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U.S. Dept. of Agriculture, State Agricultural Experiment Stations and Other Institutions

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Biological & Agricultural Engineering
Agricultural Experiment Sta, Louisiana State Univ

9. Cooperating Departments within State Performing Institution

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Goals/Objectives/Expected Outputs

Objective 1: To provide an understanding of fundamental nanoscale phenomena and processes. LSU will contribute to this task by characterizing behavior of synthetic nucleic acid oligonucleotides as tools for gene regulation in cell and tissue systems. Additionally, researchers will explore the response of biological systems to nanomaterial and nanoscale influences to help better understand the factors which govern biological response. Applications include, nano-environmental impacts, tissue engineering, cell-based sensor design and nanoscale drug delivery. Objective 2. To develop and characterize nanomaterials. LSU will contribute to this task by synthesizing novel nucleic acid oligonucleotides with stable, targeted, and activatable functionalities for use in sensing and gene regulation. Novel biomass mediated synthesis pathways will be explored for the development of value-added, biocompatible, nanoscale polymer composites for use in medical materials, food packaging and consumer products. Nanoparticles of different physical characteristics and functionalities will be developed for delivery of bioactive components for food and non-food applications. Objective 3. To develop nanoscale devices and systems. LSU will contribute to this task by integrating the nanoformulated nucleic acid components into cell and tissue systems to control biological processes such as gene expression, and detection of unique DNA or RNA targets. Other projects include creating "nanonose"arrays composed of semiconducting and conducting nanowires. The objective is to fabricate prototype chemical detection systems for low cost, deployable air and water sampling. An alternative sensing method based on measuring perturbations in the optical or electronic properties of Ionic liquid nanoparticles is a potentially more manufacturable, lower cost alternative to nanowire formation and will be evaluated for distributed sensing applications. Objective 4. To provide an understanding of the economic, environmental, safety and health impacts of nanotechnology in agricultural, food and biological processing systems. Researchers at LSU are evaluating the potential for bioaccumulation, biopersistence and toxicity of nanomaterials in the environment. Current efforts are examining the bioaccumulation commercial silver nanomaterials in bivalves and crustaceans with future efforts directed toward bioaccumulation in multi-trophic layer food chain models. Objective 5. To develop educational and outreach programs on the use and impacts of nanotechnology in food, agricultural and biological systems. LSU will contribute to this task by developing nanomaterial based antimicrobial compounds for use as chemoprophylatic agents in seafood processing and for incorporation into active packaging solutions. To reduce the risk of seafood-borne illness associated with the consumption of raw or undercooked seafood. Another active packaging program will evaluate the potential of immuno labeled nanoparticles as packaging-based detection systems for food borne pathogens.

Methods

Experimental and modeling efforts will be carried out to determine fundamental parameters governing processes and phenomena associated with fabrication of nanomaterials and nanostructures. Experimental methods include solid phase and in-vitro synthesis of non-native oligonucleotides, their functionalization with fluorphore reporters, targeting ligands, and photoactivatable moieties that govern hybridization and interaction with proteins in cellular systems. Analytical chemistry, molecular biology, and cell culture assays will be used to characterize these nanoformulated materials. Polymeric nanoparticles will be synthesized by top-down techniques (i.e. emulsion evaporation, nanoprecipitation), surface functionalized, and characterized in terms of size, size distribution, morphology, surface charge, surface characteristics, and in-vitro and in-vivo functionality (antioxidant action, targeting, controlled release of the entrapped drug).

23. Non-Technical Summary

Nanoscale science, engineering and technology (nanotechnology) have great potential for application to the food and agricultural system. The novel physical, chemical, and biological properties of systems with structural features in the length scale for nanotechnology (1-100 nanometers) can allow the development of a new understanding of biological and physical phenomena in agricultural and food systems. In addition, nanotechnology allows scientists to measure, control, and manipulate matter at the nanoscale to change those properties and functions to the benefit of these systems. Polymeric nanoparticles developed at LSU can potentially be used as controlled delivery and release devices for bioactive components (i.e. vitamins and antioxidants) in biomedical, cosmetic, food, and pharmaceutical applications. Nanoparticles can be designed to deliver the antioxidant/vitamin to the specific site of action with minimal degradation of the bioactive component during delivery. The antioxidant/vitamin is then potentially released in a controlled manner by controlling the degradation profile of the polymer, or by using "smart" polymers which interact with the cell environment (temperature, pH, enzymes, ionic strength, and other) in a predictable way. The impact of the technology is vast. Bioactive food components have been associated with the prevention and/or treatment of chronic diseases such as cancer, coronary heart disease, diabetes, hypertension, and osteoporosis. Successful encapsulation and delivery of bioactive components (i.e. vitamin E) extracted from plant materials (i.e. rice bran) in polymeric nanoparticles can bring new revenues to the food, pharmaceutical, and cosmetics industries.

24. Keywords

DNA; RNA; nanoparticle; oligonucleotide; self-assembled monolayer photoactivated; BioMEMS; biosensor; gene delivery; molecular beacon; polymeric nanoparticles; emulsion evaporation; nanoprecipitation; surface functionalization; antioxidant action; targeting; controlled release; entrapped drug; biomass assisted synthesis; antimicrobial;

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Signature	Title	Date
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