



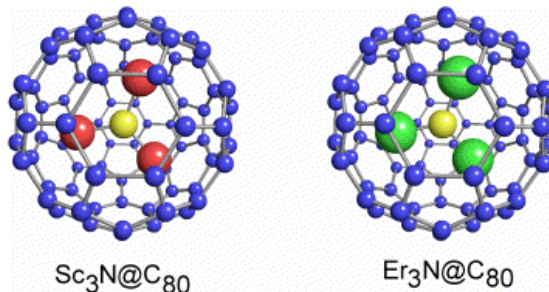
# Nanomaterials

Luna is an industry leader in nanotechnology focusing on materials manufacturing and products from carbon-based nanomaterials, Trimetaspheres™ and Single Wall Carbon Nanotubes.

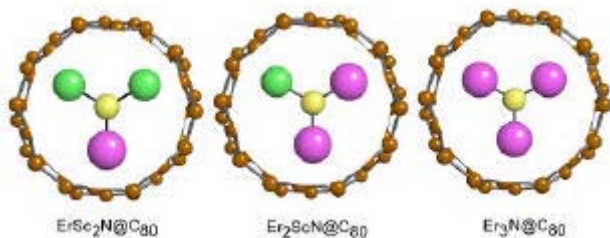
A newly discovered class of metal-encapsulated molecules exclusive to Luna is known as Trimetaspheres™. These unique molecules exist by placing up to three novel metals (i.e. Scandium, Lutetium, Holmium, Gadolinium) inside a molecular cage formed by up to eighty (80) carbon atoms. Traditional metal fullerenes are produced in very low yields and require stringent handling

safeguards to isolate the molecules due to their high instability in air. In contrast, Luna has improved methods allowing for the production of large quantities of materials that are highly stable in air and can be modified to be water-soluble allowing for dispersion in coatings and biological systems.

Luna's expertise in Trimetaspheres™ includes synthesis, purification, functionalization and specific application development for defense and commercial requirements. To date, Luna has synthesized 27 different metal-dependant species. Due to encapsulated metal variations, each species may be used for applications exhibiting different mechanical, electrical, optical and magnetic behavior based on end user needs.



Variations of Luna's exclusive Trimetasphere™.



$A_3N@C_{80}$	$A_2ScN@C_{80}$	$ASc_2N@C_{80}$
$Sc_3N@C_{80}$	$Y_2ScN@C_{80}$	$YSc_2N@C_{80}$
$Y_3N@C_{80}$	$Dy_2ScN@C_{80}$	$DySc_2N@C_{80}$
$Dy_3N@C_{80}$	$Er_2ScN@C_{80}$	$ErSc_2N@C_{80}$
$Er_3N@C_{80}$	$Tb_2ScN@C_{80}$	$TbSc_2N@C_{80}$
$Tb_3N@C_{80}$	$Ho_2ScN@C_{80}$	$HoSc_2N@C_{80}$
$Ho_3N@C_{80}$	$Lu_2ScN@C_{80}$	$LuSc_2N@C_{80}$
$Lu_3N@C_{80}$	$Gd_2ScN@C_{80}$	$GdSc_2N@C_{80}$
$Gd_3N@C_{80}$		

Individual metal atoms encapsulated within the carbon sphere can take the above three-metal mixture formats.



Single Wall Carbon nanotubes produced at Luna.

Single Wall Carbon Nanotubes consist of a single rolled up sheet of carbon hexagons and are 50,000 times thinner than a human hair. These hollow, cylindrical molecules of pure carbon are extraordinarily strong and flexible, with intriguing electronic properties which can be electrically conducting, semi-conducting, or insulating depending on the alignment of atoms. Nanotubes are 100 times stronger than steel of the same weight and have numerous applications as functional, thermal and electrical coatings, lightweight composite structures including armor and textiles, and next generation electronics.



# Nanomaterials

Cost-effective nanomaterials are needed for research and development of new defense and commercial applications. High volume production addresses the global need for large quantities of nanomaterials at a reduced cost. In a former historic 19<sup>th</sup> century tobacco warehouse in Danville, Virginia, Luna nanoWorks' focus is to be a leading manufacturer of carbonaceous nanomaterials and subsequent application development. By Q1 '05, this 24,000 sq. ft. facility will be in production.



Luna nanoWorks renovates a tobacco warehouse for nanomaterials manufacturing and R & D.

The Luna nanoWorks Division was aided by NSF programs that focused on production and separation technology and a NIST Advanced Technology Program for high-risk research of carbon nanomaterials for medical applications. Luna continues to work on Department of Defense applications and is scaling up plant capacity for supplying bulk nanomaterials. Luna's team includes senior technical and leadership staff with over 50 years of cumulative experience developing advanced materials.



Lab used for functionalization chemistry and small-scale synthesis.

## Military Applications

Luna is focused on critical Department of Defense needs including conductive coatings and sealants to improve stealth, low friction lubricating films and additives to allow aircraft engines to maintain flight with loss of lubricating fluid, and new high performance flexible solar cells. Luna's carbonaceous nanomaterials have also been demonstrated as single molecule devices for future molecular computing and data storage.

- ◆ Coatings
- ◆ Lubricants
- ◆ Electronics
- ◆ Optical Devices
- ◆ Drug Delivery
- ◆ Medical and Diagnostic Imaging

The initial commercial application of Trimetaspheres™ will be next-generation medical diagnostic and therapeutic agents.

Trimetasphere-based contrast agents for medical imaging offer the potential for improved performance over competitive technologies. Initial testing has shown that Trimetaspheres™ can be used to provide medical images with 25x better resolution than current leading technologies. Better diagnostic performance results in improved patient outcomes and reduced health care costs. Trimetaspheres™ are also being investigated for use in targeted diagnostics, for example, enabling physicians to precisely locate cancer cells and blood clots.

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## Luna nanoWorks is a division of Luna Innovation Incorporated

Luna Innovations is an employee-owned business, headquartered in Blacksburg, VA ([www.lunainnovations.com](http://www.lunainnovations.com)). Luna's business model is to invent, build and commercialize novel technologies. The company is accelerating the innovation process, utilizing the vast resources of our nation's universities and federal laboratories to address critical defense and commercial market needs.

Using Small Business Innovation Research and NIST Advanced Technology Program awards, corporate partnerships and venture capital, Luna Innovations has developed cutting-edge products that improve the diagnosis and treatment of disease, enhance the way the world communicates, and provide a brighter future for our energy needs. Most recently, Luna's products are centered on breakthroughs in nanomaterials technology. Luna has created hundreds of high quality jobs in the State of Virginia and has research, development and manufacturing facilities in Blacksburg, Charlottesville, Hampton Roads and now in Danville.