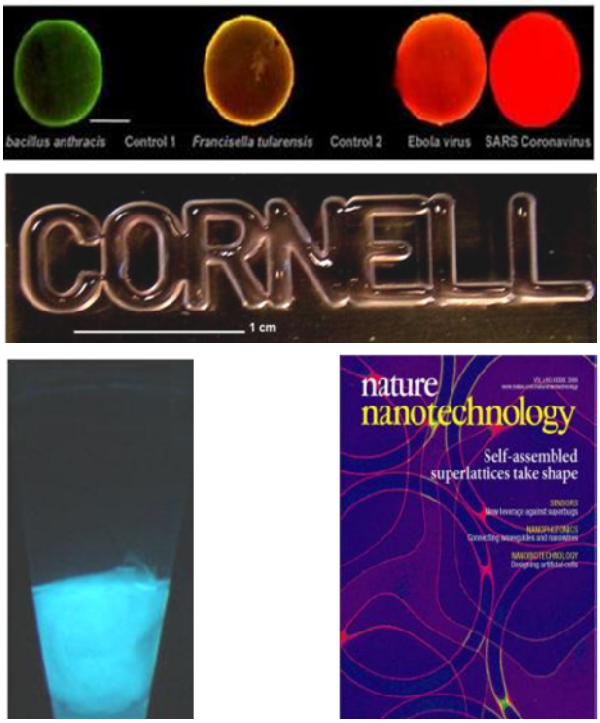
Engineering DNA as a Generic Nanomaterial

While DNA has long been recognized as a fundamental genetic material, its potential as a nanoscale, generic material building block has not been fully realized. Dr. Dan Luo and his group at Cornell University have engineered DNA with a myriad of DNA manipulating enzymes and created, at bulk scale, various DNA-based nanostructures including DNA-dendrimers (DNA-trees), DNA nanobarcodes, and a hydrogel that is made entirely of DNA. More recently, a DNA gel, termed P-gel, has been created. P-gel is capable of producing proteins without any living cells. In addition, DNA has also been used by Luo group to organize gold nanoparticles.

Built upon these DNA-based nanomaterials and nano-structures, Luo group has demonstrated real world applications in four areas: 1) The DNA dendrimers and DNA nanobarcodes have been employed to detect multiple pathogens (including anthrax, ebola, HIV, etc) simultaneously. In particular, the detection potential for agriculture and food systems has been demonstrated and the implementation of a field-use, portable detector is currently being developed; 2) The DNA hydrogel has been used to deliver therapeutic drugs along with live cells for the treatment of diabetes; 3) The P-gel has produced 16 different proteins with a 300 fold increase in yield as compared with the current cell-free method. P-gel is a platform technology that produces proteins outside of biological confinement and beyond physiological conditions. P-gel not only offers an alternative method of manufacturing difficult-to-produce proteins, but also provides real possibilities for creating extreme enzymes and novel artificial proteins; 4) Organized by DNA, patterned nanowires, free-standing nanosheets, and solid supra-crystals have been formed with the DNA-gold nanoparticle hybrid system.



Top: DNA nanobarcodes detected multiple pathogens (Anthrax, Rabbit Fever, Ebola, and SARS) simultaneously. **Middle**: A gel that is made entirely of DNA. **Bottom Left**: A firefly-like protein, Luciferase, was produced by P-gel without any living cells. **Bottom Right**: Gold nanoparticles were organized by DNA into various patterns.

Patents: 1 issued and 9 pending

Commercialization: A start-up company was founded to translate research from Luo group to real-world commercial products.

1. N. Park, et al. *Nature Protocols* Accepted (2009)
2. J.B. Lee, et al. *Nature Nanotechnology* (2009)
3. W. Cheng, et al. *Nature Materials* **8**, 519-525 (2009)
4. N. Park, et al. *Nature Materials (Article)* **8,** 432-437 (2009)
5. W. Cheng, et al. *Nature Nanotechnology, (Cover Article)* **3**, 682-690 (2008)
6. S. Um, et al. *Nature Protocols* **1,** 995-1000 (2006)
7. S. Um, et al. *Nature Materials* **5**, 797-801 (2006)
8. Y. Li, et al. *Nature Biotechnology* **23**, 885-889 (2005)
9. Y. Li, et al. *Nature Materials,* **3,** 38-42 (2004).

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