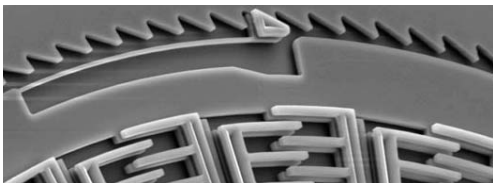
Advanced Materials and New Products

SPACE FLORIDA



The markets of interest to the state are heavily dependent on advanced materials and technologies. Ideally the enabling technologies would be readily available and we need only connect suppliers with the users. However, in some cases, a breakthrough, invention or non-traditional application is required for a market to be realized. These two different views of technology are known as "technology push" and "technology pull". Florida's industry, academic and federal laboratories are at the leading edge of technology innovation and application. It remains only for Space Florida to serve as a broker and in select, very high value situations to act as a catalyst in order to employ technology such that it leads to job growth.

The Market Horizon

The market for advanced materials is in two segments, one characterized by very large hardware elements and a second in which micro and nano materials are used in end products of varying sizes.

The exploration of space beyond low Earth orbit is totally dependent on a heavy lift capability. By definition any heavy lift vehicle will be comprised of dimensionally large pieces which imposes the need for appropriate manufacturing processes. Very large metal launch vehicle parts require the use of expensive large friction stir welders of which there are at present none in the state. Vehicles of the future will combine metal parts with composite parts much as do today's military and commercial aircraft. The introduction of very large composite parts requires correspondingly large and expensive autoclaves for the related curing process. Typically the "throughput" of a cure process involving autoclaves limits production efficiency since a single cure cycle is measured in days. Additionally, autoclaves require large amounts of uninterrupted electricity. (Loss of power during the cure results in scrapping very high value parts). Accordingly, there is a premium associated with developing a cure process that can be employed in ambient conditions of temperature, humidity and pressure.

At the other end of the spectrum are nano materials (those whose size is measured in millionths of a meter). These materials have some extraordinary properties. Copper can become transparent, gold becomes a liquid at room temperature, and perhaps most importantly, conductive materials can be made to carry almost infinite amounts of current. These materials are being introduced into end products today in limited applications and have an extraordinarily bright future for both terrestrial and non-terrestrial applications.

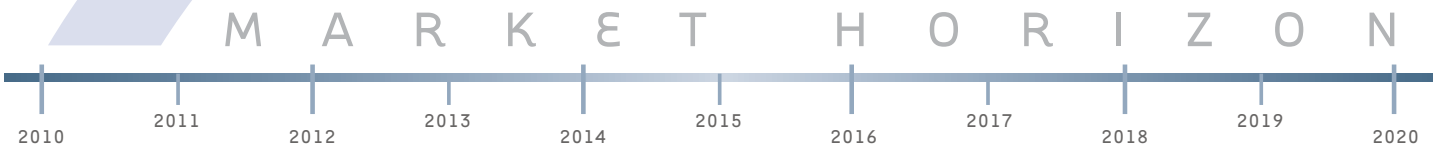
Timing

- Within 12 months compile a listing of those Florida groups that possess (or are in the development of) advanced materials capabilities
- Within 24 months be involved with one or more companies in a Space Act Agreement with NASA for a technology that has both space and other applications. An energy based SAA is the likely the subject of the first such agreement
- Within 36 months enable the successful transport a of technology or advanced material from one market sector to another
- Within 36 months have a plan for a Florida manufacturing center focused on large assemblies

Florida's Edge

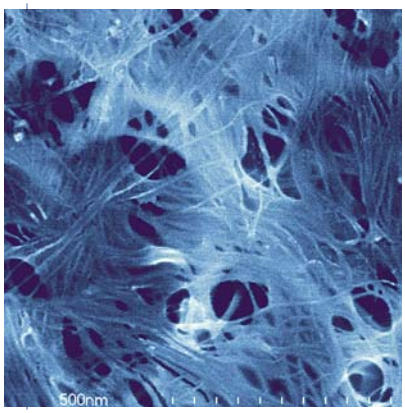
- *A large population of entrepreneurial technology companies*
- *Colleges and Universities that emphasize research and development (The Florida Center for Advanced Aerodynamics and Propulsion was created by the state legislature and funded at $14M)*
- *The laboratories and technical expertise of the Kennedy Space Center.*
- *Exploration Park and Space Life Sciences Laboratory*
- *An affordable, high technology work force*
- *The Governor's Office of Tourism, Trade and Economic Development*
- *Emerging Federal Policy and Funding for state efforts centered on Clean Energy related technologies and products*
- *Home to commercial space operations*
- *A power generation industry committed to change*
- *Active change agents comprised of the FHTC, Florida Space Grant Consortium, the Florida Space Institute*

There are many difficulties to overcome in developing a solution for on-orbit refueling of spacecraft and satellites, including temperature requirements, the physics associated with liquid cryogenic fluids in weightless environments and autonomous docking systems. Image credit: Joe Howell/NASA



Targets for Florida

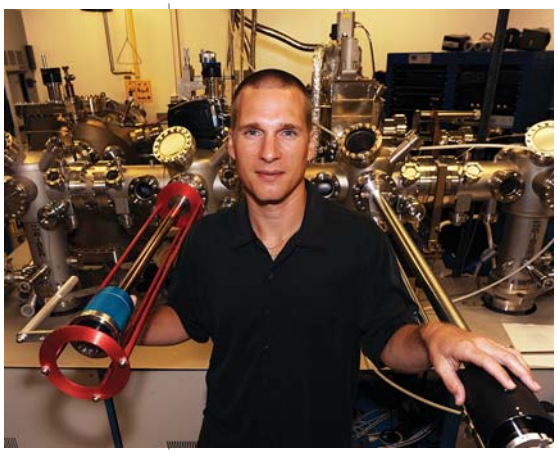
- Florida becomes a recognized focus point for the development and use of advanced materials and technologies for space applications which also have broader application potential for other disciplines and markets (such as energy, agriculture, life science, etc.)
  - For example, today's MRIs use magnets which are cryogenically cooled but tomorrow, through advanced nano materials, may be able to operate in an ambient room environment. Similarly, a magnet that can control the thrust in a plasma engine for space could also be used to deliver small doses of medicine directly to diseased cells thereby negating the requirement to flood the entire body with drugs
- Be able to demonstrate that an investment in advanced materials and technologies leads to job growth in a wide spectrum of end products



This scanning electron microscope image demonstrates a network of carbon nanotubes deposited like paper fibers in a thin sheet called Buckypaper. Buckypaper is 500 times stronger than steel at a tenth of the weight and has amazing heat dispersion and electrical conductivity properties. Future uses of buckypaper may include fire protection, air and fluid filters, armor plating and artificial muscles. Image credit: Chastek/Talbott/NIST

Tactical Development Strategies

- Create a capability to manufacture large scale hardware elements associated with exploration
- Be at the forefront of developing solutions to on-orbit fueling for earth departure vehicles and radiation protection for long duration space exploration operations
- Be a leader for extraterrestrial surface operations including habitation, in situ resource utilization, launch, logistics, etc. (in direct support of KSC's chartered tasks)
- Enable the use of high technology and advanced materials in support of the energy market (power generation, transmission and storage)
- Promote the use of high technology and advanced materials for: 1) increased efficiency of operation for traditional internal combustion engines and 2) the introduction of alternative fuels and/or propulsion devices for both stationary and vehicular applications



The University of Central Florida has been awarded a $7.5 million research grant to study ways to make photovoltaic solar cells more efficient in capturing and converting solar energy into electricity, and less costly to manufacture. Led by Winston Schoenfeld (pictured here), a professor in The College of Optics and Photonics at UCF, the work seeks to increase the efficiency between the organic material that harvests the sun's energy and the inorganic semiconductor nanostructures within a hybrid photovoltaic solar cell—with a focus on the commercial applications of the end product. Image credit: University of Central Florida

Researchers are developing a new type of rocket propellant, ALICE, made of a frozen mixture of water and "nanoscale aluminum" powder that is more environmentally friendly than conventional propellants and could be used to launch rockets into orbit or generate hydrogen for fuel cells. Purdue University, Pennsylvania State University, NASA, and the Air Force Office of Scientific Research have been developing ALICE, including using it to fuel a proof-of-concept rocket (seen here). Image credit: Purdue University photo/Dr. Steven F. Son, Purdue University

Maveric is a single-man portable and operable, immediate launch capable, customizable, unmanned aerial vehicle system (UAS) designed as a high-performance, next-generation platform for mini- and micro-UAS operations. Using advanced composite materials, Maveric's bendable-wings allow it to be stored, fully-assembled, in a six inch tube. Since becoming available in 2008, Maveric has already been used to support several military exercises. Image Credit: Prioria Robotics

***Space Florida** was created to strengthen Florida's position as the global leader in aerospace research, investment, exploration and commerce. As Florida's aerospace development organization, Space Florida is dedicated to attracting and expanding the next generation of space industry businesses. Created by the State of Florida as a special district in May 2006, Space Florida serves space-related functions in all three aerospace sectors: civil, military and commercial. Florida's attributes include its superlative workforce, proven infrastructure and unparalleled record of achievement.*