Applied Minerals Moves Closer to Commercialization of its DRAGONITE(R) Halloysite Clay for Use in Lithium-Ion Battery Technologies

17.01.2018 | Marketwired

Halloysite has significant potential value for use as a material in existing and developing lithium-ion battery technologies

Company will assess options to maximize the value of its emerging opportunity as a lithium-ion battery materials supplier

NEW YORK, NY--(Marketwired - January 17, 2018) - Applied Minerals Inc. (the "Company" or "Applied Minerals") (OTCQB: AMNL), a leading global producer of halloysite clay and advanced natural iron oxides is pleased to update shareholders and the marketplace on halloysite-based lithium-ion ("Li-ion") battery technology.

The Company's primary objective has been to combine its breadth of knowledge of halloysite with publicly available applied research to pursue the commercialization of DRAGONITE halloysite clay within select applications that offer attractive economic opportunities. To capitalize on research that demonstrates the value of halloysite for use in Li-ion battery technologies, the Company is pursuing the commercialization of DRAGONITE as a value-added material to this market. The following is a summary of the Company's progress.

Conventional Li-ion Battery Electrolytes
A conventional electrolyte is a liquid or gel-based chemical solution that enables the flow of ions (electrical charge) between a battery's anode and cathode material.

Manufacturers of Li-ion batteries that utilize conventional electrolytes are continually focused on (i) increasing the specific capacity of the battery and (ii) reducing the flammability risk associated with the combustion of the electrolyte.

Research demonstrates that the incorporation of halloysite clay within a conventional electrolyte at 10 wt% both significantly increases the energy capacity of the battery and improves its thermal stability in large part due to halloysite clay's unique tubular morphology (research).

According to Andre Zeitoun, President and CEO of Applied Minerals, "The Company has received significant interest in DRAGONITE for use in conventional electrolytes. Three of the leading global suppliers of electrolytes are evaluating DRAGONITE to enhance the performance of their conventional electrolytes. We believe this interest clearly demonstrates the potential DRAGONITE has as an additive for conventional electrolytes."

The size of the global Li-ion electrolyte market was approximately 150,000 tons or USD 1.46 billion in 2016. Consumer electronics use the majority of electrolyte production, followed by electric vehicles and industrial energy storage applications.

Solid Polymer Electrolytes
The wide adoption of electric vehicles and other industrial applications in need of large-scale energy storage is dependent on the commercialization of an all solid-state Li-ion battery ("ASSLB"), which is theoretically capable of providing the size, energy storage and safety required by electric vehicle manufacturers.

Battery manufacturers are focused on developing an ASSLB that meets the performance requirements of electric vehicle manufacturers at a cost that makes widespread commercial adoption feasible. The key technical challenge lies in the development of a solid electrolyte.

According to Andre Zeitoun: "The development of a technologically robust ASSLB is arguably the next significant advance for the Li-ion battery industry in general and for the electric vehicle market in particular. However, technical challenges and high manufacturing costs associated with the solid electrolyte have hampered a wider adoption of electric vehicles."

Zeitoun continued, "In response to these challenges, the University of Utah and Central South University (China) have developed a Dragonite-loaded solid polymer electrolyte ("SPE") that provides cost-effective conductivity over a wide range of operating temperatures, as well as the storage capacity required by the electric vehicle industry (research) (patent application). We believe the development of this technology is a further step toward the commercialization of ASSLB's."

According to an analysis carried out by the University of Utah, the opportunity for DRAGONITE as an additive in SPE's is approximately $100 million per annum.

Currently, a leading manufacturer of electrolytes is evaluating DRAGONITE for use as an additive in a solid polymer electrolyte. The Company, with the help of the University of Utah, is aggressively introducing the technology to a number of other electrolyte manufacturers.

Halloysite-Synthesized Silicon Anodes
The anode of a Li-ion battery absorbs lithium ions during the charging phase and releases ions during the discharge phase. The energy capacity of a Li-ion battery is determined, in large part, by the capacity of the anode to store these lithium ions. Conventional anodes are made of a porous carbon, such as graphite, due to its ability to absorb lithium ions.

To increase the energy storage of Li-ion batteries, some battery manufacturers have focused on developing silicon anodes. A silicon anode has 10x the theoretical storage capacity of a conventional carbon anode.

Anodes constructed from silicon have yet to receive wide commercial adoption due primarily to the mechanical failure from swelling they experience during a battery's charge/discharge cycles. Advanced technologies, such as silicon nanowires and silicon spheres, have been developed to overcome the swelling problem but they are either challenging to cost effectively manufacture or only allow for a limited number of recharge cycles.

Two research papers, one sponsored by Central South University (China) and The Hong Kong Polytechnic University (China) and the other carried out by a pioneer in the Li-ion battery space, show that halloysite is a cost-effective material from which to synthesize silicon anodes in a scalable manner (research 1) (research 2).

A silicon anode synthesized from halloysite demonstrates electromechanical performance on par with that of a silicon anode made from natural silicon and, due to its tubular shape and larger pore volume, a silicon anode synthesized from halloysite is not vulnerable to the mechanical failure that plagues anodes made from from natural silicon.

The size of the market for conventional carbon anode material was approximately $950 million in 2016. Japan and China represent 84% of the world's production capacity. Hitachi Chemical Co, Ltd. (Japan), Nippon Carbon Co., Ltd. (Japan) and BTR New Energy Materials, Inc. (China) are the world's three largest producers.

The Company believes a significant portion of the carbon anode material market may be open to the adoption of a silicon anode synthesized from halloysite upon the technology's commercialization.

A Silicon Valley, California battery technology firm is evaluating the use of DRAGONITE as an anode material.

Halloysite for Use in Nickel-Cobalt Supercapacitors
An inherent limitation of a rechargeable Li-ion battery is the relatively low rate at which it can be recharged or discharged. A low recharge rate is responsible for the longer time it takes an electric vehicle to recharge when compared to refueling a gas-powered vehicle. A low discharge rate is primarily responsible for the significantly lower acceleration power an electric vehicle has when compared to a gas-powered one.

To address the low recharge and discharge rates of rechargeable Li-ion batteries, the battery industry has been exploring the use of battery-like capacitors to power electric vehicles. Like a Li-ion battery, a capacitor is able to hold, discharge and be recharged with a source of energy. The rate at which a capacitor can be recharged or discharged is significantly greater than that of a Li-ion battery. On the other hand, the energy storage capacity of a capacitor is significantly less than that of a Li-ion battery.

Unlike a Li-ion battery, a capacitor utilizes two or more conductive plates separated by a dialectric to store and then discharge energy. To increase the storage capacity of a capacitor, the development of supercapacitors have emerged. The two conductive plates of a supercapacitor are coated with porous carbon and the dielectric is replaced with an electrolyte to improve its storage capacity. Despite these enhancements, the storage capacity of a supercapacitor is still 20 - 40 times less than that of a conventional Li-ion battery.

To meet the needs of the electric vehicle market, a number of battery technology firms are focused on developing supercapacitor materials that meet or exceed the storage capacity of Li-ion batteries. Much of the research and development to date has been focused on carbon-based and conductive polymer supercapacitor materials.

Research demonstrates that nickel-cobalt oxides, such as nickel cobaltite, when applied to a halloysite substrate to synthesize nanosheets, form a supercapacitor that possesses a greater capacitance and higher cycling stability than some other supercapacitor materials (research). The Company believes halloysite could play a critical role in the engineering of a cost effective supercapacitor material that will meet the required energy storage capacity of the electric vehicle industry. Additionally, another use of halloysite in a supercapacitor is identified in a patent (patent) filed by a leading China-based manufacturer of photovoltaic products. The patent covers a novel capacitor, which in part, utilizes halloysite to increase energy storage capacity.

Conclusion
According to Andre Zeitoun: "We believe our DRAGONITE halloysite clay products, over the near-term, will provide performance enhancing solutions for existing Li-ion battery technologies and, over the longer term, will contribute to the commercialization of emerging battery technologies. The interest in DRAGONITE for use in Li-ion batteries is particularly strong among companies based in China, where the great majority of battery manufacturers reside and where the government is providing significant funding support for the majority of the battery research being utilized today."

Zeitoun added: "According to Mercom Capital Group, LLC, $480 million was invested in battery storage technologies by venture capital (including private equity and corporate venture funding) during the first half of 2017. We believe the sizeable amount of capital being invested in this sector is evidence that the economic opportunities associated with successful new Li-ion battery technologies are considered significant by investors. In light of the strong interest in technologies like halloysite to improve Li-ion battery performance, the Company, in collaboration with its major stakeholders, will assess the available options to maximize the value of its emerging opportunity as a lithium-ion battery materials supplier as the market continues to develop."

The Li-ion battery market is very competitive. There has been, and will continue to be, a significant amount of research focused on technologies, competitive with halloysite, that provide increased capacity and performance levels for batteries. The choice(s) of technologies selected by battery manufacturers may be driven by factors such as, but not limited to, cost-effectiveness, performance, and supply availability. It could happen that technologies, other than those involving halloysite, may be viewed as superior and, as a result, there is no assurance that battery manufacturers will choose halloysite-based technologies for any of the purposes discussed above. Nevertheless, we believe halloysite-based technologies are well positioned to provide solutions for the next generation of battery technologies.

About Applied Minerals

Applied Minerals is the leading producer of halloysite clay and advanced natural iron oxide solutions from its wholly owned Dragon Mine property in Utah. Halloysite is aluminosilicate clay that forms naturally occurring nanotubes. In addition to serving the traditional halloysite markets for use in technical ceramics and catalytic applications, the Company has developed niche applications that benefit from the tubular morphology of its halloysite. These applications include carriers of active ingredients in paints, coatings and building materials, environmental remediation, agricultural applications and high-performance additives and fillers for plastic composites. Applied Minerals markets its halloysite products under the DRAGONITE „¢ trade name.

From its Dragon Mine property, the Company also produces a range of ultra-pure natural iron oxides consisting of hematite and goethite. Combining ultra-high purity and consistent quality, the inherent properties of the iron oxide from the Dragon Mine allow for a wide range of end uses in pigment and technical applications. Applied Minerals markets its comprehensive line of advanced natural iron oxide pigments under the AMIRON „¢ trade name. Additional information on the Company can be found at www.appliedminerals.com and www.AMIRONoxides.com.

Safe Harbor Statements
The following are safe harbor statements under the Private Securities Litigation Reform Act of 1995 for Applied Minerals Inc. Some statements contained or implied in this news release may be considered forward-looking statements, which by their nature are uncertain. Consequently, actual results could materially differ. For more detailed information concerning how risks and uncertainties could affect the Company's financial results, please refer to Applied Minerals' most recent filings with the SEC. The Company assumes no obligation to update any forward-looking information.

Contact

Investor Relations Contact:
MZ North America
Greg Falesnik
Managing Director
1-949-385-6449
greg.falesnik@mzgroup.us
www.mzgroup.us

Public Relations Contact:
Ness Capital & Consulting
Richard P. Brown
Principal
978-767-0048
rbrown@nesscc.com