Advance Capacitance Materials / Dielectric Materials

A.) Titanate Powders

B.) Slurries & NanoSperse Dispersant

C.) Dielectric Composites

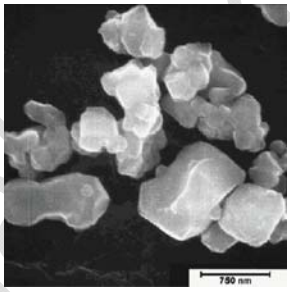
D.) Proton Accelerator

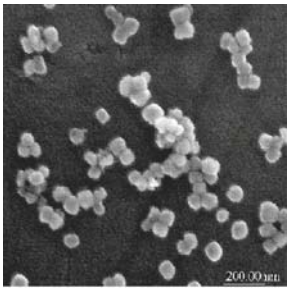
E.) High Energy Density (HED) Capacitors

A. Titanate Ceramic Nano Powders - Barium, Strontium, Barium Strontium and NOW Custom Formulations

TPL offers a range of titanate powders with controlled size and chemistry. The nano-size ceramic powders are produced via an aqueous, low temperature process that allows for binary and tertiary oxide compositions with controlled stoichiometries. (Standard compositions include barium and strontium titanate.) The ultra-fine particle size, 50 to 400 nano meters (nm) of these ceramic powders make them ideal for ultra-thin dielectric layers in composites and ceramic capacitors. TPL has the ability to provide ceramic nano-powder formulations to customer specifications.

TPL offers a range of titanate powders with controlled size and chemistry. NanOxide™ powders are produced via an aqueous, low temperature process that allows for binary and tertiary oxide compositions with controlled stoichiometries. The crystalline ceramic powders have uniform spherical morphology and high dielectric constant with sintering temperatures as low as 1000° C. Various dopants can be used with binary compositions to modify properties for a wide range of ferroelectric applications. The ultra-fine particle size makes the powders ideal for thin ceramic capacitor layers and embedded polymer/ ceramic laminates.





No.	Description
1.	Barium Titanate (<100nm, 200nm, 400nm, 800nm)
2.	Strontium Titanate (<100nm, 200nm, 400nm, 800nm)
3.	Barium Strontium Titanate (<100nm, 200nm, 400nm, 800nm)
4.	***Custom Formulation*** Particle size, Purity, Formulation and Dopants prepared to Customer Specifications in lot sizes of 5-20kg

TPL's titanate powders offer high purity, nanometer size and are designed to meet demanding electronics applications. Our titanate powders have been successfully used in multilayer ceramic capacitors (MLCC), monolithic ceramic capacitors, ceramic tapes, polymer composites, polymer-ceramic composites, electrode pastes and piezoelectric devices. TPL's Barium Strontium titanate thin films and composites are finding application into a wide range of broadband RF and microwave devices such as tunable filters, phase shift devices, electromagnetic absorbers and antennas.

TPL's titanate powders are readily dispersible in aqueous and non-aqueous solvents with their formulated dispersing agent, NanoSperse 484, specifically designed to enhance dispersion of NanOxide ceramic powders in both aqueous and organic solvents.

TPL, Inc. has considerable experience with slurry production, tape cast compositions, composite formulations, dry pressing and firing operations and can assist in determining a process for your application.

NanOxide™ - High Purity Barium Titanate (HPB) & Strontium Titanate (HPS)

Key Features of Barium and Strontium Titanate Ceramic Powders

Powders are available with nominal particle sizes of <100 nm, 200 nm and 400 nm. The crystalline ceramic powders have uniform spherical morphology and high dielectric constant, with sintering temperatures as low as 1000° C. Precise stoiciometry and high chemic purity are also key features. Various dopants can be used in binary compositions to tailor properties for a variety of applications.

Applications for Barium and Strontium Titanate Ceramic Powders

Multi-layer ceramic capacitors, Microelectronic discrete capacitors, Capacitance laminates for printed wiring board, Embedded capacitance materials, Insulator rings for high power surge arrestors, Specialty ceramic products.

Barium Titanate powders are crystallographically cubic, phase pure barium titanate. It is suitable for use in formulating X7R compositions for air fire and reducing atmospheres. In addition, base metal electrode compositions may also be developed. TPL, Inc. has worked with numerous companies to develop and manufacture compositions tailored to their processes. The formulations developed for those customers are proprietary; therefore, TPL, Inc. cannot sell these formulations to outside users. TPL is happy to work with all customers who can provide a desired composition. We are capable of doping barium titanate both homogeneously and heterogeneously to yield either, or both, solid solutions or core/shell compositions.

Key Features of High Purity Barium/Strontium Titanate

Solid solution compositions are fully adjustable to any ratio, from 1% to 99% strontium. Similarly, the primary particle size can be adjusted for the application, typically in the range of 50 nm to 500 nm. As such, barium/ strontium titanate formulations are considered a specialty product and are manufactured upon request. The dielectric constant on the barium/strontium titanate is typically between 10,000 and 15,000.

Custom Formulations of Barium Strontium Titanate Ceramic Powders

TPL is dedicated to customer satisfaction and values the necessity of custom formulations in a variety of manufacturing products. TPL's unique manufacturing process allows tremendous flexibility in the production of ceramic titanates. As with the HSB, mixed metal titanate formulations can be produced with a wide range of compositions. In addition the particle size of the powder can be varied from 50 nm to 1,000 nm.

TPL's versatile manufacturing also means that a wide variety of dopants can be added to any ceramic titanate over a range of concentrations. Dopants can be added homogeneously and heterogeneously to our ceramic titanates. Homogeneous additions yield solid solutions while heterogeneous additions are designed to yield core/shell structures to MLCC applications. TPL encourages requests for chemical formulations that will meet customer specifications.

When introducing NanOxide™ ceramic powders into your process, please keep the following points in mind:

•The manufacturing process for barium titanate includes a drying step which induces soft agglomeration (roughly 75 micron size particles). These agglomerates are easily broken up by ultrasonication or ball milling.
•Some harder agglomerates will also exist in the powder comprising several to tens of particles. Because of the extremely fine particle size, these agglomerates require more energy than is traditionally required for larger, micron sized particles. In other words, when switching from micron sized powder to nano-sized powder it may be necessary to lengthen milling time.
•Because of the extremely high surface area, higher surfactant concentrations are typically necessary to disperse nano-sized barium titanate relative to micron sized powder.

B. Slurries & NanoSperse Dispersant

TPL has considerable experience with dispersing nano-size particles in a variety of mediums. All NanOxide™ powders are available in aqueous and non-aqueous slurry form as a specialty product. TPL will work with customers to determine an appropriate solvent for the application. In addition, our NanoSperse™ has also been made available for purchase separately as a dispersant.

C. Dielectric Composites

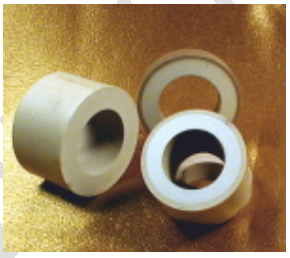
Nano Composite Dielectrics

TPL's composite dielectric material represents a significant breakthrough in dielectric materials for high energy density capacitors. Efforts in this area have transitioned from materials development, supported by basic R & D contracts, to device fabrication for a number of pulsed power and directed energy applications.

TPL has developed composite materials possessing a high dielectric constant (k>50) and forming capabilities of a polymer. The nano-composite dielectric can be molded into engineering substrates or cast into complex electrode structures for producing high voltage capacitive components. TPL has established processes for fabricating substrate dielectric and capacitors in a number of configurations including strip lines, rods, sheets and blocks.

Ceramic Components

TPL designs and produces specialty ceramic components using formulated titanate powder. Specialty parts, primarily for high voltage and high frequency applications, are produced to meet custom dimensions and electrical properties. TPL's processes accommodate a range of capacitor and substrate geometries. In addition, powder formulations are tailored to achieve specific performance characteristics including dielectric constant, dielectric loss and insulation resistance.



D. Proton Accelerator

NIH Awards TPL, Inc. an SBIR Phase II for Proton Therapy Development for Cancer Treatment

Radiation therapy is one of the primary weapons in the battle against cancer, but even with the advances that have made, there remains significant room for improvement in radiation-based treatment technologies. Proton therapy is considered the most advanced form of radiation therapy available for cancer treatment, but the size and cost of currently available proton-therapy devices have severely limited the technology's use and availability. The high-voltage machines required to generate proton beams are massive—weighing several hundred tons and requiring 90,000 square feet to house.

They also cost $100M or more to build. A substantial reduction in the size and cost is required for proton therapy machines to be rendered practical for use in typical cancer-treatment centers. Ideally, a proton-therapy machine would be miniaturized to the point that it would fit into a standard linac radiation vault and could replace existing X-ray machines.

TPL Inc., and collaborators have defined a technical approach that we believe will allow development of the first low-cost, compact proton-therapy machine. As envisioned, the new device will be an order of magnitude smaller and one-fifth the cost of the machines being used today. The key to developing this next-generation proton-therapy device is an extremely compact accelerator design based on a novel, high-voltage insulating material (dielectric) developed by TPL. This enabling material, developed initially for defense-related pulse-power applications, is a composite structure comprised of a formulated polymer resin and nano-size ceramic particles.

In Phase I of this multi-phase SBIR project, an engineering feasibility effort was proposed based on the use of TPL's established composite dielectric technology. The project focused on demonstrating the feasibility of developing the components that will serve as the building blocks for the new, miniaturized system and on demonstrating target performance capabilities from those components.

Proof of feasibility in Phase I set the stage for prototype development and demonstration/validation by TPL and its collaborators for a Phase II SBIR project. The validation work supported by Phase II will allow us to prove the value of TPL's proprietary enabling component for this technology and will position TPL and it's collaborators to partner with an industry leader to complete the development, approval, and manufacturing tasks required for "Phase III" commercialization of this exciting new technology. We anticipate that success in attaining our goals of substantially reducing cost and size of proton-therapy units will open up a very significant new marketplace in the U.S. and abroad for this type of cancer-treatment device.

E. High Energy Density (HED) Capacitors

High Energy Density (HED) Film Capacitors

TPL has established specialty fabrication capabilities for production of high voltage capacitors with significantly reduced size and weight. TPL's metallized film capacitors have demonstrated energy densities of over twice that of current state-of-the-art capacitors. TPL's new capacitors are considered an enabling technology for a number of military and select commercial pulsed power systems.

Polymer High Energy Density (HED) Film Capacitors

TPL's unique capabilities are based on a molecularly designed dielectric polymer. The innovative design and process, involves continuous coating of TPL's polymer onto high density paper and custom metallizing to specification. Conventional winding and compact packaging of TPL's film allows for energy densities of 2.5 J/cc

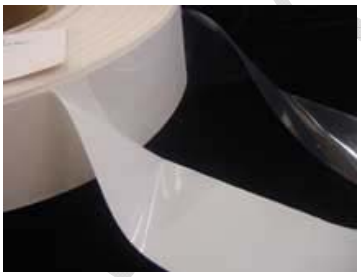
Composite High Energy Density (HED) Film Capacitors

High Temperature Applications

TPL has developed processes for fabricating unique capacitors that possess both high operating temperature and high specific capacitance. The dielectric is a nanocomposite material system comprised of TPL's nanosize titanate particles and a thermally stable polymer. This innovative capacitors are projected to be thermally stable at 300°C and have volumetric efficiency over twice that of conventional high-temperature devices, 3.0µF/cc.

High Voltage Applications

Composite dielectric films are being developed using a combination of TPL's molecularly designed dielectric polymer and TPL's nanosize titanate particles. The unique approach is based on a composite material that offers a combination of high dielectric constant and high dielectric strength. TPL's nanosize, titanate powders are uniformly dispersed and aligned (structured) in a thermal setting polymer film matrix. TPL projects capacitor capabilities with an energy density greater than 5.0 J/cc.



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