Nucleic Acid Engineering: Using DNA as a Nano-material

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Our research focuses on Nucleic Acid Engineering: engineering DNA at the nanoscale as a generic as well as a genetic material. By taking advantages of the amazing chemical, physical, and biological properties of DNA and by utilizing a myriad of DNA manipulating enzymes, we have employed DNA as a true polymer. Towards that end, we have created branched, networked, and dendritic DNA as nano-material building blocks; some of them were inspired by pioneering work of Seeman and his group. These DNA materials are water soluble, biocompatible, biodegradable, and can be made in bulk. Most importantly these DNA materials are monodisperse and anisotropic and have provided us with an enlarged tool box of designer hybrid materials for complex nano-architectures as well as novel functionalities. In essence we have created DNA-based "tinker-toys" for construction of new materials at a large scale. A few examples of nucleic acid engineered materials will be discussed in this talk; they include DNA-dendrimers, DNA nano-buckyballs, DNA-based nanobarcode systems, DNA hydrogels, DNA liposomes, DNA-Au nanoparticles, and a cell-free, protein producing DNA hydrogel. These examples not only illustrate the concept that DNA can be utilized as a generic, designer material but also demonstrate the power of nucleic acid engineered materials as a link between DNA and polymers, as well as between molecular biology and materials sciences and engineering in general. New properties and applications are expected from nucleic acid engineered materials. Commercialization plans will also be discussed.

Dr. Dan Luo's research interests focus on the cross-disciplinary field of molecular bioengineering. A primary goal of this work is to understand the chemical and cellular mechanisms, including uptake, transport and targeting, involved in macromolecule-based DNA/protein delivery. Another objective is to engineer efficient drug delivery systems for both research laboratories and clinical settings. This knowledge and these devices are key components of post-genomic research, where they will enable the "putting back" of DNA, potein and their complexes to reveal their functions in a cellular environment. In addition, they will contribute to the advancement of molecular medicine, including DNA vaccination, cancer treatment and gene therapy. Dr. Luo joined the Department of Biological and Environmental Engineering in 2001 after a postdoctoral appointment in Cornell's School of Chemical Engineering. He is currently a

member of the graduate faculty of the Field of Agriculture and Biological Engineering and the Field of Biomedical Engineering.