

WINTERGREEN RESEARCH, INC.

**Worldwide Nanotechnology Portable Fuel Cell Market
Shares, Strategies, and Forecasts, 2009-2015**

**Nanotechnology for Portable Fuel Cells Provide Increased
Energy Density**



Picture by Susie Eustis

MOUNTAINS OF OPPORTUNITY

**WinterGreen Research, Inc.
Lexington, Massachusetts**

www.wintergreenresearch.com

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CHECK OUT THESE KEY TOPICS

BICYCLES FUEL CELL POWER
PORTABLE FUEL CELL POWER
PERSISTENT COMPUTING EXTENDED POWER
FIRST RESPONDER FUEL CELLS
Portable Medical Equipment
Laptop Computer Power
CONSUMER ELECTRONICS PORTABLE POWER
INSTANT RECHARGE FOR CONTINUOUS COMPUTING
FUEL CELL NANOTECHNOLOGY
HYBRID TECHNOLOGIES
FUEL CELL CARTRIDGES APPROVED FOR COMMERCIAL AIRCRAFT
FUEL CELL TECHNOLOGY DECREASES THE WEIGHT SOLDIERS CARRY
Global Warming Drives Portable Fuel Cell Energy Adoption

Fuel Cell Efficiency
Fuel Cell Electrochemical Converter
Clean Energy
DMFC Fuel Cells
Portable Fuel Cell Hours Of Operation
Power Degradation
Nanotechnology Catalysts

OPPORTUNITY ABOUNDS

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Nanotechnology Portable Fuel Cells, Market Shares, Strategies, and Forecasts, 2009-2015

Portable fuel cells are poised to achieve significant growth as units become smaller and fuels less expensive. According to Susan Eustis, lead author of the study, "Economies of scale do not entirely solve the inherent high costs of high grade metallic catalysts used in micro fuel cells. Nanotechnology is poised to provide new ways to create advanced materials that can be used to implement portable fuel cells. More catalyst price reductions are needed to make portable fuel cells competitive with thin film batteries. Portable fuel cells are useful in cities to power bicycles and for advanced multimedia electronics that draws a lot of power."

Most of the developing world, where energy and environmental problems abound, still gets around on 2 wheels. 2% of the 1.5 billion population in China owns a car. Cities have started banning the use of 2-stroke engine motorcycles in favor of LPG scooters and electric bicycles.

19 million electric bicycles were purchased in 2008. The trend is expected to continue. As more people need to travel further each year, fuel cells take on a role in short distance travel. As economies evolve, fuel cells provide a role for green energy. Purchasing power constraints and air pollution issues stimulate the need for low cost, zero carbon transportation solutions.

Portable fuel cell vendors are strategically positioned to develop and implement solutions. Technology costs continue to decrease. Practical fuel solutions continue to develop. Experiments with portable fuel cell products are starting to take place in various parts of the world.

Nanotechnology is being used to implement a variety of portable fuel cell solutions. Many different nanotechnology techniques are being explored. One is of a silicon structure, approximately 400 microns deep, much thicker than the 10-micron depth of a membrane in a traditional PEM-based cell. This design is expected to enable a much larger reaction surface area, enabling high power in a small form-factor.

To compress more power into smaller volumes, researchers have begun to build fuel cells on the fuzzy frontier of nanotechnology. Silicon etching, evaporation, and other processes borrowed from chip manufacturers have been used to create tightly packed channel arrays to guide the flow of fuel through the cell.

The point is to pack a large catalytic surface area into a wafer-thin volume. This approach is evolving, going beyond two-dimensional aspects to gain more surface area. Methods improve the performance of nano-scale fuel cells.

Three-dimensional structures improve current electrocatalysts that have traditionally been expressed on a flat surface. Two dimensional catalysts give hundreds of microamps per square centimeter, while three dimensional catalysts increase the surface area by orders of magnitude.

Fuel channels are evolving in ready-made in a commonly available, porous alumina filters costing only about \$1. The filter is riddled with neat, cylindrical holes only 200 nanometers in diameter, and was initially used in labs as a template for the growth of nanowires.

Nanowires can be grown in a platinum-copper alloy, then dissolving the copper by soaking the filter in nitric acid creates electrodes. In place of a solid nanowire, each hole is left with a porous platinum electrode. The partially dissolved wires are structurally complex, as befits their random nature, and have an enormous surface area for their size.

The market size for portable fuel cell power at \$80.1 million in 2008 is estimated to reach \$4.4 billion dollars by 2015. Existing markets are from mobile homes and PCs used remotely. Strong growth comes as hybrid fuel cell systems evolve to support thin film batteries. The fuel will come from renewable energy sources.

Companies Profiled

Market Leaders

Toshiba
Smart Fuel Cells (SFC)
PolyFuel
Horizon
BASF
Masterflex

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Market Participants

**Altair Nanomaterials
Angstrom Power
Asahi Glass
Ballard
BASF / E-TEK
BASF Direct Methanol Fuel Cells
Ceramic Fuel Cells
Gore
GrafTech International
Heliocentris Fuel Cells AG
Horizon
ICM Plastics
JMC / Tekion
Johnson Matthey
Manhattan Scientifics
Masterflex AG
Mechanical Technology Incorporated (MTI)
Medis Technologies
Microcell
Millennium Cell Liquidation Plan
System Design Program
Sanyo / Hoku Scientific
SGL Technologies
Electric Automotive Vehicle Smart Fuel Cell Battery Charger
Solvay
Tatung System Technologies
UltraCell
BASF Venture Capital / UltraCell**

Nanotechnology Portable Fuel Cell Market Shares, Strategies, and Forecasts 2009-2015

REPORT METHODOLOGY

THIS IS THE 397TH REPORT IN A SERIES OF MARKET RESEARCH REPORTS THAT PROVIDE FORECASTS IN COMMUNICATIONS, TELECOMMUNICATIONS, THE INTERNET, COMPUTER, SOFTWARE, TELEPHONE EQUIPMENT, HEALTH EQUIPMENT, AND ENERGY. THE PROJECT LEADERS TAKE DIRECT RESPONSIBILITY FOR WRITING AND PREPARING EACH REPORT. THEY HAVE SIGNIFICANT EXPERIENCE PREPARING INDUSTRY STUDIES. FORECASTS ARE BASED ON PRIMARY RESEARCH AND PROPRIETARY DATA BASES. FORECASTS REFLECT ANALYSIS OF THE MARKET TRENDS IN THE SEGMENT AND RELATED SEGMENTS. UNIT AND DOLLAR SHIPMENTS ARE ANALYZED THROUGH CONSIDERATION OF DOLLAR VOLUME OF EACH MARKET PARTICIPATION IN THE SEGMENT. INSTALLED BASE ANALYSIS AND UNIT ANALYSIS IS BASED ON INTERVIEWS AND AN INFORMATION SEARCH. MARKET SHARE ANALYSIS INCLUDES CONVERSATIONS WITH KEY CUSTOMERS OF PRODUCTS, INDUSTRY SEGMENT LEADERS, MARKETING DIRECTORS, DISTRIBUTORS, LEADING MARKET PARTICIPANTS, OPINION LEADERS, AND COMPANIES SEEKING TO DEVELOP MEASURABLE MARKET SHARE. OVER 200 IN DEPTH INTERVIEWS ARE CONDUCTED FOR EACH REPORT WITH A BROAD RANGE OF KEY PARTICIPANTS AND INDUSTRY LEADERS IN THE MARKET SEGMENT. WE ESTABLISH ACCURATE MARKET FORECASTS BASED ON ECONOMIC AND MARKET CONDITIONS AS A BASE. USE INPUT/OUTPUT RATIOS, FLOW CHARTS, AND OTHER ECONOMIC METHODS TO QUANTIFY DATA. USE IN-HOUSE ANALYSTS WHO MEET STRINGENT QUALITY STANDARDS. INTERVIEWING KEY INDUSTRY PARTICIPANTS, EXPERTS AND END-USERS. OUR RESEARCH INCLUDES ACCESS TO LARGE PROPRIETARY DATABASES. LITERATURE SEARCH INCLUDES ANALYSIS OF TRADE PUBLICATIONS, GOVERNMENT REPORTS, AND CORPORATE LITERATURE.

YOU MUST HAVE THIS STUDY

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Nanotechnology Portable Fuel Cell Technology Market

Shares, Strategies, and Forecasts, 2009 to 2015

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