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Patent Landscape and Market Evaluation Report

Research and Analysis Completed by
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Project

Organic Photovoltaic Solar Cell Technology: Polymer/Copolymer Materials

[Note: Details of this project have been redacted to insure confidentiality and copyright compliance.]

Goals

1. Patent Landscaping and Patent Citation Analysis for Strategic View of Invention Area, Prior Art, and Potential Licensees
2. Market Research for Commercialization Opportunity
3. Grant/Funding Opportunity Research

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Patent Landscaping & Market Evaluation Service
Delivering custom reports with insights into your idea's IP and commercial landscape

 **PATENT LANDSCAPE**
Mapping subject areas of intellectual property in your invention area to find crowded peaks and open valleys

 **MARKET RESEARCH**
Researching opportunities and market size for your invention and its related products and services

 **POTENTIAL FUNDING**
Identifying possible licensees, grants and funding opportunities to reach the commercial market

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Analysis of Findings

Patent Landscape – Insights from the Research

The patent landscape identified several companies of potential interest as customers, partners, or competitors.

- Air Products and Chemicals, Inc. (<http://www.airproducts.com/>), past partner of Konarka
- Ocean's King Lighting (<http://www.oceansking.com/>), maker of professional lighting products
- Rieke Metals, Inc. (<http://www.riekemetals.com/polymers>), supplier of reagents and polymers

Patents with potential infringement issues were discussed in our last face-to-face meeting.

Scientific/Technical Literature

We identified several pieces of literature that examine the patent, business, and technology landscapes of organic solar cells and related invention areas. Details on key citations are in the results section below.

Market Research

The photovoltaic market has been flooded with an oversupply of polysilicon, which has made it nearly impossible for organic materials to compete. The competitive concerns for organic photovoltaics include cost, efficiency, and lifespan. Like all alternative photovoltaic technologies, organic photovoltaics must be innovative in a market niche to achieve commercial success. Potential opportunities for organic photovoltaics include transportation and portable electronic device applications.

The high-profile failures of Konarka and other companies have resulted in declining investment in this space as well as industry consolidation. Companies currently involved in developing organic solar technology include Belectric, Eight19, Heliatek, Plextronics, and Solarmer.

Grant and Funding Opportunities

This report includes a list of possible federal, state, and nonprofit or private foundation grant-making agencies. The Federal resources section has a two-fold focus: (1) renewable energy research, particularly from the Department of Energy and National Science Foundation and (2) Small Business Innovation (SBIR) and Small Business Technology Transfer (STTR) grants. Additionally, North Carolina has a complement award to SBIR/STTR through the One North Carolina Small Business Program. A Foundation Directory database search was conducted to find nonprofit and private foundation grant-making agencies that focus on solar research or renewable energy.

How to Review this Research

- This document provides a synopsis and the overall analysis of research for this project. Please read it thoroughly.
- Retain copies of all digital files and e-mails shared for this project. They may be used in future reviews with OTD staff and with patent attorneys.
- Review search terms below and let me know if there are any typos or missing synonyms/variations that may be key to the research.
- Excel spreadsheets of patents and applications from search results are ordered by geography and status of application: US patents are listed first, followed by US patent applications; European patents, European patent applications, then WIPO patents, and so on. Within these groupings, the documents are listed from most recent to oldest.
- Excel spreadsheets of patents and applications from search results have multiple tabs. The first tab shows a smaller set of selected results for additional review, given their relevance to your invention either in a single significant correlation or through multiple elements of correlation.
- Additional full-text documents are provided for patents, patent applications, and articles of greatest relevance to your research. Please note that these are provided from UNC-Chapel Hill resources for its faculty, staff, and students, and should not be distributed more broadly. This report provides a summary and analysis of findings to serve your needs for wider distribution. Always follow copyright law and cite sources in any presentations or other re-packaging of information.

Disclaimer: This analytical report is provided to you for informational purposes only. Detailed findings should be reviewed by you and your team (including your legal) team for final interpretation and decision-making. Remember that patents don't give anyone the right to practice, only a right to exclude others from practicing. To this end, some results presented herein should be considered as prior art for your patent filings. We are not rendering any legal opinion of which prior art overlaps or infringes, as that could be damaging to those for whom we do provide this service. We are not lawyers: we will only go as far as listing POTENTIALLY relevant prior art to give inventors a sense of crowdedness.

Recommended Next Steps

Follow-up with your contact(s) in the Office of Technology Development (OTD) to...

1. Review any patents and applications to determine if any of their claims signal possible infringement between prior art and your invention. Active hyperlinks are available in your Excel spreadsheet documents to access the documents, but if you need assistance with them, please let me know.
2. New patent applications
 - a. Has UNC filed any apps or is this in process?
 - b. Is prior art identified/not identified that suggest that we should consider filing/not filing?
3. Existing patent applications
 - c. Does any of this info suggest that we should reconsider the strategy and/or claims for apps already filed?
 - d. Some of this info may need to be added to the invention disclosure.
4. Commercialization and Freedom to Operate: Regardless of whether going for licensing to existing company or start-up..
 - e. Are there dominating patents likely needed by a licensee?
 - f. Are there similar patents such that there is a potential strategic partner identified?

EXAMPLE

Research and Analysis

Market Research

The Photovoltaic Market

The global revenue from solar cells and modules was approximately \$39 billion in 2011. BCC Research expects that the total shipment value for photovoltaics will grow and reach over \$78 billion in 2017. This growth will be driven by growth in Asia, North America, and emerging markets.¹ Market share by photovoltaic module type is in the table below.

Market Share, Module Types, 2011 (%)

Technology	Market Share %
Polycrystalline	46
Monocrystalline	41
Thin film	11
Non-silicon	2
Total	100

Source: BCC Research (2012, September). *Global Markets and Technologies for Photovoltaic Systems*.

Retrieved from <http://www.bccresearch.com>.

The Organic Photovoltaic (OPV) Market

Third-generation photovoltaic technologies, which include organic photovoltaics (OPV), are expected to experience significant market growth over the next five to ten years. BCC Research estimates that the market for these technologies will grow from \$317 million in 2013 to approximately \$2 billion in 2018. OPVs are forecast to have a very high annual growth rate, but they will still remain a small part of the alternative photovoltaic market and even smaller part of the overall solar technology industry.²

IDTechEx estimates that the OPV market will be \$87 million by 2023. According to IDTechEx, market growth will be predominantly driven by “electronics in apparel, posters and PoP smart labels, and off-grid developing world applications.” IDTechEx shares similar predictions as BCC Research analysts, noting that “OPVs will nonetheless remain a small player on the greater PV scene, obtaining total market shares <1.5%.”³

¹ BCC Research (2012, September). *Global Markets and Technologies for Photovoltaic Systems*. Retrieved from <http://www.bccresearch.com>.

² BCC Research (2014, February). *Alternative Photovoltaic Solar Cell Technologies: Global Markets*. Retrieved from <http://www.bccresearch.com>.

³ IDTechEx (2013). *Organic Photovoltaics (OPV) 2013-2023: Technologies, Markets, Players*. Report description retrieved from <http://www.idtechex.com/research/reports/organic-photovoltaics-opv-2013-2023-technologies-markets-players-000349.asp>.

**Global Markets for Third-Generation Solar Technologies by Generative Capacity Demanded,
Through 2018 (MWp)**

Technologies	2012	2013	2018	CAGR% 2013-2018
MJPVs and CPVs	400.0	500.0	3,320.0	46.0
OPVs	1.7	3.5	78.1	86.1
Total	401.7	503.5	3,398.1	46.5

Source: BCC Research (2014, February). *Alternative Photovoltaic Solar Cell Technologies: Global Markets*. Retrieved from <http://www.bccresearch.com>.

There are several markets for alternative solar photovoltaics, including grid and off-grid power for buildings, transportation, and portable electronic devices. According to BCC Research, the transportation application segment is an area that third-generation photovoltaics like OPVs may find success because of their suitability to meet environmental demands.

**Technological Mix for Transportation Applications of Alternative Solar Technologies by Generative
Capacity Demanded, Through 2018 (MWp)**

Generation	2012	2013	2018	CAGR% 2013-2018
Second-generation	28.0	39.0	131.0	27.4
Third-generation	22.0	35.0	279.0	51.5
Total*	50.0	74.0	410.0	40.8

Note: * Total may not match exactly because of rounding.

Source: BCC Research (2014, February). *Alternative Photovoltaic Solar Cell Technologies: Global Markets*. Retrieved from <http://www.bccresearch.com>.

OPVs also have potential in portable electronic device power applications, but success will depend on the utilization of other types of solar technologies.

Technological Utilization for Portable Electronic Device Power Applications by Annual Shipment Capacity, Through 2018 (MWp)

Technology	2012	2013	2018	CAGR% 2013-2018
Amorphous silicon (a-Si)	32.0	45.0	75.0	10.8
Copper Indium Gallium (di)Selenide (CIGS)	26.0	51.0	335.0	45.7
Concentrating photovoltaics (CPV)	8.0	15.0	375.0	90.4
Gallium Arsenide (GaAs)	4.0	26.0	115.0	34.6
Organic photovoltaics (OPV)	1.0	2.0	30.0	71.9
Cadmium telluride (CdTe)	-	1.0	35.0	103.6
Total	71.0	140.0	965.0	47.1

Source: BCC Research (2014, February). *Alternative Photovoltaic Solar Cell Technologies: Global Markets*. Retrieved from <http://www.bccresearch.com>.

Industry Activity

Numerous OPV and alternative photovoltaic companies failed and went bankrupt in 2011 and 2012. Konarka’s high profile failure in 2012 is an example of OPV technology being forced to market before it was ready to compete with the price and efficiency of existing technologies. A Lux Research analyst explained that “It was hard for Konarka to find that unique place where its product would win out over the alternatives.”⁴

The photovoltaic market has been flooded with an oversupply of polysilicon, which has made it nearly impossible for organic materials to compete. Konarka’s materials were tested by the U.S. Army for use on tents, but the two products that made it to market include a \$180 messenger bag and a \$10,000 patio umbrella.⁵ The failure of Konarka and other companies has resulted in declining investment in this space.

In addition to declining interest from inventors, the failure of OPV and other alternative photovoltaic technology companies has begun a trend towards industry consolidation. Larger holding companies and multinational firms have acquired these technologies in some cases. After its bankruptcy, Konarka was acquired by Belectric. At the time of acquisition, Belectric was planning on carrying on Konarka’s work in organic photovoltaics. Belectric’s CFO said that they would use the flexible and pliable “Power Plastic” material in façade construction, the automotive sector, and the consumer segment.⁶

⁴ Kirsner, S. (2012, July 8). *What Went Wrong at Solar Start-up?* The Boston Globe. Retrieved from <http://www.factiva.com>.

⁵ *Ibid.*

⁶ “Germany: Belectric Buys Konarka GMBH” (2012, October 23). Retrieved from <http://www.factiva.com>.

Other companies involved in the development and manufacture of organic solar technology include Eight19, Heliatek, Plextronics, and Solarmer. Plextronics and Solarmer have both received funding from U.S. government agencies, including the Department of Energy and various Department of Defense research laboratories.

Company	Partners & Investors	Federal Funding Sources
Eight19	Solvay The Carbon Trust Cambridge Enterprise	
Heliatek	BASF Bosch RWE Wellington Partners eCapital Entrepreneurial Partners AG	
Plextronics	Solvay Universal Display Corporation Applied Ventures, LLC Firelake Strategic Technology Fund	US Department of Energy US Army Research Laboratory US Air Force Research Laboratories
Solarmer	University of California, Los Angeles University of Chicago Inst. of Chemistry, Chinese Academy of Sciences Phillips 66 Organic Electronics Association FlexTech Alliance	US Department of Energy National Science Foundation (NSF) Office of Naval Research US Air Force Research Laboratory

Source: Company websites, Factiva

Patent Landscape – Review of Best Results

Search 1:

Derwent Manual Code U11-C01J5 classification for

- U SEMICONDUCTORS AND ELECTRONIC CIRCUITRY
- U11 SEMICONDUCTOR MATERIALS AND PROCESSING
- U11-C SUBSTRATE PROCESSING FOR SEMICONDUCTOR DEVICE MANUFACTURE
- U11-C01 DEPOSITION OF ACTIVE MATERIALS (E.G. SEMICONDUCTORS)
- U11-C01J NATURE/STRUCTURE/MATERIAL/COMPOSITION OF ACTIVE LAYERS
- U11-C01J5 POLYMER, ORGANIC FILM STRUCTURES

AND

DWPI terms: ((solar OR photovoltaic*) NEAR5 (organic OR active)) AND (polymer OR copolymer)

AND

Years: 2000 to present

Results: 51 DWPI families



Search 2:

International Patent Classes: H01L OR H01M

AND

Terms in Title/Abstract/Claims: (solar OR photovoltaic) NEAR5 (organic OR active)

AND

Years 2000 to present

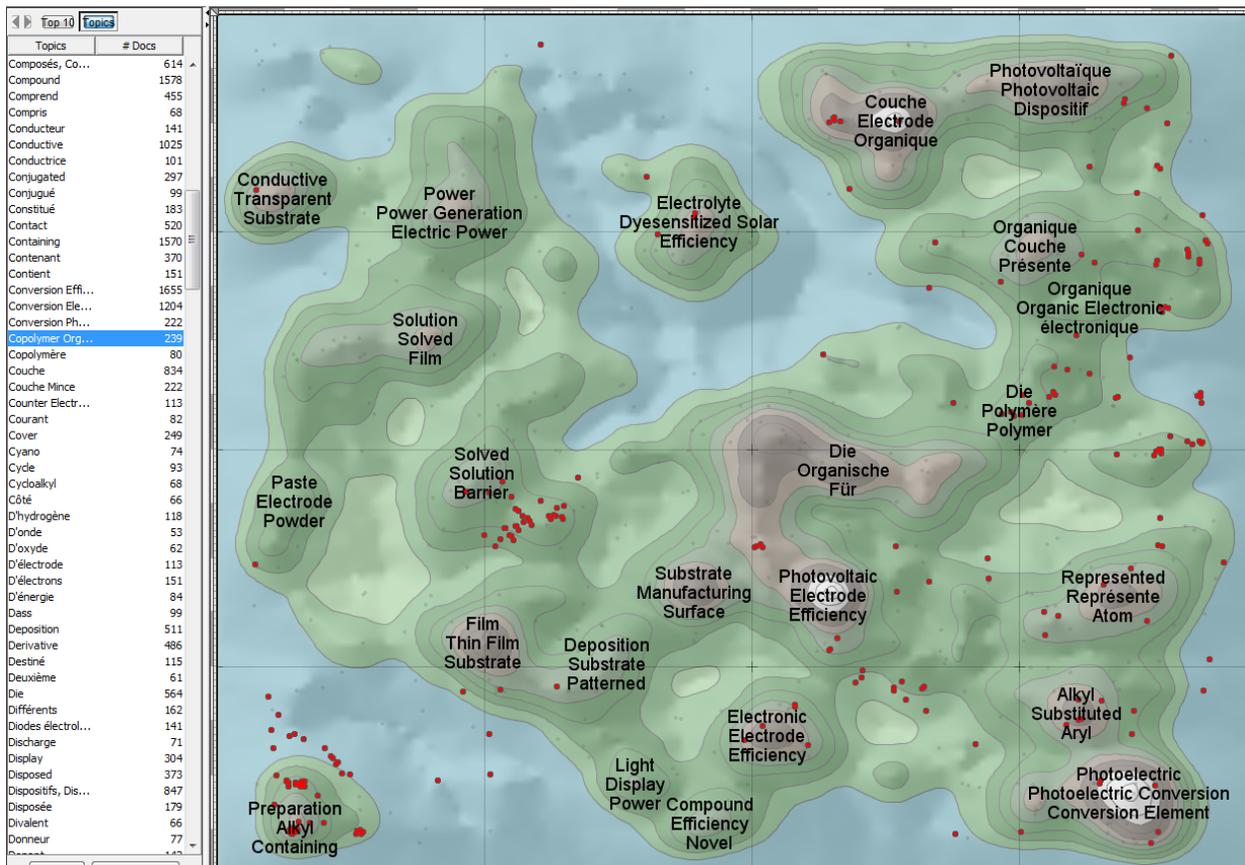
H01L: SEMICONDUCTOR DEVICES; ELECTRIC SOLID STATE DEVICES NOT OTHERWISE PROVIDED FOR (use of semiconductor devices for measuring G01; resistors in general H01C; magnets, inductors, transformers H01F; capacitors in general H01G; electrolytic devices H01G000900; batteries, accumulators H01M; waveguides, resonators, or lines of the waveguide type H01P; line connectors, current collectors H01R; stimulated-emission devices H01S; electromechanical resonators H03H; loudspeakers, microphones, gramophone pick-ups or like acoustic electromechanical transducers H04R; electric light sources in general H05B; printed circuits, hybrid circuits, casings or constructional details of electrical apparatus, manufacture of assemblages of electrical components H05K; use of semiconductor devices in circuits having a particular application, see the subclass for the application) (16 child classes)

H01M: PROCESSES OR MEANS, e.g. BATTERIES, FOR THE DIRECT CONVERSION OF CHEMICAL ENERGY INTO ELECTRICAL ENERGY (electrochemical processes or apparatus in general C25; semiconductor or other solid state devices for converting light or heat into electrical energy H01L, e.g. H01L003100, H01L003500, H01L003700) (8 child classes)

EXAMPLE

Results: 19,303 patent records in 6,433 DWPI families

Red markers show topic of copolymer organics



EX

Search 3:

(benzene AND thiophene) in title/abstract/claims

AND

("Light absorbing" OR Solar OR photovoltaic) in DWPI abstract

Years: 2000 to present

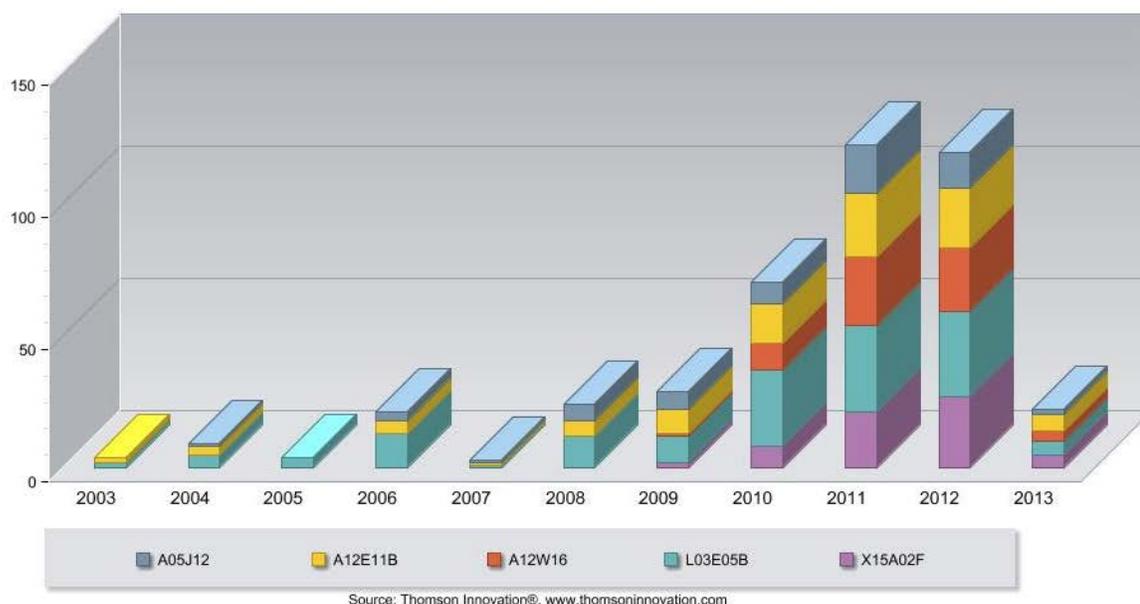
Excluding ("light emitting" OR lighting) in title/abstract/claims

629 patent results in 256 DWPI families

Results set for browsing opportunities in technologies and partnerships:

- Patent Search 3 - 256 DWPI excel2013-05-08-12-38-58.xlsx

Top DWPI Manual Codes by Year



A05J12: Polypyrroles and Polythiophenes (Optionally substituted.)

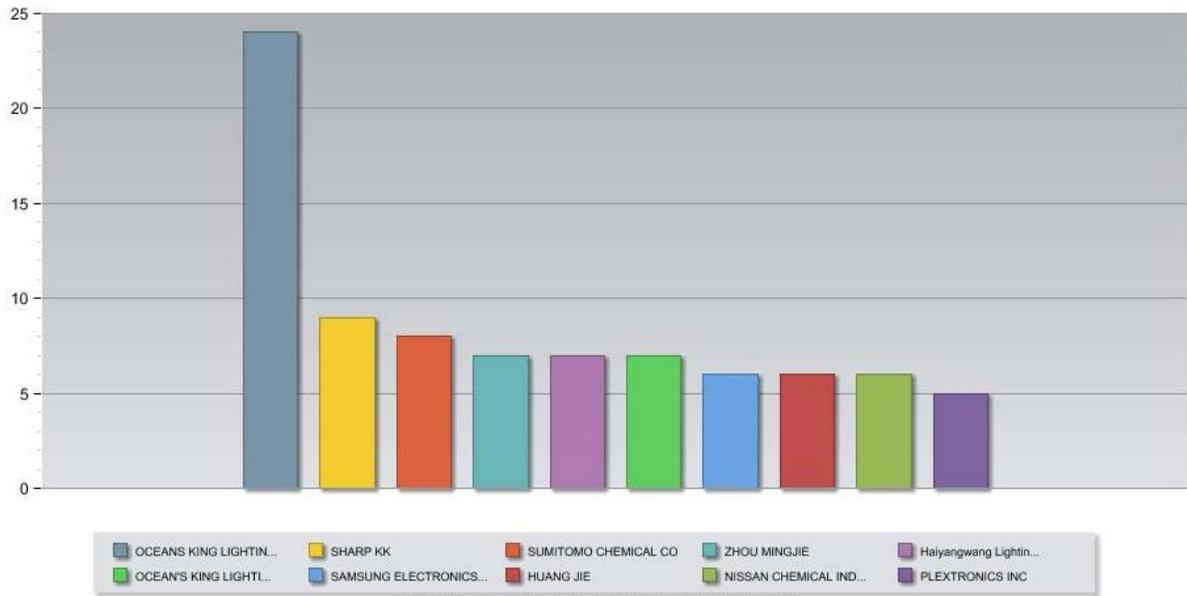
A12E11B: Photoelectric cells (Including solar cells)

A12W16: Renewable Energy

L03E05B: Solar Cells

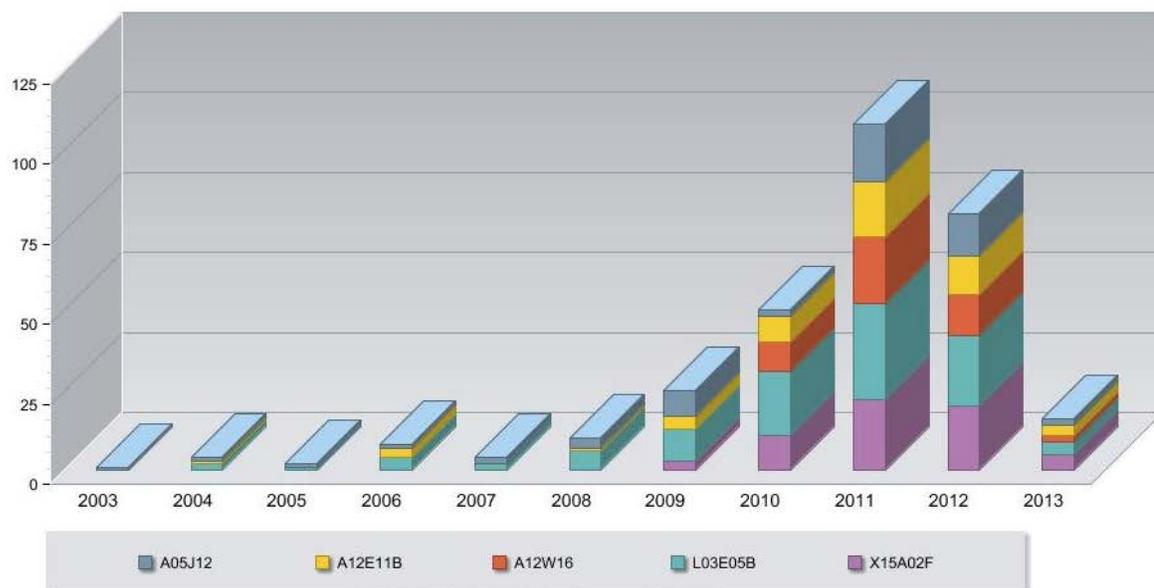
X15A02F: Organic solar cells (Includes cells that use electron-acceptor and electron-donor organic materials)

Top Assignees



EXAMPLE

Top DWPI Manual Codes by Year



Source: Thomson Innovation®, www.thomsoninnovation.com

A05J12: Polypyrroles and Polythiophenes (Optionally substituted.)

A12E11B: Photoelectric cells (Including solar cells)

A12W16: Renewable Energy

L03E05B: Solar Cells

X15A02F: Organic solar cells (Includes cells that use electron-acceptor and electron-donor organic materials)

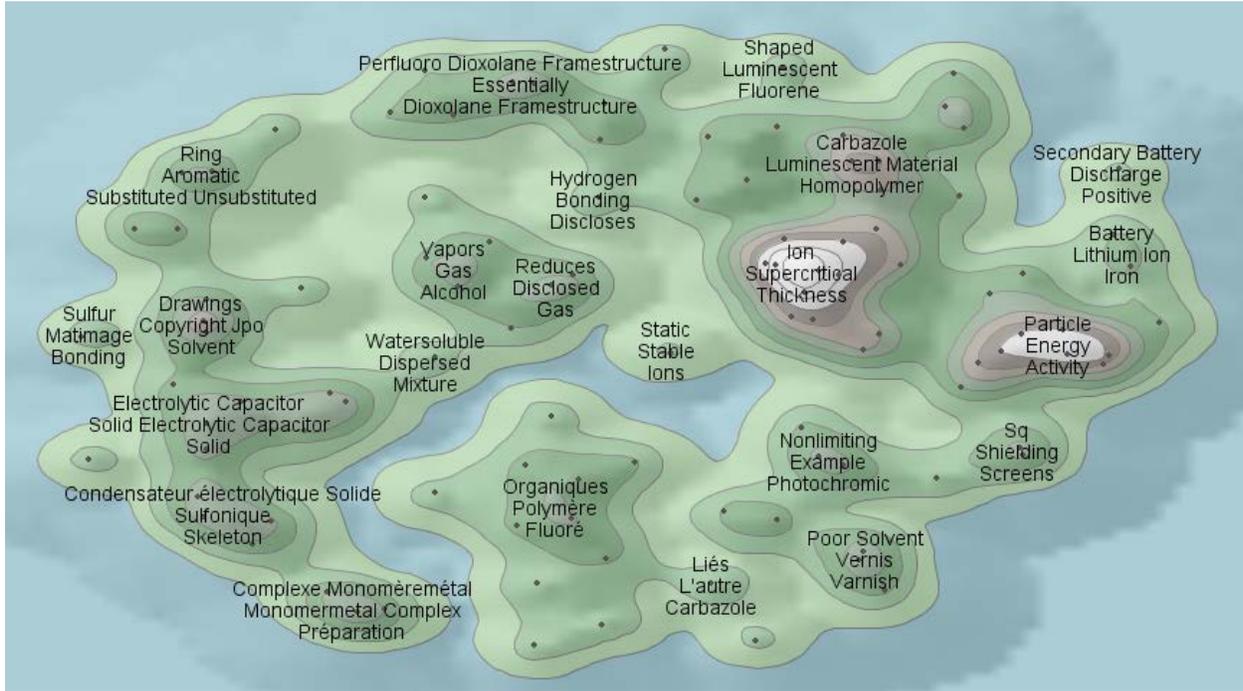
Assignee/Applicant	Publication Year	Document Count	Percentage
BASF SE	Multiple	5	4.13%
BUESING ARNE	Multiple	3	2.48%
Haiyangwang Lighting Technology Co., Ltd.	Multiple	7	5.79%
HEUN SUSANNE	Multiple	3	2.48%
HUANG JIE	Multiple	7	5.79%
LIU HUI	2011	3	2.48%
LUDEMANN AURELIE	Multiple	3	2.48%
MERCK PATENT GMBH	Multiple	14	11.57%
NISSAN CHEMICAL IND LTD	Multiple	4	3.31%
OCEAN'S KING LIGHTING SCIENCE AND TECHNOLOGY CO., LTD., SHENZHEN	Multiple	7	5.79%
OCEANS KING LIGHTING SCIENCE	Multiple	25	20.66%
OCEANS KING LIGHTING TECH CO	Multiple	5	4.13%
PLEXTRONICS INC	Multiple	4	3.31%
RIEKE METALS INC	2009	4	3.31%
SHARP KK	Multiple	4	3.31%
SHEINA ELENA E	Multiple	3	2.48%
SUMITOMO CHEMICAL CO	Multiple	5	4.13%
UNIVERSAL DISPLAY CORP	Multiple	4	3.31%
XU ERJIAN	Multiple	3	2.48%
ZHOU MINGJIE	Multiple	8	6.61%

Search 5:

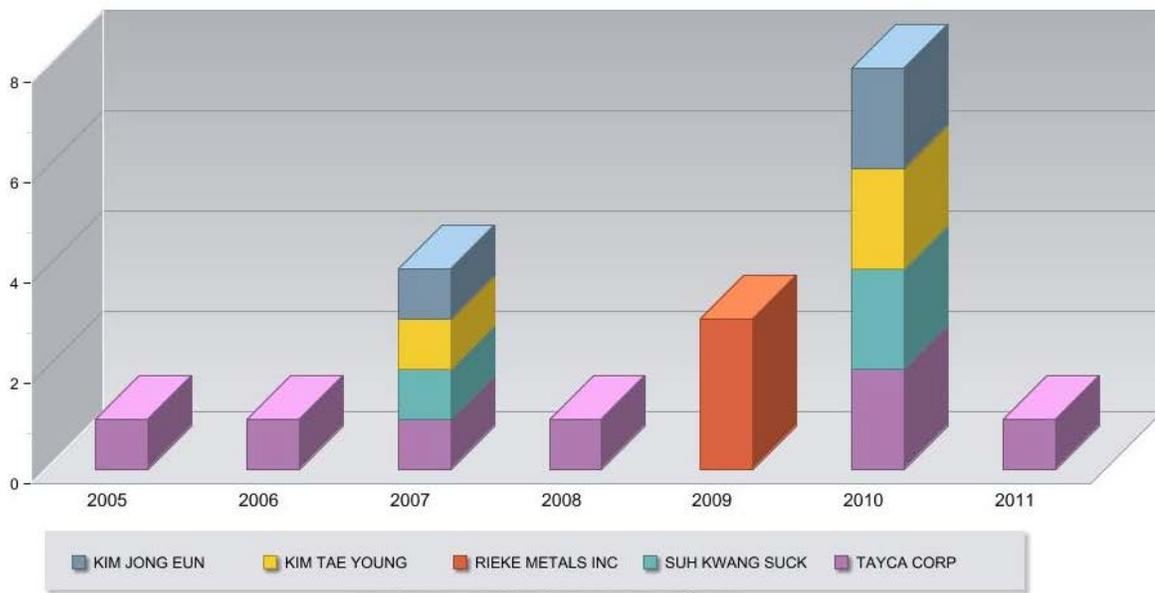
Searching all Derwent (DWPI) terms for benzene AND thiophene AND monomer* AND polymer* AND (organic OR "active material*")

Years: 2000 to present

402 patent records in 108 DWPI families

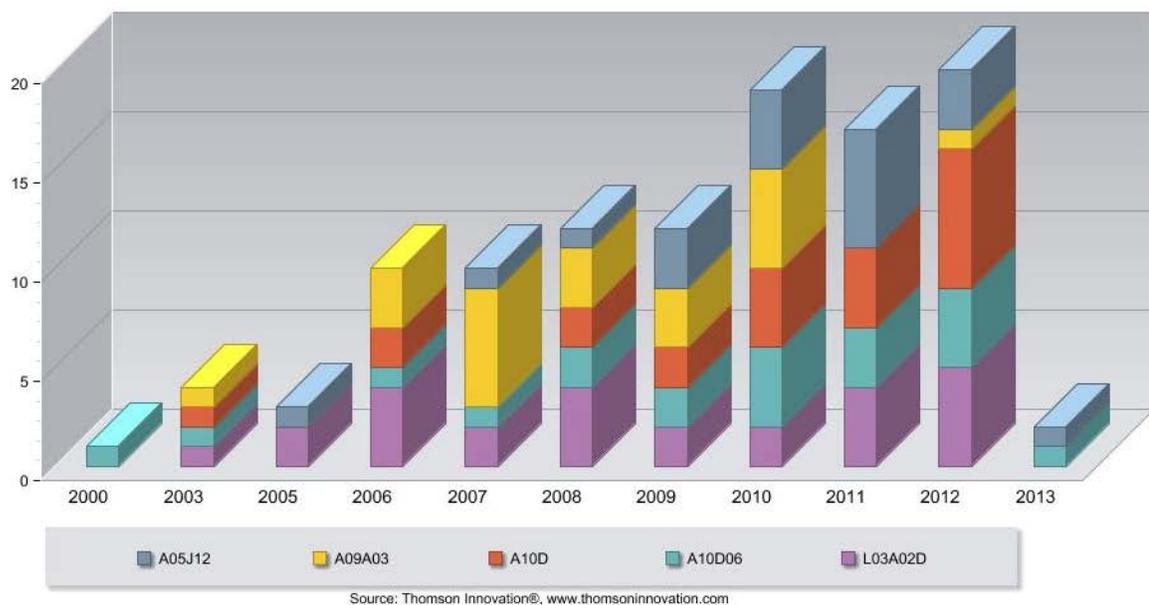


Top Assignees by Year



Source: Thomson Innovation®, www.thomsoninnovation.com

Top DWPI Manual Codes by Year



A05J12: Polypyrroles and Polythiophenes (Optionally substituted.)

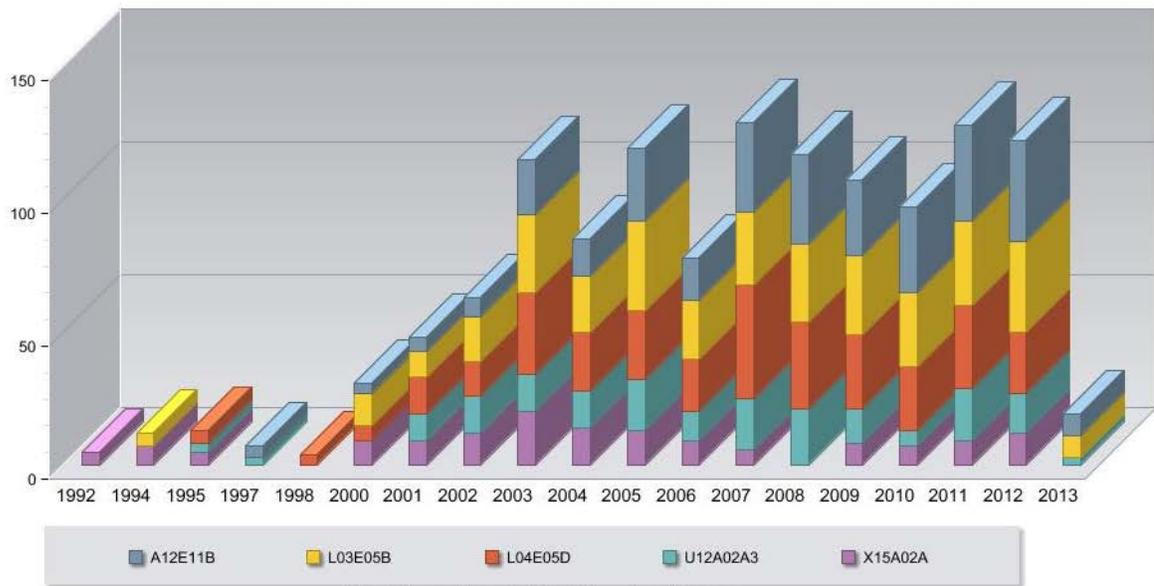
A09A03: Electrical e.g. (non)-conductivity. (Including for (doped) polyacetylenes)

A10D: CONDENSATION POLYMERISATION

A10D06: Electrolytic/oxidative polymerisation

L03A02D: Conductive polymers

Top DWPI Manual Codes by Year



Source: Thomson Innovation®, www.thomsoninnovation.com

A12E11B: Photoelectric cells (Including solar cells)

L03E05B: Solar cells

L04E05D: Other direct energy conversion devices... Hybrid cells

U12A02A3: Characterised by solar cell mfr. (Use instead of U12-A02A2 if manufacturing apparatus details are mentioned without emphasis on novel materials or structures.)

X15A02A: Direct conversion photovoltaic panel details; solar/photovoltaic cells details: Single cells (Includes photovoltaic or solar cells (see also U12-A02 codes) and their manufacture.)

Additional patent searches with variations of the above search strategies and search terms yielded similar results, thereby signaling a high level of confidence in our having a complete view of the surrounding invention space to your work.

Regarding patent maps above, “This material is reproduced under a license from Thomson Reuters. You may not copy or re-distribute this material in whole or in part without the written consent of the Scientific business of Thomson Reuters.”

EXAMPLE

Scientific and Technical Literature

Recommendation

Recommended next step: Complete an additional search of the scientific and technical literature in the next iteration of this project to look for potential future direction and other applications of this invention area.

ScienceDirect

- organic photovoltaic AND market
- organic photovoltaic AND patent

Key Citations (Listed in order of usefulness)

Sebastien Lizin, Julie Leroy, Catherine Delvenne, Marc Dijk, Ellen De Schepper, Steven Van Passel, A patent landscape analysis for organic photovoltaic solar cells: Identifying the technology's development phase, *Renewable Energy*, Volume 57, September 2013, Pages 5-11, ISSN 0960-1481, 10.1016/j.renene.2013.01.027.

(<http://www.sciencedirect.com/science/article/pii/S0960148113000657>)

T.M. Razykov, C.S. Ferekides, D. Morel, E. Stefanakos, H.S. Ullal, H.M. Upadhyaya, Solar photovoltaic electricity: Current status and future prospects, *Solar Energy*, Volume 85, Issue 8, August 2011, Pages 1580-1608, ISSN 0038-092X, 10.1016/j.solener.2010.12.002.

(<http://www.sciencedirect.com/science/article/pii/S0038092X1000366X>)

John S. Liu, Chung-Huei Kuan, Shi-Cho Cha, Wen-Ling Chuang, George J. Gau, Jeng-Ywan Jeng, Photovoltaic technology development: A perspective from patent growth analysis, *Solar Energy Materials and Solar Cells*, Volume 95, Issue 11, November 2011, Pages 3130-3136, ISSN 0927-0248, 10.1016/j.solmat.2011.07.002. (<http://www.sciencedirect.com/science/article/pii/S0927024811004041>)

Torben D. Nielsen, Craig Cruickshank, Søren Foged, Jesper Thorsen, Frederik C. Krebs, Business, market and intellectual property analysis of polymer solar cells, *Solar Energy Materials and Solar Cells*, Volume 94, Issue 10, October 2010, Pages 1553-1571, ISSN 0927-0248, 10.1016/j.solmat.2010.04.074.

(<http://www.sciencedirect.com/science/article/pii/S0927024810002746>)

Bhubaneswari Parida, S. Iniyar, Ranko Goic, A review of solar photovoltaic technologies, *Renewable and Sustainable Energy Reviews*, Volume 15, Issue 3, April 2011, Pages 1625-1636, ISSN 1364-0321, 10.1016/j.rser.2010.11.032. (<http://www.sciencedirect.com/science/article/pii/S1364032110004016>)

Naichia Yeh, Pulin Yeh, Organic solar cells: Their developments and potentials, *Renewable and Sustainable Energy Reviews*, Volume 21, May 2013, Pages 421-431, ISSN 1364-0321, 10.1016/j.rser.2012.12.046. (<http://www.sciencedirect.com/science/article/pii/S1364032113000026>)

G.K. Singh, Solar power generation by PV (photovoltaic) technology: A review, *Energy*, Volume 53, 1 May 2013, Pages 1-13, ISSN 0360-5442, 10.1016/j.energy.2013.02.057. (<http://www.sciencedirect.com/science/article/pii/S0360544213001758>)

EXAMPLE

Grant and Funding Opportunities

Federal, state, nonprofit, and private grant opportunities relevant to the project

Federal Funding Opportunities

U.S. Department of Energy – Energy Efficiency and Renewable Energy Exchange

Funding Opportunities Announcements: <https://eere-exchange.energy.gov/> including:

U.S. Department of Energy SunShot Initiative

Phone: 202-287-1862

Email: solar@ee.doe.gov

Mailing Address:

1000 Independence Avenue, SW

Washington, DC, 20585

The SunShot Initiative drives research, manufacturing, and market solutions to make the abundant solar energy resources in the United States more affordable and accessible for Americans. Since the SunShot Initiative was announced in February 2011, the office has funded more than 350 projects in the following areas:

- Photovoltaics (PV)
- Concentrating solar power (CSP)
- Balance of systems costs (soft costs)
- Systems integration
- Technology to market.

Learn more: <http://energy.gov/eere/sunshot/sunshot-initiative>

National Science Foundation’s Energy for Sustainability

The goal of the Energy for Sustainability program is to support fundamental engineering research and education that will enable innovative processes for the sustainable production of electricity and transportation fuels. Processes for sustainable energy production must be environmentally benign, reduce greenhouse gas production, and utilize renewable resources. Learn more:

http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=501026

Federal Government’s SBIR/STTR Program (<http://www.sbir.gov>)

The Small Business Innovation Research (SBIR) program is a highly competitive program that encourages domestic small businesses to engage in Federal Research/Research and Development (R/R&D) that has the potential for commercialization. Small Business Technology Transfer (STTR) is another program that expands funding opportunities in the federal innovation research and development (R&D) arena. Central to the program is expansion of the public/private sector partnership to include the joint venture opportunities for small businesses and nonprofit research institutions. The unique feature of the STTR

program is the requirement for the small business to formally collaborate with a research institution in Phase I and Phase II.

STTR differs from SBIR in three important aspects:

1. The Small Business Concern (SBC) and its partnering institution are required to establish an intellectual property agreement detailing the allocation of intellectual property rights and rights to carry out follow-on research, development or commercialization activities.
2. STTR requires that the SBC perform at least 40% of the R&D and the single partnering research institution to perform at least 30% of the R&D.
3. Unlike the SBIR program, STTR does not require the Principal Investigator to be primarily employed by the SBC.

Most relevant SBIR and STTR Programs for this technology include:

Federal Agency	SBIR/STTR	Regular Solicitations?	Program Manager	URL
Environmental Protection Agency	SBIR	No – Next solicitation listed as Spring 2015	Proposers may communicate with EPA representatives only when solicitation periods are closed.	http://www.epa.gov/ncer/sbir/
Department of Energy	SBIR and STTR	Two solicitation releases each year per phase- Topics issued Mid-July (release 1) and Mid/Late October (release 2); requires both Letter of Intent and Application	Yes – for questions about applying directly to program staff: http://science.energy.gov/sbir/about/staff/	http://science.energy.gov/sbir/
National Science Foundation	SBIR and STTR *	No- varies	Yes- Program officers contact information in proposal http://www.nsf.gov/pubs/2014/nsf14603/nsf14603.htm	http://www.nsf.gov/pubs/2014/nsf14603/nsf14603.htm

***NSF STTR Grant change:** NSF STTR program requirements are very similar to SBIR requirements. NSF STTR requires that the SBC partner with a research institution such as a University; however, the primary employment of

the Principal Investigator (PI) must be with the SBC at the time of the award. The PI must spend a minimum of two calendar months on an STTR Phase 1 project. Primary employment is defined as 51% employed by the small business for the duration of the award. NSF considers a full time work week to be normally 40 hours and considers employment elsewhere of greater than 19.6 hours to be in conflict with this requirement.

Other SBIR Agencies include: Department of Agriculture; Department of Commerce - National Institute of Standards and Technology; Department of Commerce - National Oceanic and Atmospheric Administration; Department of Defense; Department of Education; Department of Health and Human Services; Department of Homeland Security; Department of Transportation; Agency; and National Aeronautics and Space Administration

Other STTR Agencies include: Department of Defense; Department of Health and Human Services; and National Aeronautics and Space Administration;

North Carolina Funding Opportunities

One N.C. Small Business Program

Those companies that are awarded a SBIR or STTR grant are eligible to receive funding through the One N.C. Small Business fund. Incentives include:

- **SBIR/STTR Phase 1 Incentive Funds Program** reimburses qualified N.C. businesses for a portion of the costs associated in preparing and submitting Phase 1 SBIR/STTR proposals
- **Phase 1 Matching Funds Program** awards matching funds to N.C. businesses that are awarded SBIR or STTR phase 1 awards from the Federal Government. This program is currently open until June 30, 2015; applicants must apply within 45 days of receiving official notification of Phase 1 award by federal SBIR/STTR agency.

Nonprofit and Foundation Funding Opportunities

Doris Duke Charitable Foundation

650 5th Ave., 19th Fl.

New York, NY United States 10019-6108

Telephone: (212) 974-7000

Fax: (212) 974-7590

URL: www.ddcf.org

The mission of the foundation is to improve the quality of people's lives through grants supporting the performing arts, environmental conservation, medical research and the prevention of child abuse.

Environmental Program. The Environment Program awards grants through invited proposals and the occasional funding competition. In general, the Environment Program does not make grants outside of its four primary grant-making strategies. The strategy most relevant to this technology is "Wildlife and Energy Development." Read more here:

<http://www.ddcf.org/Programs/Environment/Goals-and-Strategies/Wildlife-and-Energy-Development/>

Energy Foundation

301 Battery St., 5th Fl.
San Francisco, CA United States 94111-3237
Telephone: (415) 561-6700
Contact: Eric Heitz, Pres.
Fax: (415) 561-6709
E-mail: energyfund@ef.org
URL: www.ef.org

Power Program. The Energy Foundation works to build markets for energy efficiency and renewable power sources, to increase our energy independence, create new jobs at home, and reduce the carbon pollution that comes from conventional coal-fired power plants. Learn more about their Power program: <http://www.ef.org/programs/power/>

Mertz Gilmore Foundation

218 E. 18th St.
New York, NY United States 10003-3694
Telephone: (212) 475-1137
Contact: Jay Beckner, Pres.
Fax: (212) 777-5226
E-mail: info@mertzgilmore.org
URL: <http://www.mertzgilmore.org>

The Foundation's Climate Change Solutions program builds on past Mertz Gilmore investments to study climate change, promote climate-friendly energy usage, and develop renewable energy sources in the U.S. The Foundation identified global warming as a critical long-term issue in 1984 and began making grants immediately. By 1987, global warming had become a primary focus of environmental grant-making, with an emphasis on domestic policy and public education. In 1997, Mertz Gilmore became a funding partner of the Energy Foundation, a funder collaborative that promotes permanent shifts in energy policy and practice. That partnership resulted in nearly \$24 million in grants over 14 years.

Research Corporation for Science Advancement

4703 E. Camp Lowell Dr., Ste. 201
Tucson, AZ United States 85712-1292
Telephone: (520) 571-1111
Contact: Daniel Gasch, C.F.O.
Fax: (520) 571-1119
E-mail: awards@rescorp.org

URL: <http://www.rescorp.org/>

RCSA stimulates innovation and discovery in the physical sciences. Their programs and support target challenges of national and global importance. They support chemistry, physics, astronomy and science in other fields that interfaces with these disciplines.

Additional Resources

The North Carolina Small Business and Technology Development Center

5 West Hargett St, Suite 600, Raleigh, NC 27601

(919) 715-727

www.sbtcd.org

Capital Opportunities for Small Businesses: A Guide to Financial Resources for Small Business in North Carolina. Learn more: <http://www.sbtcd.org/pdf/capopps.pdf>

N.C. Clean Energy Technology Center

919-515-3480

nccleantech@ncsu.edu

Campus Box 7409, North Carolina State University, Raleigh, NC 27695-7409

<http://nccleantech.ncsu.edu/>

EXAMPLE

Patent and Literature Search Strategies

Applying what I learned from your team, from reading your provisional patent filing and from discussion with our OTD staff, I determined the key concepts in your invention to create search strategies for this custom research project.

Resources Selected

1. Thomson Innovation for patent databases and patent analytics
 - a. This tool includes multiple databases of patents and patent applications from the US, Europe, World Intellectual Property Organization (WIPO), China, and many more geographies.
 - b. It includes analytical tools for creating landscape maps of patent results and for citation analysis of cited and citing prior art to view generations of related patents, similar to a genealogical family tree.
 - c. Full-text documents are available within this tool for most patents and patent applications.
 - d. The Derwent World Patents Index (DWPI) is accessible within this tool, enabling powerful searching of English language abstracts from expert (human!) editorial staffers, an indexing system and patent families that group inventions across geographic filings. See http://en.wikipedia.org/wiki/Derwent_World_Patents_Index for more details.
2. Scientific/Technical literature: ScienceDirect was selected as the most appropriate database for the scientific and technical portion of this research.

Search Terms

The following subject terminology was applied, with similar terms and spellings applied.

1. Solar
 - a. Photovoltaic
2. Organic
 - a. Active material
3. Copolymer
4. Monomer
5. Benzene
6. Thiophene

Search terms were used in multiple search strings connected by Boolean terminology and additional connectors such as “near”. I used varying combinations of terms in the search strings (not all major terms were used in every string). Dates searched were generally from 2000 to present. Some very specific searches were also performed for inventors and assignees discovered during the research project.