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**Fuel Cell Catalysts Market Opportunities, Strategies, and
Forecasts 2007 to 2013**

Fuel Cell Catalysts



Picture by Susie Eustis

MOUNTAINS OF OPPORTUNITY

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

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WORLDWIDE FUEL CELL CATALYSTS MARKET SHARES

Fuel Cell Catalyst Market Forecasts

Fuel Cell Catalysts Market Driving Forces

Most Cited Catalyst Scientific Research

Types Of Fuel Cell Technologies

Platinum Dissolution And Deposition In A Membrane

CATALYST ALLOWS CHEMICAL CONVERSIONS

CARBON NANOTECHNOLOGIES

NEC NANOPARTICLE FABRICATION

MEMBRANE PEM FUEL CELL

JOHNSON MATLEY NOBLE METAL HYDRODECHLORINATION

CATALYST

COAL GASIFICATION

HYDROGEN

GOLD CATALYST FOR FUEL CELLS

FUEL CELLS STRENGTHS AND WEAKNESSES

STATIONARY FUEL CELL CATALYSTS

OPPORTUNITY ABOUNDS

WinterGreen Research, Inc.

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Fuel Cell Catalyst Market Shares, Market Forecasts, and Market Strategy, 2007 to 2013

Mostafa A. El-Sayed Most Cited Catalyst Scientific Research

Mostafa A. El-Sayed at the Georgia Institute of Technology Laser Dynamics Laboratory is the undisputed leader in catalyst scientific research. He has been the most articulate scholar and engineer and the most often cited scholar in describing that different shapes of the same metal create different characteristics of the same materials. More work needs to be done to understand the basic science of nanoparticles before fuel cell catalysts can be made to scale commercially.

Mostafa A. El-Sayed Is The Undisputed Leader In Catalyst Scientific Research

Mostafa is the most likely to achieve the scientific breakthrough. The effects of different size nanoparticles are still being investigated. Companies are poised to fund more research with him at the Laser Dynamics Laboratory, School of Chemistry and Biochemistry, Georgia Institute of Technology to investigate the impact of shape on material characteristics.

Susie Eustis Describes The Electromagnetic Effect Of Surface Oscillation On Nanoparticles

Susie Eustis describes the electromagnetic effect of surface oscillation on nanoparticles. One of the interesting things about nanoparticles that makes them different from other particles is that there is very little interior, the nanoparticle is mostly surface, creating a different type of entity than a particle with an exterior and interior.

The different shapes of the same material create different characteristics because the electrons are so close to the surface in a very small particle that the behavior of the electrons depends on how soon it hits the edge of the particle more than what type of material chemistry and physics as may be constituted in a larger particle.

In the case of a larger particle that has an interior wall to give the electrons a more consistent way of behaving, the shape of the particle is not so significant as it is in a nanoparticle. Susie Eustis has been a leader in describing that the reason the change of shape affects the characteristics of the metal. Scientific procedures used to observe the surface plasmon resonance absorption are used to discover new materials properties.

Surface plasmon resonance and synthesis procedures for nanoparticles are a basis for discovering more efficient catalysts. Nanoparticle catalysts lower the activation energy of the reaction, and increase the rate of reaction and the yield of the desired products with small amounts of material. Metal nanoparticles generally take advantage of the electromagnetic field enhancement of noble metal nanoparticles resulting from the surface plasmon oscillations, creating variations in nanoparticles characteristics that can be leveraged to achieve better fuel cell catalysts.

The color of metal nanoparticles changes depending on the shape and size of the nanoparticle and dielectric constant of the surrounding medium. The varying characteristics of nanoparticles are needing more investigation before contributing to the basic science in a manner that creates the ability to use nanoparticles for fuel cell catalysts.

The properties of a material are dependent on particle size and shape. Materials on the 1-100nm scale have characteristics relevant to the size and scale. New properties develop on the nanoscale. Lack of symmetry and electron confinement are unique properties of nanoparticles.

Characteristics Of Nanoparticles Do Not Scale Linearly With Size And Are A Function OF Electron Behavior

The characteristics of nanoparticles do not scale linearly with size, the same material in larger quantity had different characteristics.

According to Susie Eustis in her PhD thesis, "The nanometer scale (1-100nm) incorporates collections of atoms or molecules, whose properties are neither those of the individual constituents nor those of the bulk. On this scale, many of the atoms are still located on the surface, or one layer removed from the surface, as opposed to the interior. The interface between substances is just now beginning to be understood. New properties are observed on this scale due to the interface that is not observed in the bulk or individual atoms. Since the properties depend on the size of the structure, instead of just the nature of the material, reliable and continual change can be achieved using a single material."

Johnson Matthey

Johnson Matthey has an agreement with PolyFuel on supply of membranes for portable fuel cell market. Johnson Matthey and PolyFuel have an agreement for hydrocarbon direct methanol fuel cell (DMFC) membranes intended for fuel cells to power portable devices. Johnson Matthey will use these membranes in the manufacture of catalyst coated membranes (CCMs) and membrane electrode assemblies (MEAs), which are the part of a fuel cell that transforms fuel into electricity.

Johnson Matthey is a leader in fuel cell catalysts, in marrying catalysts and membranes, and in engineering, manufacturing and selling the catalyst coated membranes and membrane electrode assemblies. Johnson Matthey fuel cells support is as a channel partner. Partners purchase DMFC hydrocarbon membranes to manufacture a variety of CCM and MEA products for the portable fuel cell market.

A high volume, portable fuel cell market is an important driver in the development and widespread use of fuel cells in all applications. Strategically, the Johnson Matthey / PolyFuel supply of membranes for portable fuel cell market partnering strategy is significant.

Market For Fuel Cell Catalysts

The market for fuel cell catalysts was \$51.5 million in 2006. Markets are anticipated to grow rapidly to \$2.4 billion in 2013 as stationary and portable fuel cells are implemented.

Companies Profiled

Market Leader

Johnson Matthey

Market Participants

ACTA

BASF

DoppStein Enterprises

Fuel Cell Energy

Oxford Catalysts

QuantumSphere

Sud-Chemie Incorporated

Argonne National Laboratory

Cabot Corporation

Engelhard

National Hydrogen Association

PolyFuel

SGL Group

Superprotonic

Fuel Cell Catalysts Strategies and Forecasts

2007-2013

REPORT METHODOLOGY

THIS IS THE 321ST 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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Table of Contents

FUEL CELL CATALYSTS EXECUTIVE SUMMARY

FUEL CELL CATALYSTS EXECUTIVE SUMMARY	ES-1
Most Cited Catalyst Scientific Research	ES-1
Mostafa A. El-Sayed Is The Undisputed Leader In Catalyst Scientific Research	ES-1
Susie Eustis Describes The Electromagnetic Effect Of Surface Oscillation On Nanoparticles	ES-2
Characteristics Of Nanoparticles Do Not Scale Linearly With Size And Are A Function Of Electron Behavior	ES-3
Fuel Cell Catalysts Market Driving Forces	ES-4
Worldwide Fuel Cell Catalysts Market Shares	ES-6
Johnson Matthey	ES-7
QuantumSphere	ES-8
QuantumSphere Consistent, Narrow Particle Size Distribution	ES-9
Cabot's Dynalyst Spray-Based Powder Processing Catalyst Formation Technique	ES-10
Cabot Proprietary Technology Attaches Organic Groups To The Surface Of Carbon Black Particles	ES-10
Fuel Cell Catalyst Market Forecasts	ES-11
Proper Catalysts, The Water-Shift Reaction	ES-14

FUEL CELL CATALYSTS MARKET DESCRIPTION AND MARKET DYNAMICS

1. FUEL CELL CATALYST MARKET DESCRIPTION AND MARKET DYNAMICS	1-1
1.1 Mostafa A. El-Sayed Most Cited Catalyst Scientific Research	1-1
1.1.1 Mostafa A. El-Sayed "Cubic" Colloidal Platinum Nanoparticles -- 1986	1-1
1.1.2 Mostafa A. El-Sayed Is The Undisputed Leader In Catalyst Scientific Research	1-2
1.1.3 Susie Eustis Describes Electromagnetic Effect Of Surface Oscillation Of Nanoparticles	1-3
1.1.4 Influence Of The Surface Morphology On The Kinetics Of A Cathodic Fuel Cell Reaction	1-5
1.2 Catalysts Overcome Fuel Cell Technical Obstacles And Operational Disadvantages	1-6
1.3 Types Of Fuel Cell Technologies	1-6
1.3.1 Comparison of Fuel Cell Technologies	1-9
1.3.2 PEM Platinum / Ruthenium Catalysts	1-10
1.3.3 Direct Methanol Fuel Cells	1-10
1.3.4 Alkaline Fuel Cells	1-11
1.3.5 Phosphoric Acid Fuel Cells	1-12
1.3.6 Molten Carbonate Fuel Cells	1-13
1.3.7 Solid Oxide Fuel Cells	1-14
1.3.8 Regenerative Fuel Cells	1-15
1.4 Nanoscopic Bits Of Platinum For Fuel Cell Catalyst Technology	1-16
1.4.1 Improving The Performance Of Platinum Catalysts	1-16
1.4.2 Shape Transformation and Surface Melting of Cubic and Tetrahedral Platinum Nanocrystals	1-18
1.4.3 Catalytic Activity Dependent On The Size And Shape Of Nanocrystals	1-18
1.4.4 Why Gold Nanoparticles Are More Precious Than Pretty Gold: Susie Eustis and Mostafa A. El-Sayed	1-19
1.4.5 Effect of Catalysis on the Stability of Metallic Nanoparticles: Suzuki Reaction Catalyzed by PVP-Palladium Nanoparticles Radha Narayanan and Mostafa A. El-Sayed	1-20
1.5 Palladium Catalysts Prepared By Glow Discharge Plasma For The Selective Hydrogenation Of Acetylene	1-20
1.5.1 Shape-Controlled Synthesis of Colloidal Platinum Nanoparticles	1-21
1.5.2 Platinum Nanocrystals Daniel.Feldheim@Colorado.edu	1-21
1.5.3 Testing of the Palladium Membrane Reactor and Potential Applications for Hydrogen Production	1-22
1.6 Platinum Dissolution And Deposition In A Membrane	1-22

1.6.1	TEM Platinum Deposition Image Of The Cathode	1-25
-------	--	------

FUEL CELL CATALYSTS MARKET SHARES AND MARKET FORECASTS

2.	FUEL CELL CATALYST MARKET SHARES AND MARKET FORECASTS	2-1
2.1	Platinum Fuel Cell Catalyst	2-1
2.2	Fuel Cell Catalysts Market Driving Forces	2-1
2.2.1	Fuel Cell Catalysts Market Dynamics	2-2
2.3	Worldwide Fuel Cell Catalysts Market Shares	2-6
2.3.1	Johnson Matthey	2-8
2.3.2	QuantumSphere QSI-Nano Palladium	2-10
2.3.3	QuantumSphere Fuel Cell Catalysts	2-11
2.3.4	Acta Breakthrough Electrolyser Catalyst	2-11
2.3.5	Acta Platinum Free Catalysts	2-13
2.4	Fuel Cell Catalyst Market Forecasts	2-14
2.4.1	Fuel Cell Catalyst Regional Market Analysis	2-16
2.5	Platinum Market Analysis	2-18
2.5.1	Fuel Cell Catalysts	2-22
2.5.2	Platinum Fuel Cell Catalysts	2-23
2.5.3	Platinum Supply By Region	2-24
2.5.4	Reduction Of The Amount Of Platinum-Loading	2-29
2.6	Stationary Fuel Cell Catalysts	2-30
2.6.1	Stationary Fuel Cells Market	2-32
2.6.2	Fuel Cells Portable Market	2-32
2.6.3	Fuel Cells Transportation Market	2-32
2.6.4	Worldwide Stationary Fuel Cell Market Growth Drivers	2-33
2.7	Fuel Cells Strengths and Weaknesses	2-37
2.8	Fuel Cell Market Regional Analysis	2-39
2.8.1	Fuel Cells California	2-39
2.8.2	Fuel Cells U.S.	2-41
2.8.3	U.S. Solid-State Energy Conversion Alliance SECA	2-41
2.8.4	U.S. Boston Area Acumentrics, Cell Tech Power, Protonex Technology of Southborough, Ztek in Woburn, and Cambridge sister companies TIAX and Nuvera Fuel Cells	2-41
2.8.5	Fuel Cells Canada	2-42
2.8.6	Fuel Cells in Canada	2-42
2.8.7	Fuel Cells Japan	2-44
2.8.8	New Energy Foundation Project (NEF) And The Japan Gas Association Matsushita Electric	2-49
2.8.9	Sales Prospects Japan	2-49
2.8.10	New Sunshine Project (Japan)	2-51
2.8.11	Fuel Cell Development in Japan	2-53
2.8.12	Fuel Cell Cogeneration in Japan	2-54
2.8.13	Tokyo-Based JGA Millennium Program,	2-55
2.8.14	Japanese Government Subsidies in 2006	2-56
2.8.15	Fuel Cell Cogeneration In Japan	2-56
2.8.16	Establishing Codes And Standards Are Very Important For Advancing Fuel Cell Systems In Japan	2-57
2.8.17	Fuel Cells Germany	2-57
2.8.18	EPRI Strategic Planning	2-58
2.8.19	Electric Power Research Institute (EPRI) Scenarios: Fuel Prices And Environmental Mitigation Costs High	2-59
2.8.20	Electric Power Research Institute (EPRI) Scenarios: Evolution Of Fuel Prices And CO2 Costs	2-59

FUEL CELL CATALYSTS PRODUCT DESCRIPTION

3.	FUEL CELL CATALYST PRODUCT DESCRIPTION	3-1
3.1	Johnson Matthey Fuel Cell Catalysts	3-1
3.1.1	Johnson Matthey Fuel Cells	3-2
3.1.2	Johnson Matthey HiSPEC® Catalyst	3-3

3.1.3	Johnson Matthey Addresses Catalytic Components	3-3
3.1.4	Johnson Matthey Catalysts For Hydrogen Production	3-8
3.2	ACTA	3-9
3.2.1	Acta Catalyst For Direct Alcohol Fuel Cells	3-11
3.2.2	Acta Platinum Free Catalysts	3-12
3.3	QuantumSphere	3-15
3.3.1	QSI Methanol Fuel Cell / Hydrogen Fuel Cell	3-17
3.3.2	QSI Methanol Fuel Cell	3-18
3.3.3	QuantumSphere Funds University Research	3-22
3.3.4	QuantumSphere QSI-Nano® Palladium	3-26
3.3.5	QuantumSphere Efficiencies in Hydrogen Generation	3-27
3.3.6	QuantumSphere 45% Increase in Power Incorporating QSI-Nano® Cobalt in Direct Methanol Fuel Cells Membrane Electrode Assembly	3-32
3.3.7	QuantumSphere QSI-Nano® Catalysts For Large Batteries Has 320% Increase In Power For Zinc-Air Battery Cathodes	3-34
3.3.8	QuantumSphere Ultra-Pure, Highly Uniform Nanometals And Alloys Under 100 Nanometers	3-35
3.4	DoppStein Enterprises DSE	3-38
3.4.1	DoppStein Enterprises Independent Scientific Data To Validate QuantumSphere	3-38
3.5	Argonne US National Laboratory	3-40
3.6	BASF Fuel Cell	3-41
3.6.1	PEMEAS (BASF)	3-43
3.6.2	E-TEK™ Division Of BASF / PEMEAS	3-43
3.7	Fuel Cell Markets Ltd	3-46
3.8	Cabot Fuel Cell Electrocatalysts	3-46
3.8.1	Cabot's Dynalyst® Electrocatalysts Manufacturing Process	3-49
3.8.2	Cabot Advanced Fuel Cell Development	3-50
3.8.3	Cabot Modified Carbon Electrocatalyst Technology	3-51
3.8.4	Cabot Modified Carbon Black Technology	3-52
3.8.5	Cabot Low Relative Humidity Fuel Cell Catalysts	3-53
3.8.6	Cabot Advanced Fuel Cell Development	3-57
3.9	NEC Carbon Nanohorns Fuel Cell Catalysts	3-57
3.9.1	Fuel Cell Catalyst Nanotechnology At NEC	3-58
3.9.2	NEC Bottom-Up Self-Assembly Nanotechnology For Creation Of Materials With New Properties Such As Fullerene And The Carbon Nanotube	3-58
3.9.3	Top-Down Type Of Nanofabrication Technology	3-58
3.9.4	NEC Calixarene	3-59
3.9.5	NEC Nanofabrication/Nano-Characterization – Calixarene and CNT Control Technology –	3-60
3.9.6	CNT Cylindrically Shaped Carbon Material	3-60
3.9.7	NEC CNH Nanometric Carbon Tubes	3-61
3.9.8	NEC Synthesis of CNT and CNH	3-62
3.9.9	NEC Nanotechnology Lets Platinum Works As The Catalyst Efficiently	3-62
3.9.10	NEC Increases Surface Area Of Platinum Particles	3-62
3.10	PolyFuel Key Polymer Portable Fuel Cell Technology	3-63
3.10.1	PolyFuel Engineers The Nano-Architectures And The Chemical Characteristics Of A Membrane	3-65
3.10.2	Fluorocarbon Membranes State Of The Art	3-65
3.11	Oxford Catalysts	3-69
3.11.1	Oxford Catalysts Platform Is For A Novel Class Of Catalysts Incorporating Metal Carbides	3-70
3.12	Grace Davison	3-72
3.13	Voller Energy Group	3-72
3.14	Zhong Lin Wang Catalyst For Hydrogen Production	3-73
3.15	Oxford University Enzyme-Based Hydrogen Fuel Cell	3-74
3.15.1	Trulite Fuel Cell Technology	3-75
3.16	Hydra Fuel Cell	3-76
3.17	Brookhaven National Laboratory	3-76
3.17.1	Metal Nanoparticles Do Catalysis When Put On Ceria	3-77
3.17.2	GSI Creos Carbon Nanotubes (CNTs) For Fuel Cells	3-78
3.17.3	Topsoe Fuel Cell Solid Oxide Fuel Cell	3-79
3.17.4	Umicore elyst Electrocatalysts	3-80

3.17.5	Advent Technologies SA	3-81
3.18	Altair Nanomaterials	3-81
3.19	Best Water Technology ALTI BWT	3-81
3.20	Dupont Fuel Cells Nafion® Membranes and Dispersions	3-81
3.21	Hoku Scientific	3-82
3.22	Ion Power Membranes For Direct Methanol Fuel Cells	3-82
3.23	ITM Power Ltd	3-82
3.24	Solvay Solexis	3-82
3.25	Entegris Cell Stack Subassembly	3-83
3.26	Argonne National Laboratory Catalyst Breakthrough Boosts Hydrogen Fuel Cells	3-83
3.26.1	Thermal Stability in Air of Pt/C Catalysts and PEM Fuel Cell Catalyst Layers	3-85
3.26.2	Department of Chemistry, Brookhaven National Laboratory Stabilization of Platinum Oxygen-Reduction Electrocatalysts Using Gold Clusters	3-86
3.27	Süd-Chemie Incorporated	3-86
3.27.1	Süd-Chemie Feedstock Purification Catalysts:	3-86
3.27.2	Süd-Chemie Feedstock Reforming Catalysts:	3-87
3.27.3	Süd-Chemie Water-Gas Shift Catalysts	3-88
3.27.4	Süd-Chemie Carbon Monoxide Purification Catalysts:	3-88
3.27.5	Süd-Chemie Off-Gas Combustion Catalysts:	3-89
3.27.6	Süd-Chemie Syngas Catalysts	3-90
3.28	Catalysts for Butane Reforming in Zirconia Fuel Cells	3-90
3.29	IdaTech and RWE	3-91

FUEL CELL CATALYSTS TECHNOLOGY

4. FUEL CELL CATALYST TECHNOLOGY	4-1	
4.1	Catalyst Allows Chemical Conversions	4-1
4.2	Cabot Proprietary Technology Attaches Organic Groups To The Surface Of Carbon Black Particles	4-1
4.2.1	Surface Of Carbon Black Particles Ewplaxes Organic Groups Oxidation And Surfactant Adsorption	4-2
4.3	Johnson Matley Noble Metal Hydrodechlorination Catalyst	4-2
4.3.1	Johnson Matley Tungsten-Containing Fuel Cell Catalyst	4-3
4.4	Carbon Nanotechnologies	4-3
4.5	NEC Nanoparticle Fabrication	4-4
4.5.1	Calixarene	4-4
4.5.2	NEC Iron Nanoparticle LANS Process	4-5
4.5.3	Key Nanotechnologies	4-6
4.6	QuantumSphere Positions Nano-palladium To Replace Platinum	4-9
4.7	Membrane PEM Fuel Cell	4-10
4.7.1	QuantumSphere High-Quality Nanocatalysts	4-11
4.8	Coal Gasification	4-12
4.9	Hydrogen	4-12
4.9.1	Metalloporphyrin Catalysts	4-17
4.10	Gold Catalyst For Fuel Cells	4-17

FUEL CELL CATALYSTS COMPANY PROFILES

5. FUEL CELL CATALYST COMPANY PROFILES	5-1	
5.1	ACTA	5-1
5.1.1	Acta Technology	5-3
5.1.2	ACTA Revenue	5-4
5.1.3	ACTA Fuel Cell Technology Distribution Contract With Sumitomo / Summit Medichem	5-4
5.1.4	Acta Proprietary Nanotechnology	5-5
5.2	Argonne National Laboratory	5-6
5.3	BASF Fuel Cell GmbH Targets Fuel Cell Industry	5-7

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5.3.1	BASF / PEMEAS	5-7
5.3.2	BASF Fuel Cell	5-7
5.3.3	BASF / PEMEAS / E-TEK	5-9
5.4	Cabot Corporation	5-10
5.4.1	Cabot Fuel Cells Group	5-11
5.5	DoppStein Enterprises	5-12
5.6	Engelhard	5-13
5.7	Fuel Cell Energy	5-13
5.8	Johnson Matthey	5-15
5.8.1	Johnson Matthey Catalysts Division	5-16
5.8.2	Johnson Matthey Builds Autocatalyst Facility In Korea	5-16
5.8.3	Johnson Matthey Autocatalyst Facility In Russia	5-17
5.8.4	Johnson Matthey Speciality Chemicals	5-18
5.9	National Hydrogen Association	5-19
5.10	Oxford Catalysts	5-19
5.10.1	Oxford Catalysts Revenue	5-22
5.10.2	Oxford Catalysts Licences	5-23
5.10.3	Oxford Catalysts Patents	5-23
5.11	PolyFuel	5-24
5.2	QuantumSphere	5-27
5.11.1	QuantumSphere Advanced Materials Leveraging Nano Catalysts for Clean-Energy Applications	5-29
5.11.2	QuantumSphere Nanoscale Catalyst Materials	5-30
5.11.3	QuantumSphere Highly Efficient Hydrogen Generation via Water Electrolysis Using Nanometal Electrodes	5-31
5.12	SGL Group:	5-32
5.12.1	SGL Group – The Carbon Company	5-33
5.3	Süd-Chemie Incorporated	5-44
5.12.2	Süd-Chemie in Quebec in Lithium Iron Phosphate production	5-44
5.13	Superprotonic	5-46

List of Tables and Figures

FUEL CELL CATALYSTS EXECUTIVE SUMMARY

Table ES-1	ES-5
Fuel Cell Catalysts Market Driving Forces	
Figure ES-2	ES-6
Worldwide Fuel Cell Catalysts Market Shares, Dollars, First Half 2007	
Figure ES-3	ES-13
Worldwide Fuel Cell Catalysts Market Forecasts, Dollars, 2007-2013	

FUEL CELL CATALYSTS MARKET DESCRIPTION AND MARKET DYNAMICS

Table 1-1	1-5
Influence Of The Surface Morphology On The Kinetics Of A Cathodic Fuel Cell Reaction	
Table 1-2	1-7
Types Of Fuel Cell Technologies	
Table 1-3	1-8
Comparison of Fuel Cell Technologies	
Figure 1-4	1-24
Schematic Drawing Of Platinum Deposition In A Polymer Electrolyte Membrane.	
Figure 1-5	1-26
TEM Images Of A Cross-Section Of MEA	

FUEL CELL CATALYSTS MARKET SHARES AND MARKET FORECASTS

Table 2-1	2-4
Fuel Cell Catalysts Market Driving Forces	
Table 2-2	2-5
Fuel Cell Catalysts Market Functions	
Figure 2-3	2-7
Worldwide Fuel Cell Catalysts Market Shares, Dollars, First Half 2007	
Figure 2-4	2-8
Worldwide Fuel Cell Catalysts Shipment Market Shares, Dollars, 2006 and First Half 2007	
Figure 2-5	2-15
Worldwide Fuel Cell Catalysts Market Forecasts, Dollars, 2007-2013	
Table 2-6	2-16
Worldwide Fuel Cell Catalysts Market Forecasts, Dollars, 2007-2013	
Table 2-7	2-17
Worldwide Fuel Cell Catalysts Market Forecasts, Percent, 2007-2013	
Table 2-8	2-29
Platinum Supply and Demand	
Table 2-9	2-34
Worldwide Stationary Fuel Cell Market Growth Drivers	
Table 2-10	2-35
Worldwide Stationary Fuel Cell Market Segments	
Table 2-11	2-36
Fuel cell Technology Positioning	
Table 2-12	2-37
Stationary Fuel Cells Strengths and Weaknesses	
Table 2-13	2-48
Japanese Government Schedule for Fuel Cell Introduction	
Table 2-14	2-50
Japanese Sales Prospects	

FUEL CELL CATALYSTS PRODUCT DESCRIPTION

Table 3-1	3-4
Johnson Matthey Products	
Table 3-2	3-5
HiSPEC® Product Line	
Table 3-3	3-6
Johnson Matthey Ongoing Catalyst Development	
Table 3-4	3-7
Fuel Processing Applications Of The Johnson Matthey Syntex Company	
Table 3-5	3-9
Fuel Cell Catalysts:	
Table 3-6	3-13
Acta Catalyst Products	
Table 3-7	3-21
QSI-Nano® catalyst solution:	
Table 3-8	3-24
QuantumSphere Central Research Strategies	
Table 3-9	3-25
QuantumSphere Central Research Directions Meant to Achieve Commercially Viable FuelCell Catalyst Applications	

Figure 3-10	3-29
QuantumSphere Porous Electrode	
Figure 3-11	3-30
QuantumSphere Surface of Electrode 10 nm Particles In Electrode (Nanoparticles On A Support)	
Figure 3-12	3-31
QuantumSphere 10 nm particles in electrode (Width 75 Nanometer) Porous Catalyst	
Figure 3-13	3-32
Cost per gge As A Function Of Electricity Cost	
Table 3-14	3-36
Quantumsphere's catalyst products	
Table 3-15	3-41
BASF Fuel Cell Features	
Table 3-16	3-44
E-TEK Catalyst Products	
Table 3-17	3-44
E-TEK's Catalyst Technologies	
Table 3-18	3-47
Cabot's Dynalyst® Electrocatalysts	
Table 3-19	3-48
Cabot's Dynalyst® Electrocatalysts Key Properties	
Table 3-20	3-49
Cabot's Dynalyst® Electrocatalysts Key Applications	
Table 3-21	3-53
Cabot Manipulation Of More Substances Via Expansion Of What Is Possible With Carbon Blacks	
Table 3-22	3-56
Cabot Advanced Fuel Cell Electrocatalysts Functions	
Figure 3-23	3-71
Oxford Catalysts	

FUEL CELL CATALYSTS TECHNOLOGY

Table 4-1	4-13
Hydrogen-Air Fuel Cell Performance	
Figure 4-2	4-15
Metal Chalcogenides Group Of Materials With Potential For Replacing Platinum In The Pefc Cathode	

FUEL CELL CATALYSTS COMPANY PROFILES

Table 5-1	5-2
University ACTA Development Programs	
Table 5-2	5-8
BASF Fuel Cell Activities	
Table 5-3	5-20
Oxford Catalysts Group Initiatives	

ABOUT THE COMPANY

WINTERGREEN RESEARCH, HAS A UNIQUE RESEARCH STRATEGY THAT RELATES TO IDENTIFYING MARKET TRENDS THROUGH READING AND INTERVIEWING OPINION LEADERS. BY READING THE ELECTRONIC EQUIVALENT OF 40 FEET OF PAPER, WINTERGREEN RESEARCH SENIOR ANALYSTS CAN LEARN A LOT MORE ABOUT MARKETS, A LOT FASTER THAN CAN BE LEARNED THROUGH EXPENSIVE SURVEYS AND FOCUS GROUPS. THINKING ABOUT MARKET TRENDS IS A HIGH PRIORITY AT WINTERGREEN RESEARCH. AS WITH ALL RESEARCH, THE VALUE PROPOSITION FOR COMPETITIVE ANALYSIS COMES FROM INTELLECTUAL INPUT.

IT IS A LUXURY REALLY, AVAILABLE TO ONLY A VERY FEW PEOPLE, TO BE ABLE TO GATHER INFORMATION, LOTS OF INFORMATION FROM READING MASSIVE AMOUNTS OF CONTENT, AND THEN TRYING TO MAKE SENSE OF THAT CONTENT. THE ABILITY TO THINK ABOUT MARKET TRENDS IS ENHANCED BY DOING IT OVER AND OVER FOR MANY DIFFERENT MARKETS. THAT IS WHAT WINTERGREEN RESEARCH IS ALL ABOUT: READING AND THINKING IS AN ESSENTIAL ASPECT OF COMPETITIVE ANALYSIS. TALKING TO OPINION LEADERS IS THE THIRD ESSENTIAL ASPECT OF PRODUCING GOOD, RELIABLE DATA.

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ABOUT THE PRINCIPAL AUTHORS

ELLEN T. CURTISS, TECHNICAL DIRECTOR, CO-FOUNDER OF WINTERGREEN RESEARCH, CONDUCTS STRATEGIC AND MARKET ASSESSMENTS IN TECHNOLOGY-BASED INDUSTRIES. PREVIOUSLY SHE WAS A MEMBER OF THE STAFF OF ARTHUR D. LITTLE, INC., FOR 23 YEARS, MOST RECENTLY AS VICE PRESIDENT OF ARTHUR D. LITTLE DECISION RESOURCES, SPECIALIZING IN STRATEGIC PLANNING AND MARKET DEVELOPMENT SERVICES. SHE IS A GRADUATE OF BOSTON UNIVERSITY AND THE PROGRAM FOR MANAGEMENT DEVELOPMENT AT HARVARD GRADUATE SCHOOL OF BUSINESS ADMINISTRATION. SHE IS THE AUTHOR OF RECENT STUDIES ON WORLDWIDE TELECOMMUNICATIONS MARKETS, THE TOP TEN INTERNET EQUIPMENT COMPANIES, THE TOP TEN CONTRACT MANUFACTURING COMPANIES, AND THE TOP TEN TELECOMMUNICATIONS MARKET ANALYSIS AND FORECASTS.

SUSAN EUSTIS, PRESIDENT, CO-FOUNDER OF WINTERGREEN RESEARCH, HAS DONE RESEARCH IN COMMUNICATIONS AND COMPUTER MARKETS AND APPLICATIONS. SHE HOLDS SEVERAL PATENTS IN MICROCOMPUTING AND PARALLEL PROCESSING. SHE HAS THE ORIGINAL PATENTS IN ELECTRONIC VOTING MACHINES. SHE HAS NEW PATENT APPLICATIONS IN FORMAT VARYING, MULTIPROCESSING, AND ELECTRONIC VOTING. SHE IS THE AUTHOR OF RECENT STUDIES OF THE REGIONAL BELL OPERATING COMPANIES' MARKETING STRATEGIES, INTERNET EQUIPMENT, BIOMETRICS, A STUDY OF INTERNET EQUIPMENT, WORLDWIDE TELECOMMUNICATIONS EQUIPMENT, TOP TEN TELECOMMUNICATIONS, DIGITAL LOOP CARRIER, WEB HOSTING, WEB SERVICES, AND APPLICATION INTEGRATION MARKETS. MS. EUSTIS IS A GRADUATE OF BARNARD COLLEGE.

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