

## Summary:

For the April 2<sup>nd</sup> issue of NAATBatt's Advanced Battery Weekly, we highlight the ongoing sector activities. On April 5<sup>th</sup>, we will be hosting a webinar on "*Separator Films: The State of the Art and the State of the Market*". In addition, we have included an interview with Tim Feaver, CEO of Porous Power Technologies.

The NAATBatt and Asia Battery Indices were flat while the U.S. Battery Index increased a modest 1.4%.

## Key Highlights:

- The **DOT** and **EPA** announced a set of fuel economy guidelines to help reduce oil use and greenhouse gas emissions. By 2016, all cars and trucks will have to achieve 34.1 miles per gallon (MPG) -- from the current minimum of 25 MPG.
- **President Obama** toured the **Celgard** business unit (a subsidiary of **Polypore International**). The company manufactures separators, a critical component for lithium-ion (li-ion) batteries.
- **Ford Motor Company** has agreed to sell **Volvo Cars** to **Zhejiang Geely Holding** for \$1.8 billion. Volvo is planning to launch a 50-car test fleet of its C30 all-electric vehicles (EVs) in early 2011 with **Ener1** supplying the li-ion batteries.
- A study by the **Massachusetts Institute of Technology** predicted 10 million EVs would be sold globally by 2016. **Canada Lithium Corp.** has stated lithium carbonate annual supply would have to double to over 200,000 tonnes (or 440+ million lbs) from current levels to support EV growth.
- **NEC Corporation** will invest more than 50 billion yen (or \$542 million) to expand production of parts used in li-ion batteries supplied to **Nissan Motor Company**. The money will be spent over the next 12 months.
- **FedEx Corporation** is rolling out 4 all-electric parcel delivery trucks in the U.S. The EVs are designed with a range that enables many couriers to make a full eight-hour shift of deliveries.
- **THINK** announced plans to begin selling the THINK City in New York and other select cities later this year. **Ener1** will be the primary li-ion battery supplier for THINK's EVs.
- The **University of Delaware** has been focused on a Vehicle to Grid (V2G) program since 1997. Delaware has helped lay the groundwork for V2G as the state law requires utilities to compensate EV owners for power sent back to the grid at the same rate paid to charge the battery.
- **Pietzo** has rolled out "hybrid electric bikes" ranging from \$1,299 to \$1,899. A daily recharge of the bike's battery costs about 5 cents - a lot lower than the price of gasoline, now going for about \$2.74 a gallon in Massachusetts.
- The first shots have been fired in a price war in the EV market. **Nissan Motor's** announcement that the Leaf EV will sell for 2.99 million yen (~\$31,625) after factoring in a government EV purchase subsidy triggered an almost immediate retaliatory strike from rival **Mitsubishi Motor**; a hefty cut in the price of its i-MiEV to 2.84 million yen (~\$30,040) with a subsidy.
- **Bergstrom Inc.** and **Johnson Controls-Saft** announced the development of a li-ion battery for NITE® no-idle systems. The technology will help drivers reduce emissions and comply with increasingly stringent anti-idling laws, and save money on fuel.

## A Few More Details:

The Department of Transportation (DOT) and the Environmental Protection Agency (EPA) announced a set of fuel economy guidelines to help reduce oil use and greenhouse gas emissions. By 2016, all cars and trucks will have to achieve 34.1 miles per gallon (MPG) -- from the current minimum of 25 MPG. In addition, the EPA has set a tailpipe emissions standard of 250 grams (8.75 ounces) of carbon dioxide per mile – equivalent to what would be emitted by vehicles meeting the mileage standard.

Source: Associated Press

President Obama toured the Celgard business unit (a subsidiary of Polypore International). The company manufactures separators, a critical component for lithium-ion (li-ion) batteries. The li-ion separator industry is dominated by 3 companies with about a combined 90% market share -- Celgard, Tonen Chemical and Asahi Chemical.

Source: Polypore International

Ford Motor Company has agreed to sell Volvo Cars to Zhejiang Geely Holding for \$1.8 billion. Geely has also stated the board and management of Volvo, which will operate as a separate unit based in Sweden, "will have a mandate to develop Volvo Cars' leadership in safety and clean environmental technologies. Volvo is planning to launch a 50-car test fleet of its C30 all-electric vehicles (EVs) in early 2011 with Ener1 supplying the li-ion batteries.

Source: Bloomberg and Earth2tech

A study by the Massachusetts Institute of Technology predicted 10 million electric vehicles (EVs) would be sold globally by 2016. If this projection is accurate, the demand for high-grade lithium used in rechargeable batteries could soar by as much as 150% over the next six years (per Canada Lithium Corp). The company stated lithium carbonate supply would have to increase to over 200,000 tonnes (or over 440 million lbs) from the current 100,000 tonnes annually to meet the suggested EV growth.

Source: The Canadian Press

NEC Corporation will invest more than 50 billion yen (or \$542 million) to expand production of parts used in li-ion batteries supplied to Nissan Motor Company. The money will be spent over the next 12 months. Nissan starts Leaf domestic production this year and in the U.S. in 2012.

Source: Bloomberg

FedEx Corporation is rolling out 4 all-electric FedEx parcel delivery trucks (see **Exhibit 1**) in the U.S. The vehicles are slated to hit the road in the Los Angeles area starting in June 2010. Two of the new all-electric trucks come from Navistar. These are based on the Modec design already operated by FedEx in Europe. Ten such Modec vehicles serve FedEx routes in London and five more are on order for Paris. The EVs are designed with a range that enables many FedEx Express couriers to make a full eight-hour shift of deliveries before their vehicles need recharging.

### Exhibit 1: FedEx's All-Electric Parcel Delivery Truck



Source: FedEx Corp.

THINK announced plans to begin selling the THINK City, one of the world's first highway-capable electric vehicles (EVs), in New York and other select cities later this year. Per CEO Richard Canny, New York is ranked 3<sup>rd</sup> on the company's EV-Ready Cities Index based on the great fit of EVs for city driving and the strength of state and local government support. Ener1 is the primary li-ion battery supplier for the EVs.

Source: THINK

The University of Delaware has been focused on a Vehicle to Grid (V2G) program since 1997. Electric car batteries are viewed as a vast, reliable source of energy for the grid in a future when the national power supply will increasingly rely on renewable but fluctuating sources like sun and wind. To help lay the groundwork for V2G in Delaware, the state passed a 2009 law - the first of its kind in the world -- requiring utilities to compensate electric car owners for power sent back to the grid at the same rate they pay to charge the battery. One typical electric car can put out more than 10 kilowatts, the average draw of 10 houses, according to university researchers, and the power is readily available, since cars are idle on average for 95% of each day.

Source: Reuters

**Pietzo** has rolled out "hybrid electric bikes" (see **Exhibit 2**) ranging from \$1,299 to \$1,899. The motorized bikes are similar to those in Asia and Europe. The ebikes can zip along at 18 mph, requiring a plug-in recharge after up to 40 miles of use. A daily recharge of the bike's battery costs about 5 cents - a lot lower than the price of gasoline, now going for about \$2.74 a gallon in Massachusetts.

Source: Boston Herald

#### Exhibit 2: Pietzo E-bike



Source: Pietzo

The first shots have been fired in a price war in the EV market. Nissan Motor's announcement that the Leaf EV will sell for 2.99 million yen (~\$31,625) after factoring in a government EV purchase subsidy triggered an almost immediate retaliatory strike from rival Mitsubishi Motor (MMC); a hefty cut in the price of its i-MiEV to 2.84 million yen (~\$30,040) with a subsidy. MMC cut the i-MiEV price by 619,000 yen (~\$6,547) to 3.98 million yen (~\$42,096). The Leaf is priced at 3.76 million yen (~\$39,769) without a subsidy. The price of the i-MiEV with the subsidy is 2.84 million yen (~\$30,040), 150,000 yen (~\$1,587) less than the Leaf.

Source: Daily Yomiuri

**Bergstrom Inc.** and **Johnson Controls-Saft** announced the development of a li-ion battery for NITE® no-idle systems. As a battery-powered, no-idling system, the CARB-approved NITE units are able to generate high BTU cooling capacity without sending damaging emissions into the environment. The technology will help drivers reduce emissions, comply with increasingly stringent anti-idling laws, and save money on fuel.

Source: PowerPulse.net



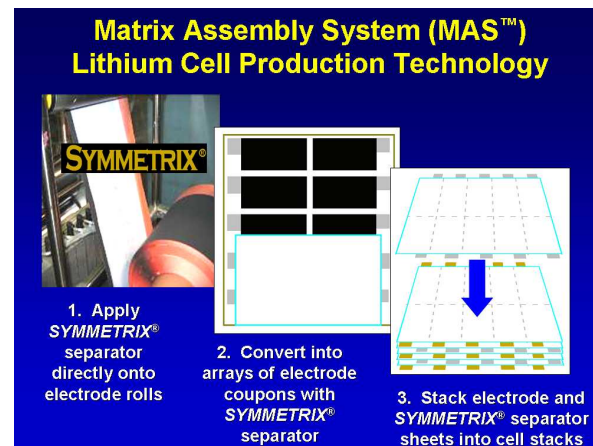
## Interview with Tim Feaver, CEO of Porous Power Technologies (PPT):

### Please describe Porous Power Technologies (PPT).

Porous Power's patent-pending SYMMETRIX<sup>®</sup> separator membranes and MAS<sup>™</sup> production system will allow lithium-ion cell manufacturers to improve nearly all aspects of performance, eliminate a very expensive purchased component and use high-volume roll-to-roll production to gain dramatic productivity improvements over one-at-a-time processes now used universally.

While SYMMETRIX can benefit any lithium-ion battery, PPT is focused on flat cells for hybrid- and electric-drive vehicles and similar large-cell applications, particularly those using stacked electrodes that enable efficient use of space and better performance, safety and cycle life.

Customers can either buy SYMMETRIX separators in finished rolls from licensed PPT distributors or license the SYMMETRIX production process and produce separators in-house at a cost less than half that of other separators. SYMMETRIX separators can be thermally laminated or solution-coated directly onto electrodes, greatly simplifying the assembly of stacked cells, as well as improving the safety and reliability of completed cells, particularly in high-vibration environments. Many large non-battery markets exist for PPT membranes, including waterproof breathable fabrics, filtration products, and other energy storage devices.



### Discuss the functionality and importance of the separator in determining battery performance.

#### How much of the BOM does the membrane account for?

SYMMETRIX<sup>®</sup> separators are up to twice as porous as separators now used in all lithium-ion cells and can improve performance across the board for nearly any cell. Improved ionic conductivity means less resistance and less heat generation, particularly during high-rate charge and discharge. Argonne National Lab tests (5C HPPC, 10 seconds) have shown that the area-specific impedance of common polyolefin separators is around 25% higher than that of SYMMETRIX. At discharge rates above 2C, 3-4X improvements in cell capacity are common; both in high-energy and high-power cells, as the voltage of cells with traditional polyolefin separators drop with the increased current drain. Third-party tests in which 10 Ah pouch cells using SYMMETRIX were discharged at 2C rates at low temperatures showed average capacity doubled vs. identical cells with polyolefin separators at -20°C, and *increased by nearly eight times* at -30°C.

Higher porosity and excellent pore uniformity across the surface of the electrode also increases cycle life, which can reduce the total cost of electric drive vehicles by thousands of dollars. Cycle life increases of 20-25% or longer are very typical in most charge/discharge scenarios.

Shrink-resistance and exceptional thermal stability (the separator's PET backbone is stable to 250°C) improve safety. Testing performed by PPT and customers have demonstrated that the highly efficient SYMMETRIX separators promote very stable voltage and temperature profiles under hot box and overcharge conditions, leading to graceful degradation without thermal runaway under extreme conditions

where traditional shutdown separators catch fire. Similarly, cells with SYMMETRIX may be charged and discharged at significantly higher rates without generating excessive heat that can affect performance and cycle life.

SYMMETRIX' unique open pore structure allows it to wick electrolyte 2-3 times faster than any of the leading polyolefin separators, making it practical to produce larger cells more rapidly and efficiently and reducing the likelihood of dry spots that can create performance, safety and cycle life issues. This is because traditional separators are made with a stretching process in which the open pore structure tends to run through the thickness of the separator. SYMMETRIX is made with a solution casting process that results in a very open, omnidirectional pore structure that soaks up electrolyte very uniformly and efficiently.

The separator is traditionally considered to be one of the most expensive components of a lithium-ion battery, ranging from 5% of the COGS of a typical high-energy cell to as high as 25% in a high-power cell. Various industry analysts have indicated that current separators share the dubious honor of being the most expensive component of a lithium-ion HEV cell, along with the cathode active materials.

The U.S. Advanced Battery Consortium (USABC), made up of the DOE and the Big Three automakers, have set a separator cost target of \$1.00/m<sup>2</sup>. Most separators now sell for \$2.00/m<sup>2</sup> or more and show little sign that their price can be reduced to hit the USABC target. However, cell manufacturers that license the SYMMETRIX process from PPT should easily be able to reduce their separator costs to less than half of what they are currently paying. The in-house coating process also enables high-volume roll-to-roll assembly of cell stacks, creating an entirely new cell assembly paradigm (PPT's patent-pending *Matrix Assembly System*<sup>™</sup>, or MAS<sup>™</sup> production processes) enabling much higher productivity and lower production costs.

### **Is the material that Porous Power is developing better suited for specific applications (i.e. energy vs. power or stationary vs. consumer)?**

The improved cycle life, low-temperature performance and safety benefits associated with SYMMETRIX are applicable to all types of cells. While improved high-rate capacity is most frequently of interest to those producing high-power cells, SYMMETRIX can also enable high-energy cells to operate at significantly higher rates and is a good tool to optimize power and energy for many applications. A large part of PPT's experience and expertise has been focused on the construction of laminated cells, in which the separator is thermally laminated across the entire surface of the electrodes, rather than only at the edges, as is done in most pouch cells. This can enable a fully integrated cell stack with better safety, performance, and cycle life characteristics that is also easier to manufacture. Much of this work has been focused on cells with flat stacked electrodes, a design that appears to be becoming the standard for next-generation automotive cells.

### **Three major players dominate the lithium-ion separator market, what is the Porous Power value proposition?**

All of the mainstream suppliers of separator membranes provide polyolefin separators that are extruded and stretched using one of two similar processes. These products are generally limited to less than 50% porosity (SYMMETRIX separators are typically 65-80% porous) and are not amenable to thermal lamination, nor to coating in-situ directly on electrodes, as is SYMMETRIX. None are practical for application in wide-format roll-to-roll cell assembly techniques. PPT roll goods offer across-the-board performance improvements at similar prices to polyolefin separators. Licensees of PPT's SYMMETRIX production process and MAS production systems can produce cells with higher electrochemical performance, at separator prices less than half those of existing suppliers, and achieve additional productivity gains and cost reductions in their entire cell assembly process. PPT's principals have many

years experience in the lithium-ion and lithium-ion separator industry and a wealth of practical knowledge that gives us a significant competitive advantage vs. other would-be competitors.

### **What is the go-to-market strategy?**

PPT's U.S.-based production line can now produce six million m<sup>2</sup> of SYMMETRIX per year, and capacity is readily expandable. PPT has begun production and distribution of SYMMETRIX roll goods by selected licensees in China and Japan (production in the U.S.), and expects to establish similar agreements with commercial partners in the U.S. and Europe. PPT recently executed a large non-equity based product development agreement with a commercial partner to develop an advanced automotive-grade separator. PPT is also engaged with various equipment suppliers to develop and sell production equipment that is compatible with PPT's MAS production system. While PPT is developing close working relationships with preferred equipment suppliers, we are following an open development approach in which we encourage other manufacturers to develop equipment that may be used with the SYMMETRIX and MAS production processes. PPT will license cell manufacturers directly, regardless of equipment supplier, and sell materials optimized for the application.

PPT's 12,000SF Technical and Engineering Center in Plymouth Meeting, PA allows us to build and test large, high performance lithium-ion cells. It includes coaters for electrode and separator production, laminators and cell assembly equipment, a large dry room, electrolyte fill and packaging, and computerized cell cyclers. Our first MAS™ production system is being constructed there. PPT is working with various battery manufacturers in the facility to develop high-performance cell designs melding PPT technology with customer electrodes and other components.

### **The STOBA material (developed in Taiwan) was recently unveiled. What kind of impact has it had (if any at all) on the company's long-term target market objectives?**

At this point, STOBA has had no impact on PPT's long-term market objectives. It appears to be an interesting product with good potential for improving the safety of lithium-ion cells if it can be implemented at an acceptable cost. One appealing aspect of PPT's unique production process is that it uses a relatively low-temperature, low-pressure casting process that is very amenable to the use of various additives. These can include ceramic materials (which are very difficult to securely apply to most polyolefin products), different polymer formulations and various other passive and active materials that can be readily added to SYMMETRIX formulations to enable novel performance enhancements in the finished product. We expect to evaluate STOBA along with other materials to determine their benefit and compatibility with PPT's unique processes. Along these lines, PPT recently began a \$1.5M joint project with Oak Ridge National Laboratory to develop enhanced safety separators optimized for our new in-plant coating process.

### **Please highlight some of the obstacles that the company has overcome and challenges ahead.**

PPT is a startup company, albeit a mature startup company, competing against some of the largest corporations in the world. However, we have been extremely resourceful by leveraging our capabilities with those of various customers and other strategic partners to accomplish far more than we could have on our own. Our recently commissioned high-volume production capabilities with coating partner NEPTCO is testament to that, as are large product development contracts, of which a number have either been secured or are pending. New and ongoing cooperative relationships will help us keep up with the demands of providing a ground-breaking technology to a rapidly growing large international market.

### **How large is the addressable market opportunity?**

We anticipate that the total separator demand will exceed one billion square meters by 2014, with between half and two-thirds of that coming from large-cell automotive applications. We believe that we can supply a substantial portion of that market, particularly through licensing of the SYMMETRIX and MAS production processes directly to cell builders.

**How large do you envision the market for electric vehicles (include bikes and heavy-duties) will be by 2015?**

Based on stated customer RFQs and various other industry estimates, we anticipate the market for electric vehicle batteries to grow to nearly \$40 billion annually by that time. The market for lithium-ion cells (as opposed to full packs) will be slightly less than half of that number.

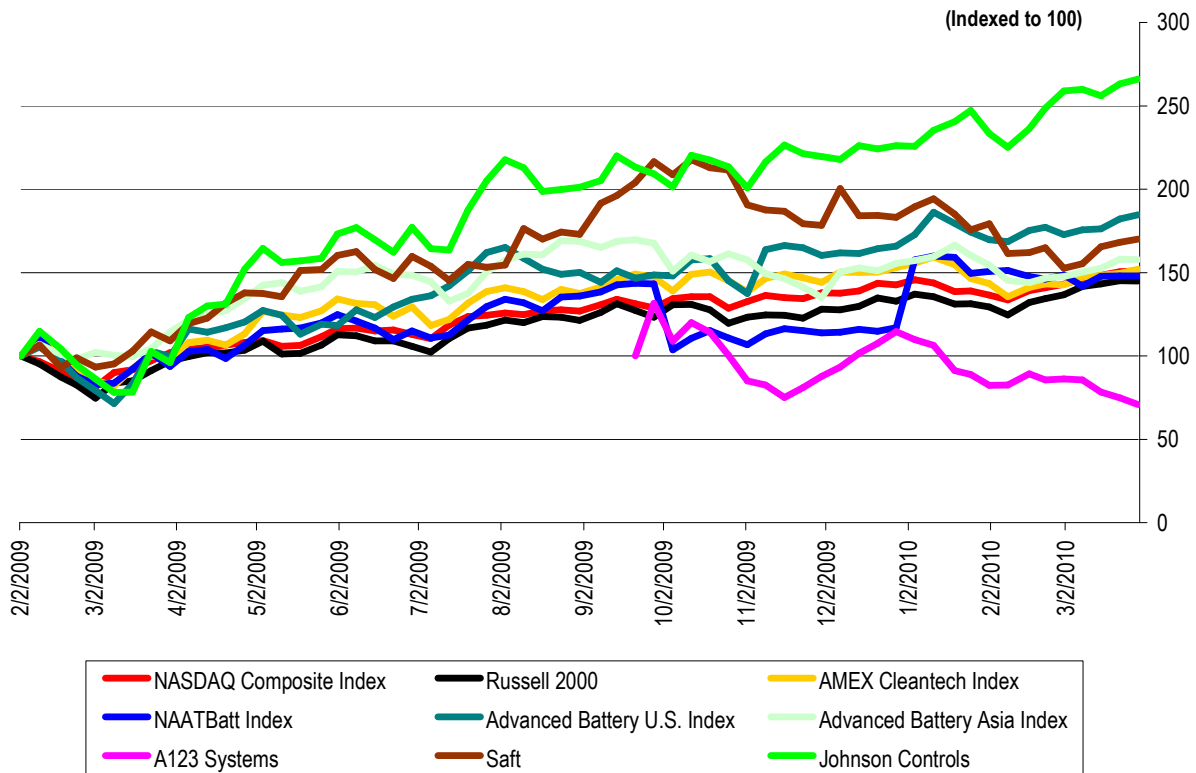
**How large do you envision the stationary market will become for lithium-ion applications in the long-term?**

We don't have nearly as good a read on that market as we do the automotive space and have treated it very conservatively in our own financial projections at 10% of the balance of market. Lithium-ion seems to be a less likely solution for stationary applications where pack weight and volume is not nearly as critical.

**Any closing thoughts.**

Porous Power Technologies is developing and selling next-generation high-performance materials, equipment and processes that will dramatically improve the performance, and reduce the cost, of lithium-ion batteries, and could fundamentally change the way that large cells for automotive and similar applications are produced in the future. We are always seeking strategic corporate partners and investors with compatible objectives that can help us help us take advantage of the large opportunities that are before us.

**Exhibit 3: Indices Performance**  
(From February 2, 2009)

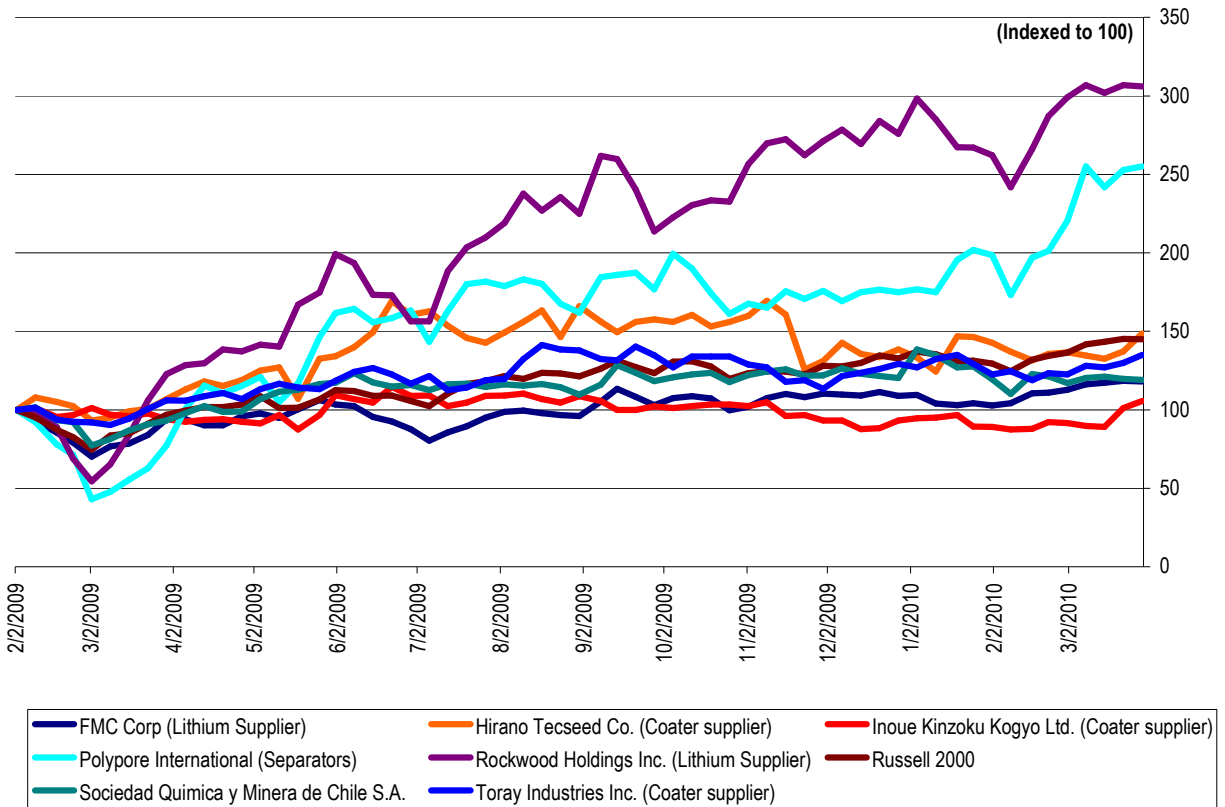


Index	Close on 3/29/2010	52-Wk High	% of 52-Wk High	Performance		
				LTM	YTD	Week
Dow	10,895.9	10,985.3	99.2%	40.2%	4.5%	1.0%
S&P 500	1,173.3	1,180.7	99.4%	45.0%	5.1%	0.6%
NASDAQ	2,404.4	2,432.3	98.9%	58.5%	4.8%	0.4%
Russell 2000	682.3	693.3	98.4%	61.0%	8.6%	(0.1%)
AMEX Cleantech Index	1,056.1	1,112.5	94.9%	50.0%	(1.0%)	1.8%

Source: Bloomberg and ThomsonOne

Note: The select NAATBatt Index is a market-value-weighted average and includes ALTI, BASF, COP, ENS and XIDE. The Advanced Battery U.S. Index is a market-value-weighted average and includes HEV, MGA, MXWL, UQM and VLNC. The Advanced Battery China Index is a market-value-weighted average and includes BYD, CBAK, GS Yuasa, LG Chem and Panasonic.

**Exhibit 4: Supplier Performance**  
(From February 2, 2009)



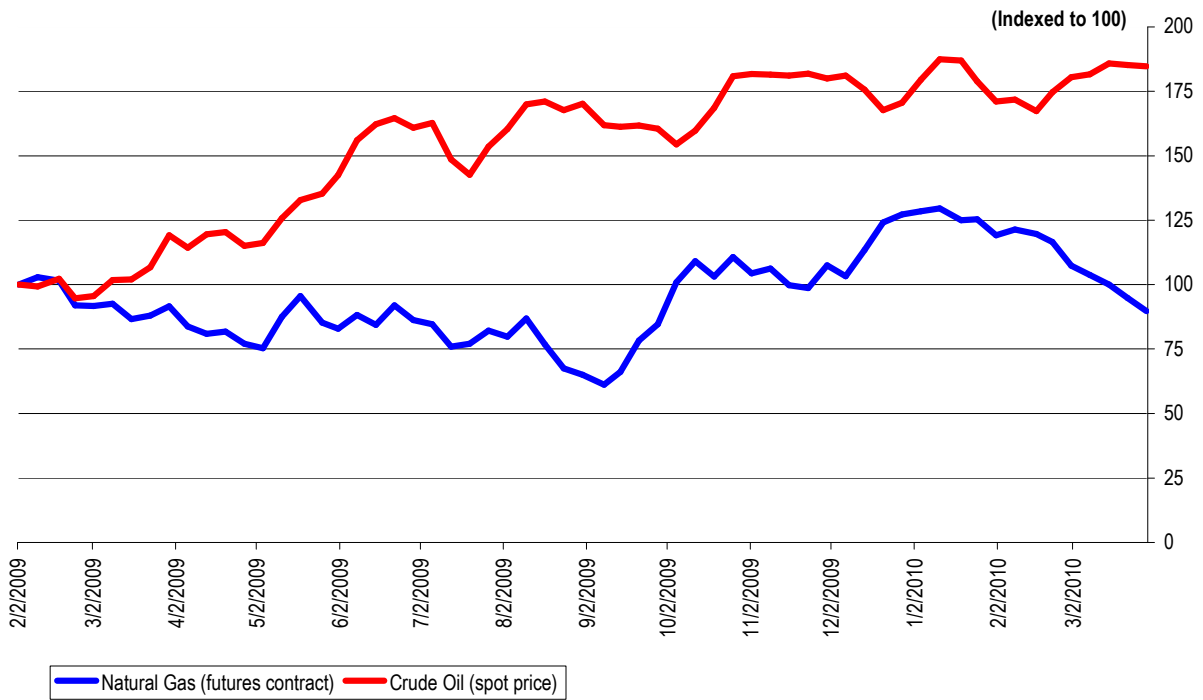
Source: Bloomberg

**Exhibit 5: Commodity Prices**

Commodity	Price on 3/29/2010	Price on 3/22/2010	Price on 3/1/2010	1 Week Change	1 Month Change
LME Nickel (Cash, \$ per tonne)	23,925	21,290	21,365	12.4%	12.0%
LME Lead (cash, \$ per tonne)	2,153	2,185	2,151	(1.5%)	0.1%

Source: LME

**Exhibit 6: Natural Gas and Crude Oil**  
 (From February 2, 2009)



Source: EIA



### **WHACKING THE WEEDS OF ENERGY STORAGE**

On Tuesday, Nissan announced the MSRP of the LEAF electric vehicle in the United States: \$32,780. The price of the LEAF to U.S. consumers, after taking into account the \$7,500 tax credit, will therefore be \$25,280. While this is a lower MSRP than many expected (and Nissan is to be commended for it) and likely sufficient to attract some early adopter customers, the price still reflects a significant GEV premium, which the general American consumer may be unwilling to bear.

As I have pointed out previously in this column, the battle for electric drive will be won or lost in the general consumer market. Until we penetrate that market, the industry remains at significant risk.

In a seemingly unrelated story, earlier today President Obama visited the Celgard separator film plant in Charlotte, North Carolina to underscore his interest in supporting electric drive and the U.S. advanced battery industry. Celgard was a curious choice of venue for a politician, given that standing in front of a Volt or a Roadster or a Karma would clearly have provided a better photo op.

Properly understood, however, the President's choice of venue has important significance. While lines and looks and 0-60 performance are important, the battle for the general U.S. consumer will turn on cost. The cost battle will be won by making progress on the mundane details of energy storage technology—such as separator films.

Earlier this week I spoke with a senior staff member of the Senate Energy Committee, who will be one of the speakers at our April 19 Webinar program on grid-level energy storage legislative initiatives. Of NAATBatt and our separator film Webinar he said, "You guys are really getting down in the weeds of energy storage." I replied, that's right, and we mean to whack the hell out of them. Because in those weeds, the battle for the American consumer will be won or lost, and the future of the advanced energy storage industry will be won or lost.

Next Monday we follow our President into the weeds for a look at separator film technology. Lie Shi, Vice President, Research & Development at Celgard, and Kirby Beard, chief operating officer and Vice President for Technology at Porous Power Technologies, will talk about "Separator Films: The State of the Art and the State of the Market."

I hope you will join us at 2PM ET, on Monday, April 5 to hear what the President heard about separators. Please contact S. Schnitzer to register for the program at [Suzanne@McCloudCommunications.com](mailto:Suzanne@McCloudCommunications.com).



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Executive Director



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