cerion nanomaterials

Custom Design & Manufacturing

Nanomaterials for **Defense Applications**

Providing custom-designed nanomaterials that enable products to provide **over-matched capability** to the warfighter.

At Cerion Nanomaterials, we don't develop end-use products or systems – only the nanomaterials that enable them. In this role, our customers stay focused on their product development, while Cerion focuses on providing customers with the exact nanomaterial composition they need, at the manufacturing scale and price point they require. In this role, we support our customers from cradle to grave – from applied research through pilot manufacturing and high-rate production.

Key to our strategic competitive advantage is a relentless focus on the three factors that enable nanomaterials to be designed in the lab and successfully transitioned to the warfighter:

DESIGN

High degree of precision control over nanoparticle size and technical attributes to maximize nanomaterial performance

SCALE-UP

Proven ability to scale-up nanoparticles 1,000 to 10,000X their lab-scale counterparts while preserving critical design parameters

MANUFACTURING

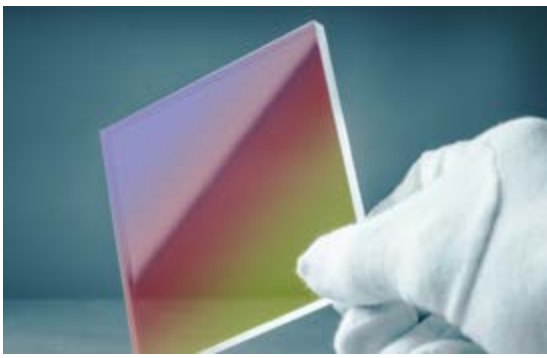
Infrastructure designed to ensure companies can acquire cost-effective nanoparticles at pilot and industrial scale volumes

SUPPORTED INDUSTRIES

Cerion Nanomaterials supports companies across 40+ broad industries and countless products in the industrial, life science and defense sectors.

The majority of our customers are mid-cap and large-cap global leaders of their respective industries – leveraging nanomaterials to improve the mechanical, chemical, electrical, thermal, optical and magnetic properties of their products or subcomponents in their systems. We've successfully supported customers across a broad class of application focuses, including but not limited to:

- Automotive
- Aerospace
- Batteries
- Catalysts
- Coatings
- Computing
- Displays
- Drugs
- Electronics
- Electrical Systems
- Medical Devices
- Optics
- Personal Care
- Security
- Sensing
- And more…



A FOCUS ON NANOMATERIALS FOR DEFENSE

Cerion Nanomaterials supports multiple programs across the military, for applications as diverse as penetrators, armor, electronics, electrical systems and energy generation.

> Design and industrial scale manufacturing of unique, novel & custom nanomaterials for a diverse set of offensive, defensive and support-related applications

Cerion routinely supports the defense community by:

- Supplying new novel nanomaterials to product developers during applied research, and supporting pilot and high-rate production as required for prototyping, qualification and manufacturing.

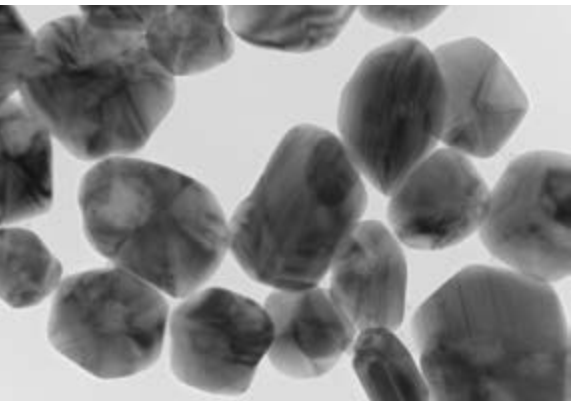
- Replicating novel nanomaterials created by our customers in their lab using synthetic pathways and processes that are better suited to meet scale-up and high-rate production targets.

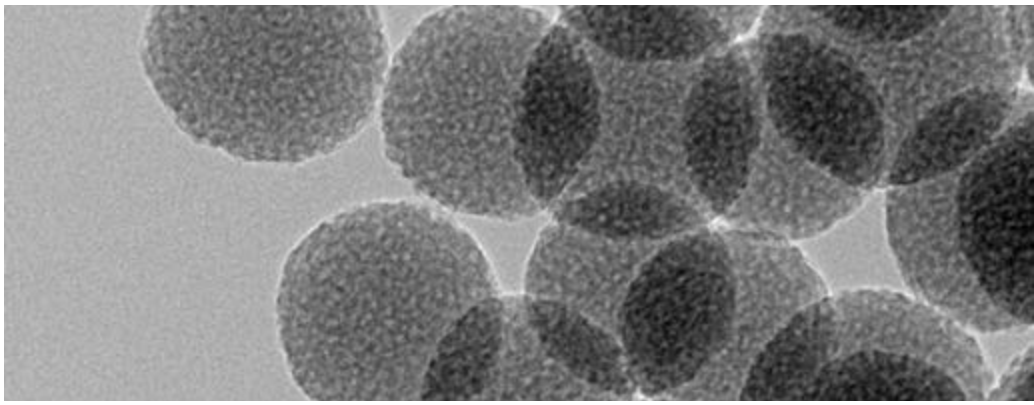
Providing inorganic nanomaterials spanning metals, metal oxides & ceramics

NANOMATERIAL TYPES

We specialize in a broad class of inorganic nanomaterials spanning metal, metal oxide and ceramic nanoparticles – with a wide degree of precision control over the design of the nanoparticle's size and technical attributes. This specialization is further extended to include unique compositions such as alloys, core/shells and doped nanoparticles.

- Barium titanate ($BaTiO_3$)
- Boron carbide (B_4C)
- Cerium dioxide (CeO_2, ceria, cerium(IV) oxide, ceric oxide, ceric dioxide, cerium oxide or cerium dioxide)
- Cobalt oxide (Co_3O_4, cobalt(II,III) oxide)
- Copper (Cu)
- Gold (Au)
- Iron oxide (Fe_3O_4, iron(II,III) oxide, magnetite, Fe_2O_3, iron(III) oxide-hydroxide, FeOOH, iron oxyhydroxide)
- Palladium (Pd)
- Silica (silicon dioxide, SiO_2)
- Silver (Ag)
- Silver chloride (AgCl)
- Titanium dioxide (titanium(IV) oxide or titania, TiO_2, anatase)
- Tungsten carbide (WC)
- Zinc oxide (ZnO)
- Zirconium dioxide (zirconia ZrO_2)
- And more…





PRECISION NANOMATERIAL DESIGN

An often-overlooked aspect of working with nanomaterials is that 'one size does not fit all.' Off-the-shelf materials are rarely a ready-made solution to achieve specific applied research goals. The design of a nanomaterial can radically alter its behavior, and small changes can have an outsized influence on its performance.

> Unparalleled control over nanomaterial size and technical features & attributes – in the lab and at industrial scale manufacturing

Cerion Nanomaterials is widely known for the degree of customization and flexibility in its technology and manufacturing process. We take atoms and individual molecules, attaching them together through precisely controlled chemical reactions, a process that enables us to build each nanoparticle from the ground-up. This has enabled us to produce some of the smallest (down to 2 nm), monodispersed and un-agglomerated nanoparticles in the industry.

PRODUCT FORMATS

Cerion has also invested to create a wide variety of product formats. These formats are crucial for the diverse set of requirements our customers have for integration of nanomaterials into their product or system. These include:

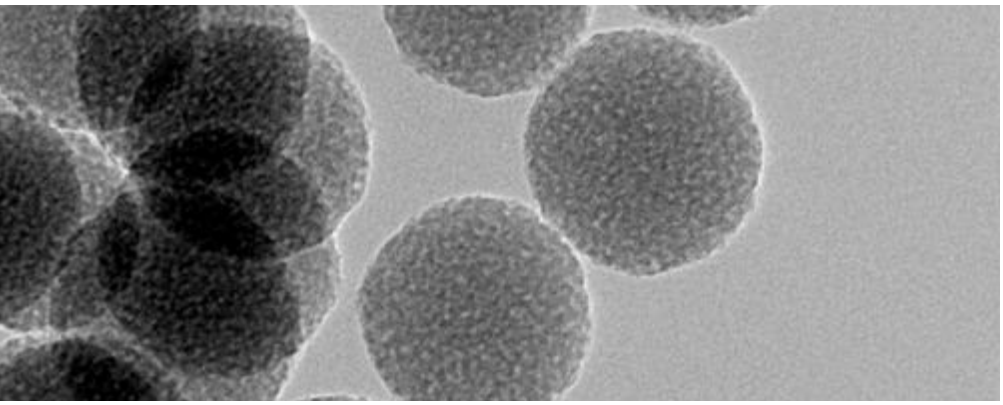
- Aqueous dispersions
- Organic dispersions
- Powders
- Pastes
- Re-dispersible "wet cakes"

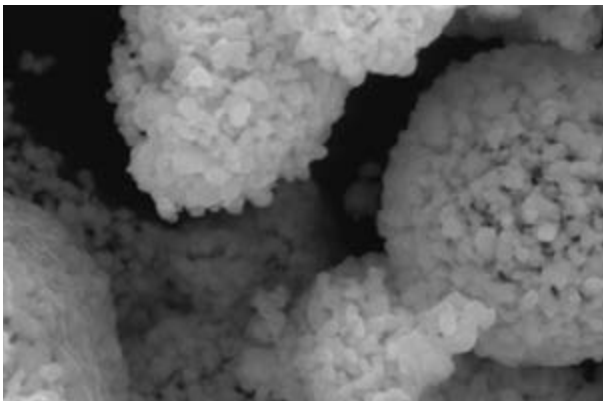
Size Related Design Parameters

- Particle Size
- Tight Particle Size Distributions
- Monodispersity
- No / Low Agglomeration

Technical Design Parameters

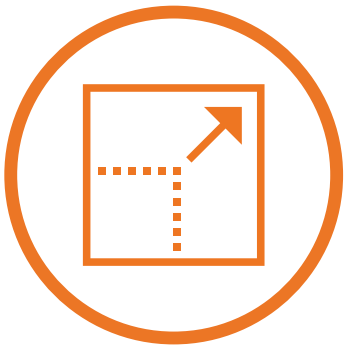
- Particle morphology
- Particle surface charge
- Homogeneous alloyed particles of two or more elements with the ability to tightly control ratios of each element
- Doping one or more elements with the ability to tightly control dopant levels
- Core/shell particle compositions
- Surface functionalization of the particle for stability and integration into a customer product or system
- Surface functionalization to attach various constituents to the surface of the particle (e.g., small molecule therapeutic compounds)
- Wide pH range for aqueous suspensions
- Use of a variety of solvents for organic dispersions
- Use of a variety of organic and polymer capping agents for particle stability and integration into customer systems
- Inclusion of one or more promoters in aqueous and organic dispersions
- Particle and dispersion purity





› Routine scale-up of nanomaterials 1,000 to 10,000 times from what is created in the lab

ROBUST AND REPEATABLE SCALE-UP PROCESSES



Unlike most nanomaterial firms, Cerion Nanomaterials has a dedicated development team whose sole focus is transitioning nanomaterials from the lab to the manufacturing environment, which is widely regarded as the most significant barrier of entry for groups working with nanomaterials. Cerion has repeatedly demonstrated successful manufacturing scale-up by routinely transitioning nanomaterials for its customers from the lab up to production batches 1,000 to 10,000 times larger.

While the process Cerion has developed for scale-up and engineering is a closely guarded trade secret, we employ a "Design for Manufacturing" (DFM) program to ensure researchers are operating within the parameters of the company's platform manufacturing systems, and to identify and study new processes that may be required for feasibility in a manufacturing environment.

After a nanomaterial has been created and optimized in our research labs, it is moved to the development lab. During this stage formulas are replicated at lab scale and stress-tested for chemical and process sensitivities. Throughout this process we work to improve the economics of a nanomaterial and are focused on a.) testing and accrediting raw material vendors, b.) modifying or re-designing formulas and manufacturing processes for robustness and yields and c.) decreasing takt time and d.) minimizing required energy inputs.

Upon completion, scale-up is moved into our pilot manufacturing plant, which operates at 10 times (10X) our development lab's scale – and upon accreditation – the nanomaterial is moved to high-rate production.

› Proprietary "Design for Manufacturing" process ensuring what's made in the lab will transition to manufacturing tomorrow

› 150 metric ton manufacturing capacity and growing

INDUSTRIAL SCALE MANUFACTURING

Cerion Nanomaterials' manufacturing plant is a full-scale, fully operational industrial facility based at Eastman Business Park in Rochester, NY. Using Six Sigma and Lean Manufacturing principles this operation has been designed to be efficient and nimble, with the ability to quickly change over between manufacturing runs while requiring minimal energy inputs. Our facility provides for both pilot and industrial rate manufacturing. Supplementing these manufacturing systems are specialty on-line and off-line systems engineered by Cerion to add process capabilities unique to our industry and our customer's needs.

The design of the plant is focused exclusively on leveraging industrial equipment and components readily available on the commercial market. As a result, Cerion boasts the lowest capital intensity per metric ton of production capacity on the market when compared to its competitors, and can rapidly build new manufacturing lines as necessitated by customer demand. The facility infrastructure is also fitted for future growth, with industrial scale utilities in place for electricity, municipal water, chilled water, high purity water, high and low-pressure steam, process gas and industrial chemical sewage.

Over the years we have progressively expanded our manufacturing capacity from its original 5 metric tons per annum, to over 150 metric tons (dry weight) per annum. Due to our customer pipeline and demand from the market, Cerion is currently in the planning process to increase its manufacturing capacity to at least 450 metric tons per annum, with expectations to exceed 750 metric tons over a 5 to 10-year horizon.

- Lowest cost per metric ton of manufacturing capacity in the United States
- Six Sigma, Lean Manufacturing and just-in-time operation

› Customer needs first, synthetic approach second

SYNTHETIC PATHWAYS

In synthetic chemistry, there are multiple pathways that can be used to create a material, and nanomaterials are no exception. Each route has unique advantages and disadvantages that must be evaluated against the design criteria for the nanomaterial, technical outcomes desired and cost of employing that method.

Nanomaterial manufacturers will often have invested in capability for a single synthetic method and attempt to fit this approach to every customer's needs. This does not give the customer, or the material being produced, the advantage. Instead, Cerion is focused on providing customers with access to the synthetic pathway that will yield the best technical and cost performance for their product or system. Our synthetic pathways include bottom-up approaches such as precipitation and high temperature processes, as well as unique top-down approaches such as high-energy milling.

Our **bottom-up** approaches include:

- Precipitation
- High-temperature processes

Our **top-down** approaches include:

- High-energy milling

ABOUT CERION NANOMATERIALS

Founded in 2007, Cerion Nanomaterials is a United States based leader in the science of designing, scaling and manufacturing metal, metal oxide and ceramic nanomaterials for companies developing products or systems.

The cost of developing in-house advanced expertise in nanomaterials is prohibitively expensive and time intensive, resulting in a significant barrier to entry for companies considering its adoption. Cerion provides companies with access to this expertise through all phases of their product lifecycle including applied research, development, scale-up, commercialization and manufacturing. This allows companies to remain focused on what they do best – advancing the development and delivery of their product, while Cerion stays focused on providing the custom designed nanomaterials necessary to create new product performance.

Cerion's position in the market is enabled by three strategic competitive advantages: deep and demonstrated capability in a.) precision design and customization of both nanoparticle size and technical attributes, b.) robust processes to scale materials from prototype to low and high-volume production rates, and c.) industry-leading, cost-effective manufacturing systems and production capacities.

FOR MORE INFORMATION

To learn more about Cerion Nanomaterials and it's capabilities, visit www.cerionnano.com or use the QR codes right now:

Get More Information!
Select from a variety of Cerion FAQs, articles and information and have them emailed directly to you.

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