Structurally Amorphous Metals (SAM)

- Bulk amorphous (non-crystalline) metallic materials or amorphous-derived material systems have achieved combinations of mechanical properties that provide revolutionary improvements (strength, wear, and corrosion) at low-cost compared to those of comparable conventional alloys

Corrosion and wear cost the U.S. economy an estimated $65 billion annually

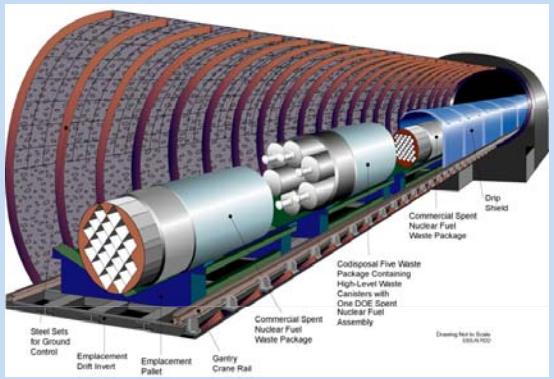
Carpenter Powder licensed and manufacturers the powder

CARPENTER

Bradley Fighting Vehicle

Developed and demonstrated ultra-hard wear resistant materials for treads and non-skid surfaces.

DARPA Objective



Developed corrosion resistant materials for drip shields for storage of spent nuclear fuel.

Joint DOE/DARPA Objective

Drill bits

Through develop of materials and manufacturing processes for wear resistant applications such as tunnel boring and drill bit.

DOE Objective

OAK RIDGE National Laboratory

Alumina Forming Austenitic (AFA) Stainless Steels

R&D 100 2009

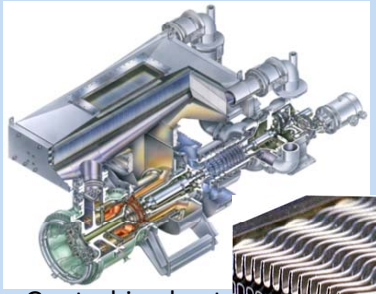
- AFA stainless steels deliver superior performance properties for corrosion resistance and extended lifetime at higher temperatures while at 2 - 3 times lower cost than conventional high cost nickel-based alloys
- Applications: petrochemical, gas and steam turbines, fuel cell, and automotive industries

Carpenter Powder licensed and manufacturers AFA steels

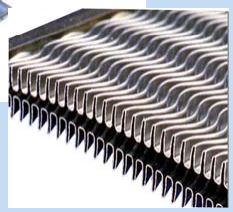
CARPENTER

Solar Turbines
A Caterpillar Company

Capstone Turbine Corporation

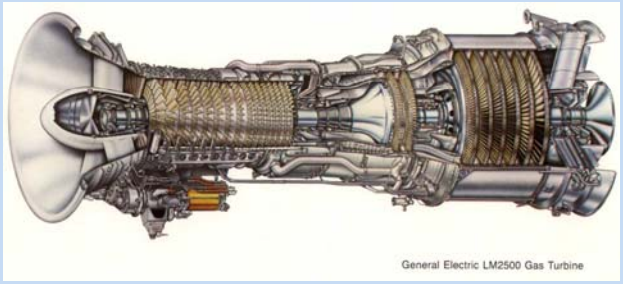


Gas turbine heat exchanger



Developed AFA materials and manufacturing processes and demonstrated in energy applications such as gas and steam turbines providing increased efficiencies as well as chemical process tubing.

DOE Objective



Jet engine

Goal is to improve the performance of AFA stainless steels by 10x for propulsion systems, to achieve higher performance and extend component life.

DARPA Objective

OAK RIDGE National Laboratory

Low-Cost Titanium

R&D 100 2007

- Development, production, qualification and commercialization of low-cost Ti components
- Reduce energy and costs, while increasing material yield

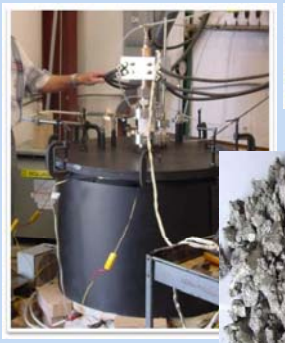
International Titanium Powder

BOEING

AMETEK

BAE SYSTEMS

LOCKHEED MARTIN
We never forget who we're working for™



Lab scale powder production

DARPA Titanium Initiative

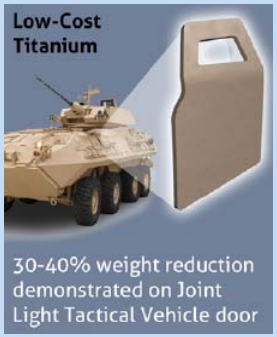
Low cost titanium powder

DARPA's Titanium Initiative (DTI) significantly reduced production costs of titanium and cleared the way for its widespread use in DoD systems.

DARPA Objective

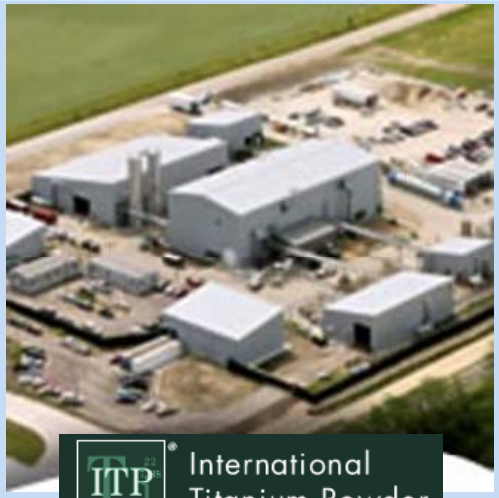
Brake rotor

Heat exchanger plate for desalination



Development of low cost and energy efficient manufacturing processes utilizing the newly developed low cost powder for commercial applications.

DOE Objective



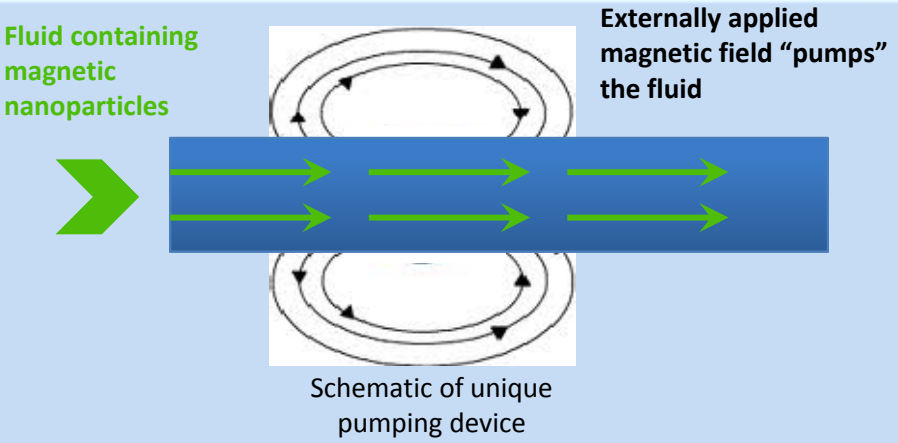
Newly constructed production plant producing 4 million pounds per year of low cost titanium powder creating manufacturing jobs in Ottawa, IL.

Commercialization

Low Cost Production of Nanomaterials

2006

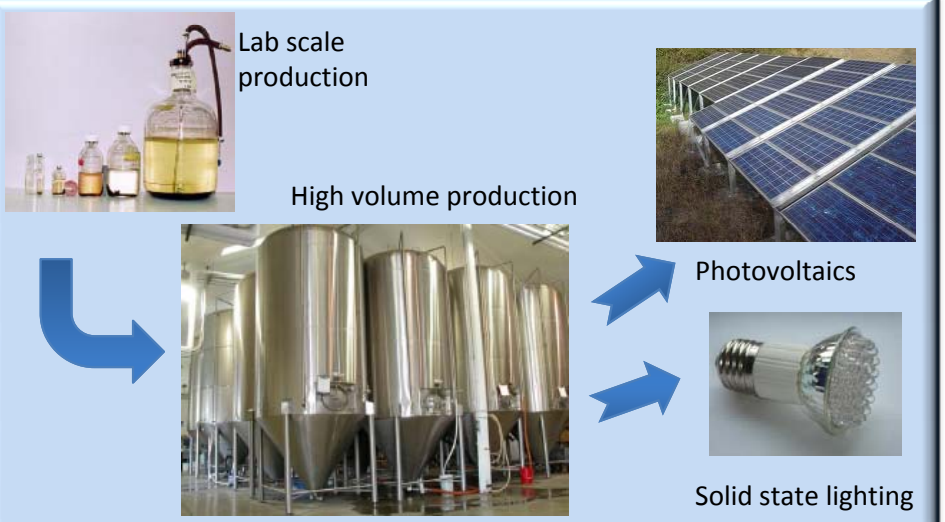
- Early stage development of a scalable, low temperature, low energy environmentally friendly bio-synthesis process to produce a wide range of cost effective nanomaterials
- This technology offers a high potential to enable low-cost, non-vacuum, high-volume manufacturing of thin-film photovoltaics



Schematic of unique pumping device

Goal was to develop unique methods for pumping fluids for micro-electronic applications. Program successfully demonstrated bio-synthesis process for the production of magnetic iron based nanoparticles for hydraulic propulsion, eliminating pumps, reducing cost and increasing reliability.

DARPA Objective



Program goal is to develop large-scale bio-synthesis process for the production of nanomaterials for low-cost products such as photovoltaics, solid state lighting, and other applicable functional material systems.

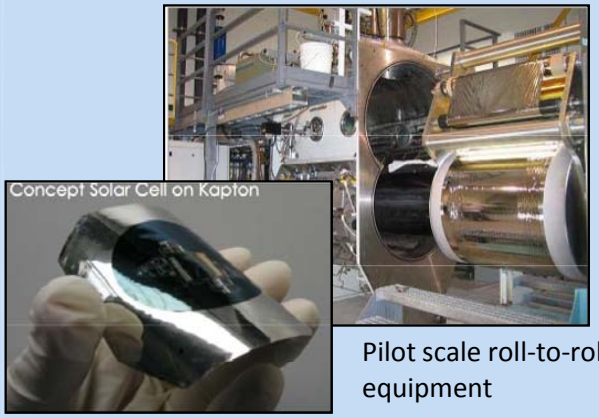
DOE Objective

Pulse Thermal Processing (PTP)

2009

- Unique rapid thermal processing technology enabling the fabrication of low cost highly efficient thin-film functional material systems on flexible low temperature polymer substrates
- The technology has the potential to enable cost effective high volume roll-to-roll non-vacuum processing of photovoltaics and batteries

GENERAL ATOMICS | Ascent SOLAR | ITN ENERGY SYSTEMS INC. | NOVACENTRIX

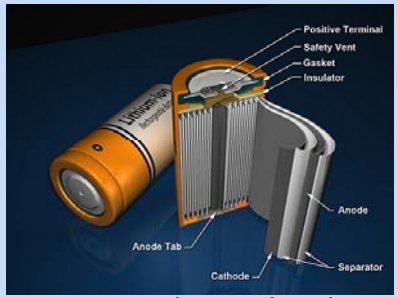


Pilot scale roll-to-roll equipment

Program goal is to develop a manufacturing process that enables low-cost ($0.20/Watt), high volume manufacturing of flexible solar cells on polymer substrates.

DARPA Objective

Thin-film battery cathode on polymer substrate.



Schematic of battery

Program goal is to develop a manufacturing process for lightweight thin-film batteries on flexible polymer substrates for increased performance.

DARPA/DOE Objective

NovaCentrix commercial PulseForge system

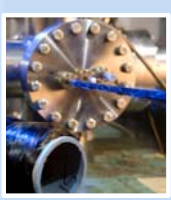
NovaCentrix licensed the processing technology from ORNL and is manufacturing the equipment to support the commercialization of the technology. Creating jobs in Austin, TX.

Commercialization

Advanced Carbon Fiber for Composite Products

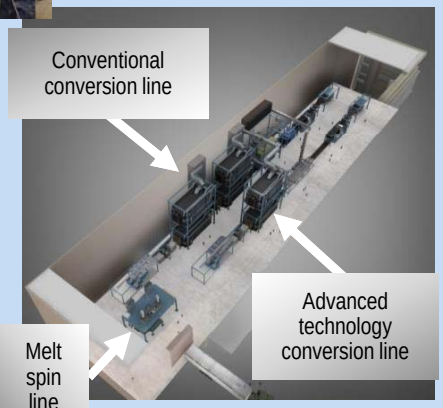
- Development, production, qualification and commercialization of low-cost and high performance carbon fibers for use in composite products
- Reduce cost and energy through advanced energy-efficient manufacturing technologies
- Reduce dependency on petroleum based feedstocks through renewable or recycled sources

Early use of the next generation of advanced materials will establish U.S. automotive industry leadership and secure future jobs.



Advanced carbon fiber manufacturing line

Schematic of pilot facility at ORNL (25 tonnes/year capacity)



Building a first of its kind pilot scale low cost carbon fiber production facility to produce 25 tonnes fiber/year. When successful this will enable lightweight, affordable automotive parts that will improve fuel economy and reduce emissions while maintaining safety.

DOE Objective

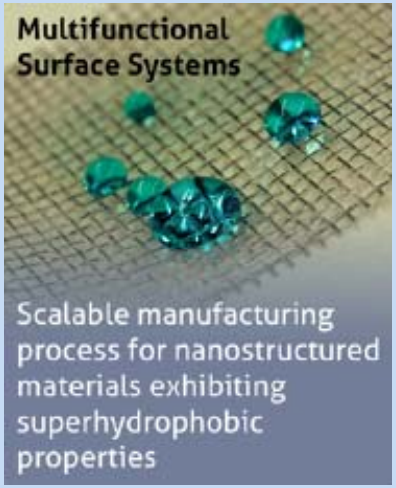
DARPA Advanced Structural Fiber program goal is to develop and produce fibers almost twice as strong as today's fibers for enhanced performance of DOD systems.

DARPA Objective

Superhydrophobic Materials

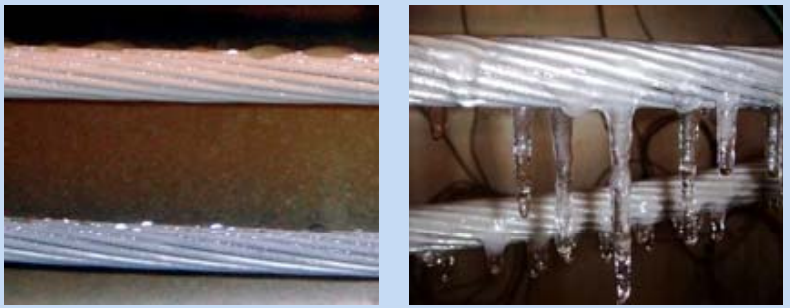
2008

- Development of low cost nanostructured super water repellent (superhydrophobic) materials that are resistant to wetting, bio-fouling, and corrosion, leading to reduced friction forces potentially providing energy savings for various industrial, transportation, and consumer products



DARPA's Multifunctional Surface Systems Program is focused on scaling the manufacturing process for large area superhydrophobic applications for DOD applications.

DARPA Objective



Power line coated with SH material (left) and uncoated (right) demonstrating the water repellent nature of the material, thus no ice build up.

Program goal is to replicate the superhydrophobic (SH) performance when the technology is scaled and implemented on component surfaces. Such an application would be for anti-icing for power lines to reduce ice build up.

DOE Objective

Additive Manufacturing (AM)

- Innovative manufacturing technology for fabrication of complex parts not possible by conventional manufacturing methods
- AM is the process of producing complex parts by successive melting of layers of powder material rather than removing material by conventional machining; lending itself to rapid energy efficient manufacturing of products with greatly reduced material waste

SOLIDICA STRATASYS Make It Real PCM arcam Boston Dynamics DARPA DMACE Challenge (Digital Manufacturing Analysis, Correlation and Estimation)

Arcam electron beam processing AM equipment

POM laser processing AM equipment

Program goal is to accelerate the manufacturing capability of a multitude of AM technologies utilizing various materials from metals to polymers to composites.

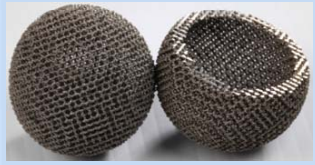
DOE Objective

ORNL's cam-based robotics (energy efficient hydraulics)

ORNL's freeform fingers

ORNL lightweight low-cost titanium robotic arm

Program goal is to reduce the cost and weight of robotic components made by low-cost titanium powders allowing a paradigm shift leading to low cost disposable robots.



AM mesh spheres

ORNL digitally manufactured over 200 complex shaped meshed spheres for the DARPA DMACE Challenge demonstrating accurate predictive modeling.

DARPA Objective