Overview of Business Opportunity
The right entrepreneur and/or investor group could form a company to employ these nanoparticle designs for a wide range of industries such as herbicides, drug delivery, cosmetics, catalysis and bio-separation. UNM's nanoparticle design technology can control and provide precisely tailored composition, size, structure, morphology, and crystalline phase. The designs are easier, scalable aerosol methods that are operated at a lower temperature which means lower manufacturing costs.

Principle Investigators
Dr. Xingmao Jiang
Dr. Jiang is a Research Assistant Professor in Chemical and Nuclear Engineering at the University of New Mexico. He holds a B.S. and a M.S. in Chemical Engineering from Nanjing University of Technology in Nanjing, China. He also holds an M.S. in Chemical Engineering from the North Carolina State University along with a Ph.D. in Chemical Engineering from the University of New Mexico. Dr. Jiang is an outstanding, prolific inventor with extensive industrial experience and a strong background in chemical process research and development. He has received a prestigious award from the Chinese government for his inventions and their commercialization.

Dr. C. Jeffrey Brinker
Dr. Brinker received his B.S., M.S., and Ph.D. in Ceramic Science and Engineering at Rutgers University and joined Sandia National Laboratories in Albuquerque, New Mexico, in 1979 where he currently holds the position of Sandia Fellow (one of three scientists to hold this highest technical position). He also is a Regents’ Professor of Chemical and Nuclear Engineering with co-appointments in the Departments of Molecular Genetics and Microbiology and Chemistry at the University of New Mexico. Dr. Brinker has been recognized internationally for his work in sol-gel chemistry, which is the formation of ceramic materials from molecular precursors, specifically in the area of sol-gel processing and its extension to self-assembly of porous and composite nanostructures. He published Sol-Gel Science in 1990 (with co-author George Scherer), the most highly cited reference in this rapidly growing field. Dr. Brinker also has received two R&D 100 Awards from R&D Magazine in 1996 and 2007. Recently, Dr. Brinker has focused on new areas of nanomaterials science, specifically at the interface of living organisms and nanostructured materials with the goals of enhancing biocompatibility and developing new hierarchical nano/bio structures with new behaviors and functions.

Background
The UNM technology here is a package of intellectual property that provides different methods of producing nanoparticles. Nanoparticle design is important in several different industries that are now requiring improved methods. High cost, fast disintegration and/or easy degradation of the nanocapsule shells, and difficulty maintaining shape and stability of nanocapsule suspensions impede current fabrication techniques for industrial development. These novel methods described within are scalable, cheaper, and controllable in regards to size, shape, and structure. Size distribution is narrow for the engineered nanoparticles. Most importantly these methods are easier and less costly because they are manufactured at lower temperatures and use cheaper raw materials.
Technical Overview of Intellectual Property

Hollow Sphere Metal Oxides (STC Ref. 2007-028)
Issued Patent 7,744,673
This technology provides an easy, single-step, and template-free method for hollow spheres and encapsulation of drugs, beads, or quantum dots into hollow nanospheres by aerosol assisted interfacial diffusion control for medical applications such as controlled release of drugs. This method controls mass and heat transfer which allows for large-scale production at lower cost and is a “green” method because it does not involve calcination or removal. Additionally, the size and thickness of the nanomaterial (nanospheres in this case) can be controlled. This is a facile fabrication method for drug encapsulation and a general method for a broad range of possible applications.

Method for Nano Silver-Silica Composite Anti-Microbial Agent (STC Ref. 2008-040)
Issued Patent 8,246,933
The present invention relates generally to aerosols and, more particularly, to a method for forming nanosilver-silica composite having an anti-microbial agent. The method employs aerosol assisted evaporation induced self-assembly (EISA) for the synthesis of nano-structured silver-silica particles. The silver nanoparticles that are created by this process can be released in a controlled manner from a nontoxic silica matrix for long term disinfection. The dry powder can be dispersed in water, plastics, or other medium and can be lipophilic by chemical modification of the particle surface. This aerosol method is promising, providing a continuous low-cost method for large-scale production of advanced materials. The particle size, size monodispersity, evaporation rate can be well controlled. The process is quick, flexible, cheap, simple, easy to scale up, and causes less pollution.

Freezing Assisted Fabrication of Nano Hollow Cubic Metal Oxides (STC Ref. 2008-096)
Issued Patent 8,501,057
This invention has overcome current limitations by developing a novel method of fabricating nano hollow cubic metal oxides using a freezing technique. This template-free method employs freezing induced assembly to control the monodispersity and the morphology. Highly monodisperse robust hollow metal oxide nano cubes are created by controlling liquid-solid phase equilibrium, sol gel reactions, and interfacial mass transport, allowing for the fabrication of highly monodisperse cubic nano metal oxides of uniform shell thickness. Applications include drug delivery, sensors, microelectronics, wave scattering, wave absorption, lightweight composites, disinfection, and catalysis.

A Novel Aerosol Method for Monodisperse Nanocrystallites (STC Ref. 2010-015)
Pending Patent Application
Currently there is a high demand for a new low-cost method for manufacturing these nanocrystallites. An innovative aerosol process has been developed that overcome the barrier of current methods. Through wet chemistry and subsequent unique aerosol processing various nanostructures containing well-dispersed metal, metal alloys, or metal oxide spherical nanoparticles of uniform size can be fabricated. The nanostructures undergo special thermal treatment and monodisperse unaggregated nanocrystallites with controlled phase, size, and composition can be fabricated. For example, monodisperse quartz nanocrystallites with controlled size have been made. Monodisperse magnetic nanoparticles can be converted to desired phase without any aggregation.
**Funding**
The Brinker and Jiang labs have a large portfolio of funding from the Air Force Office of Scientific Research, National Science Foundation, and the National Institutes for Health.

**Market Overview of Possible Business Opportunities**
Their most recent research has significant implications in a diverse range of technologies like herbicides, drug delivery, cosmetics, catalysis, chromatography and custom designed pigments.

**Drug Delivery**
According to Reportlinker, healthcare nanotechnology has greatly impacted the drug delivery and diagnostic fields and is promising in providing treatment for cancer. The healthcare nanotechnology market growth is largest in North America, at $4.75 billion in 2009, followed by Europe at $3.65 billion and is expected to grow at a compound annual growth rate (CAGR) of 21.7% from 2009 to 2014, to reach almost $16 billion by 2014. Controlled release of heat-sensitive drugs such as enzymes, vaccines, peptides, genes, and oligonucleotides from nanocapsules is of importance for treatment of cancers and infections due to the improved therapeutic index. However, fast disintegration and/or easy degradation of the nanocapsule shells, and difficulty maintaining stability of nanocapsule suspensions impede medical applications and industrial development. There is an urgent need to develop a general, low-temperature, low-cost, template-free, nondestructive fabrication method for metal oxide nanostructures. The UNM technology can deliver this need. Nanopharmaceutical is new market of nanotechnology applications in drug delivery. This UNM technology could be used to create a clinical-stage company specializing in the design drug-containing nanoparticles that improve the therapeutic index of drugs.

**Herbicides**
According to Hoovers, the US agricultural chemicals manufacturing industry includes about 700 companies with combined annual revenue of $30 billion. US nondurable goods manufacturers' shipments of pesticides, fertilizers, and other agricultural chemicals, an indicator of agricultural chemicals production, skyrocketed 41.1 percent in the first eight months of 2010 compared to the same period in 2009. The same principles in using nanoparticles for drug delivery can be applied for use in the delivery of agrochemicals to plants. According to research, nanoparticles tagged or carrying agrochemicals or other substances could reduce the damage to other plant tissues and the amount of chemicals released into the environment. The key benefits to agrochemical formulations include, but are not limited to: an enlarged surface area of the chemical to boost product potency; accelerated chemical uptake by the plant; faster absorption to avoid biodegradation from UV light; better spray application through smaller nozzles; and less risk of dispersant settling for increased consistency and less waste.

**Cosmetics and Personal Care Products**
According to RNCOS, nanoparticles are increasingly being used in cosmetics including sun care and anti-aging products to enhance cosmetics products quality and efficiency. First Research, Inc. states that the US personal care products industry has annual revenue of $50 billion. According to an independent analysis, there are several established companies and brands in the cosmetic industry that are known to currently use nanomaterials in their products including Revlon, Clarins, L'Oreal, Yves Saint, Laurent, Clinique, Lancome, Max Factor, Christian Dior. As in other delivery applications, items such as vitamins or oils could be encapsulated in nanoparticles that are then put into foundations, lotions or other skincare products. UNM’s technology would allow for these nanoparticles to be evenly distributed in the product through an easier and cheaper nanoparticle design.

**Other Applications**
Other possible applications include smart delivery systems of many applications, imaging, biodetection, chemical and biological sensing and labeling, optoelectronics, catalysis, wave scattering, lasing, photonics, and for the pain and lacquer industry.

For more information or for licensing opportunities, please contact Erin Beaumont, Innovation Manager, STC.UNM at (505)272-7912 or at ebeaumont@stc.unm.edu.