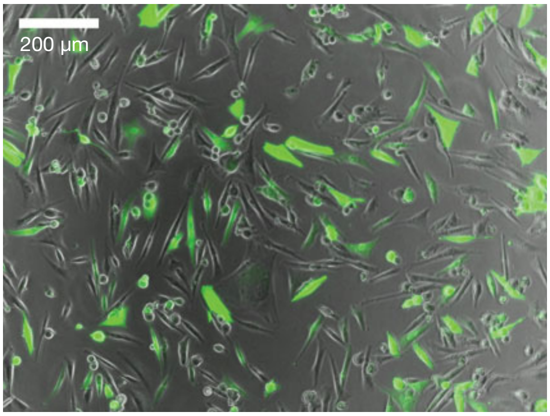
To develop the nanoparticles, Green's team prepared a library of cationic poly(b-amino esters) from commercially-available small molecules. They then mixed DNA that encodes a glowing protein with each different polymer to allow the DNA to bind to the polymers and form polymer-DNA nanoparticles. Each different sample was added to human brain tumor and glioblastoma cells. After 48 hours, the team examined and counted how many cells glowed. These cells had taken up the nanoparticles and synthesized the fluorescent protein encoded by the introduced DNA.

The team rated success by counting how many cells survived, and what percentage of those glowed.

Of the many combinations tested, the researchers found that one particular formulation of polymer nanoparticles were particularly successful in entering both glioblastoma and brain tumor stem cells. These nanoparticles were then freeze-dried and stored at different temperatures (freezer, refrigerator, and room temperature) for between one and three months. Their ability to be taken up by the cells was then re-tested. According to Green, after six months in storage, the effectiveness dropped by about half, but there was virtually no change in effectiveness after three months of storage at room temperature.

Furthermore, the team found that certain nanoparticles had a particular affinity for brain tumor cells over healthy brain cells.

"I could imagine particles based on this technology being used in conjunction with, and even instead of brain surgery," said A. Quiñones-Hinojos, an associate professor of neurosurgery and oncology at Johns Hopkins.



Brain cancer cells produce a green fluorescent protein. DNA encoded to produce the protein was delivered to the cancer cells by freeze-dried polymer-DNA nanoparticles. *Credit*: Stephany Tzeng.

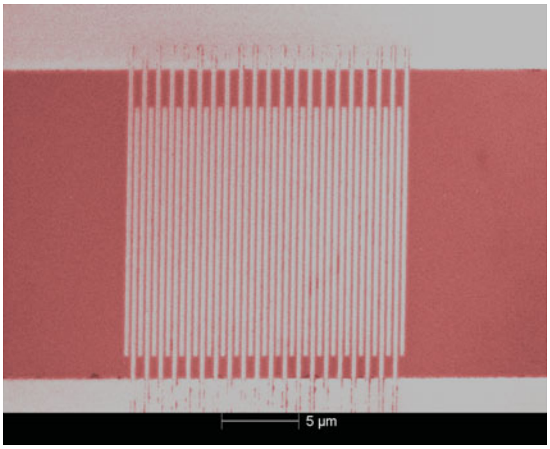
Nano Focus

Change in material boosts prospects of ultrafast single-photon detector

By swapping one superconducting material for another, B. Baek and colleagues at the National Institute of Standards and Technology (NIST) have boosted the efficiency of an ultrafast single-photon detector while also extending light sensitivity to longer wavelengths. The new tungsten-silicon alloy could make the ultrafast detectors more practical for use in quantum communications and computing systems and emerging applications such as remote sensing.

The detector, made of superconducting nanowires, is one of several sensor designs developed or used at NIST to register individual photons. The original, uncoated nanowire detector uses wires made of niobium nitride and has a detection or quantum efficiency of less than 10% when coupled to a fiber. As reported in the June 21 online edition of *Applied Physics Letters* (DOI:10.1063/1.3600793), the tungsten-silicon alloy version has an efficiency of 19–40% over a broad wavelength range of 1280–1650 nm, including bands used in telecommunications. The limitations are due mainly to imperfect photon absorption, suggesting that, with further design improvements, detector efficiency could approach 100% reliably, the researchers said.

Niobium nitride is difficult to make into nanowires that are narrow, long, and sensitive enough to work well. The researchers selected the tungsten-silicon alloy mainly because it has higher energy sensitivity, resulting in more reliable signals. A photon breaks more electron pairs in the tungsten-silicon alloy than in niobium nitride. The tungsten alloy also has a more uniform and less granular internal structure, making the nanowires more reliably sensitive throughout. As a result of the higher energy sensitivity, tungsten-silicon nanowires can have larger dimensions (150 nm wide versus 100 nm or less for niobium nitride), which enlarges the detectors' functional areas to more easily capture all photons.



Colorized micrograph of an ultrafast single-photon detector made of superconducting nanowires. Electron beam lithography is used to pattern the nanowires (colorized vertical lines) on a thin film of tungsten-silicon alloy, which produces more reliable signals than the niobium nitride material used previously. *Credit*: Baek/NIST.