Further Talga Li-ion Battery Success

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Corporate Information

ASX Codes **TLG, TLGOA**

Shares on issue **202.4m**

Options (listed) **44.9m**

Options (unlisted) **33.5m**

Company Directors

Terry Stinson
Non-Executive Chairman

Mark Thompson
Managing Director

Grant Mooney
Non-Executive Director

Stephen Lowe
Non-Executive Director

Ola Mørkved Rinnan
Non-Executive Director

- **Highly encouraging endurance test results from new Talga Li-ion battery anode formulation**
- **New anode successfully cycled for over 1,200 hours while retaining 99.5% capacity**
- **Talga's latest combined graphene/micrographite formula shows higher capacity and efficiency than conventional spherical graphite and Talga's previous anode materials**
- **Results attract partners across the battery supply chain in Europe via consortia programs targeted at UK government electric vehicle (EV) funding initiatives**
- **Talga enters partnership with Recruit R&D Co Ltd in Japan to jointly develop Li-ion battery materials for EV markets in Europe and Asia**
- **Results reinforce Talga's product strategy which includes the energy sector as a key near-term market**

Technology minerals company, Talga Resources Ltd ("Talga" or "the Company"), is pleased to provide an update on its UK battery development programs in Warwick Manufacturing Group's ("WMG") Energy Innovation Centre and at Talga's Cambridge product development labs.

Following successful initial anode results using the Company's micrographite, and then graphene nanoplatelet ("GNP") materials (ASX:TLG 10th October 2016 and 7th June 2017), Talga expanded testwork of its graphitic carbons as the active material of Lithium-ion ("Li-ion") battery anodes (Fig 1).

Talga has received highly encouraging results from 1,200 hours of testwork on a new Li-ion battery anode formulation that combines both its micrographite and GNP materials. The anode exhibited outstanding electrochemical performance across a range of key industry measures, including reversible capacity of ~420mAh/g over a 100 cycle average with a retention of 99.5% and coulombic efficiency of 99.9%.

The capacity measure reflects a ~20% increase in capacity performance compared to commercially available graphite anodes (usually around 330mAh/g). This is significant as increased battery energy density translates into increased range for electric cars and more usage time for a mobile device.

Further, Talga's WMG test data has enabled the Company to participate in consortia based applications for UK government funding programs and enter a development partnership with Recruit R&D Co Ltd, a major Japanese technology company with extensive experience of the Li-ion battery manufacturing sector.

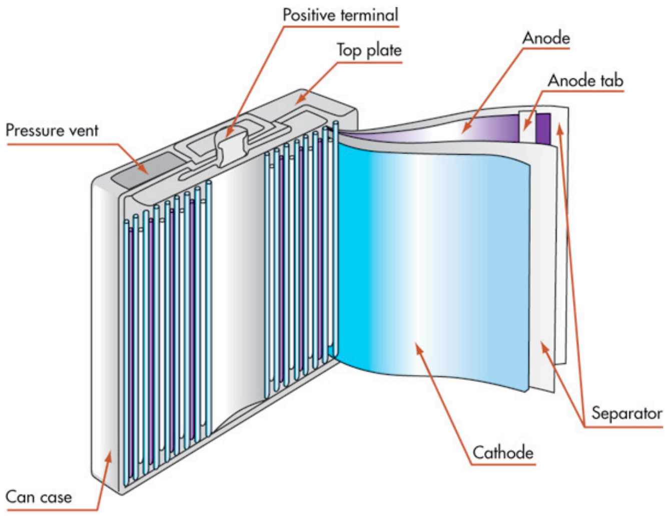
Talga Managing Director Mark Thompson commented:

"Talga continues to receive strong results from its battery material testwork, utilising our unique ore source with in-house processing and material technologies. The duration of our cycling tests is becoming significant and we are attracting industry attention with our data. This fits our strategy to access more valuable downstream opportunities in the battery value chain in addition to raw material supply. We are exceptionally well placed to benefit in the short term from the booming demand for battery and related conductive materials".

Test Program

Following encouraging initial benchmarking tests of Talga's micrographite and then graphene nanoplatelet ("GNP") materials in separate coin cell anode test programs (ASX:TLG 10th October 2016 and 7th June 2017), Talga has compiled data from testwork on a new anode formulation trialled at WMG.

The new Li-ion battery anode formulation employs a combination of Talga's micrographite and graphene (GNP) materials from Talga's test facility in Germany. The formulation was trialled in coin cells using WMG's standard N-Methyl-2-pyrrolidone ("NMP") based anode materials, coated onto copper foils and tested with lithium metal as the counter and reference electrode. The electrodes for the cell were prepared by punching discs from the graphitic carbon coated copper foil and lithium foil. Various components of the cell were then assembled after the addition of the electrolyte. The cells were tested using an industry standard constant current charge discharge technique at a rate of 0.2C.



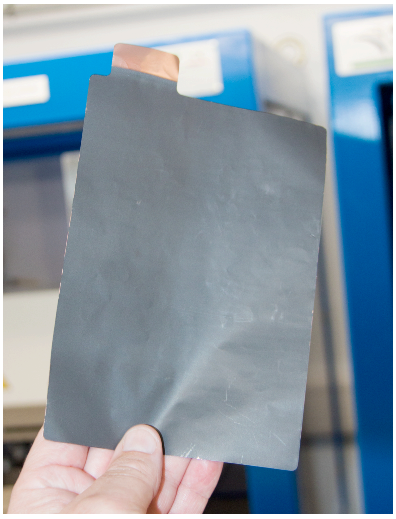


Figure 1 *(Left) Schematic of prismatic or "pouch" cell Li-ion battery showing main components including anode and (Right) graphite-based anode for prismatic Li-ion battery at WMG.*

Performance

Talga's anode exhibited outstanding electrochemical performance across a range of key industry measures. Significantly, the anode showed capacity of ~420mAh/g over a 100 cycle average with a retention of 99.5% and coulombic efficiency of 99.9% (Figure 2).

The results show a ~20% increase in capacity compared to the theoretical maximum capacity of graphite at 372mAh/g. This outcome is significant given the testwork was conducted using WMG's standard processes and materials.

Importantly, it can also be seen that the anode charge-discharge profile remained nearly identical at initial cycling and after 1,200 hours of testing with no long term deterioration. In real terms this demonstrates that Talga's anode could support a Li-ion battery to last longer in between recharge cycles, to enjoy a longer life and to charge and discharge efficiently with minimal loss of energy.

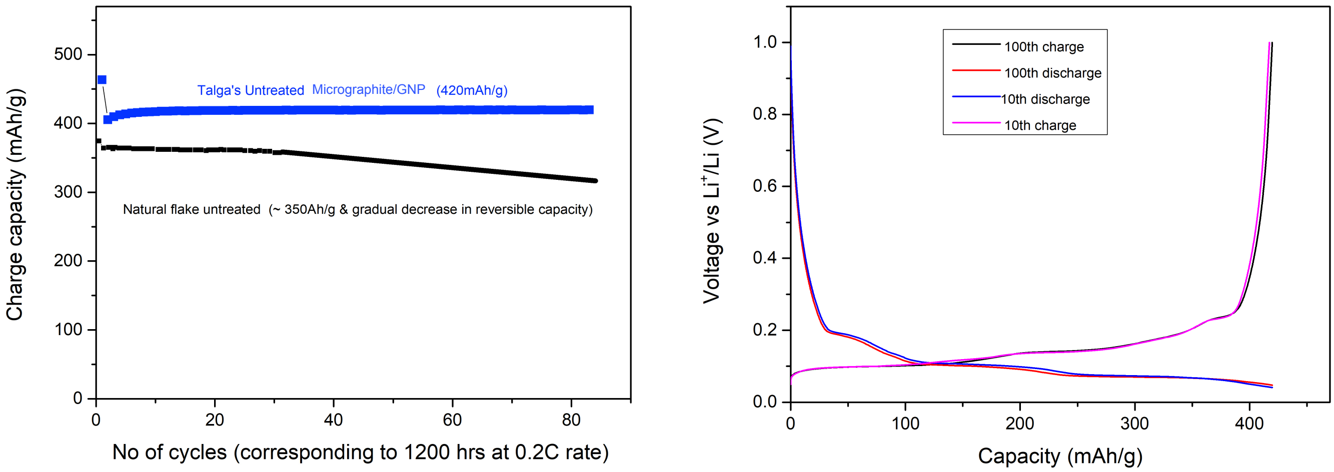


Figure 2 *Figure 1 (Left) Charge-discharge capacity plotted against the number of cycles demonstrating a high reversible capacity retention. (Right) Voltage versus capacity profiles at 10 charge discharge cycles and 100 charge-discharge cycles.* ***Note:*** *These figures show the intercalation potential for lithium ions in a graphitic material but with added capacity close to 420mAh/g. Regular graphite for comparison has a theoretical capacity of 372mAh/g which corresponds to one Lithium ion present in the middle of 6 hexagonally arranged carbon atoms to give LiC_6. In graphene materials additional intercalation sites exist due to the presence of chemical groups and disorder present in the edge carbon atoms.*

Talga believes this can be attributed to the novel electrochemical behaviour exhibited by its unique graphite ore when combined with the Company's in-house process technology.

Talga's micrographite and graphene materials demonstrate behaviours similar to certain types of synthetic materials - like hard carbons and graphene - that have shown a capacity greater than 372mAh/g in literature. Similar to these materials, Talga's graphitic carbons also have additional intercalation and edge sites present for molecules to insert or attach, explaining the outperformance over conventional synthetic and spheronised flake graphite.

UK Battery Material Partnerships

The global push to reduce greenhouse gases and promote cleaner energy sources has seen several recent examples of nations leading with policies to move away from internal combustion engines.

In the last few months, China, France and the UK have joined India and Norway in the move to phase out fossil fuel vehicles. Many countries in Europe are aggressively pursuing stretch targets for electric vehicle production and this includes Sweden where Volvo Cars has decided to stop designing combustion engine-only vehicles by 2019.

Figure 3 *Talga management and staff visit the WMG facility in the UK.*

The raw materials required for Li-ion and other next generation batteries have become a critical focus for multinational corporates who wish to secure these materials from clean, reliable and ethical supply chains.

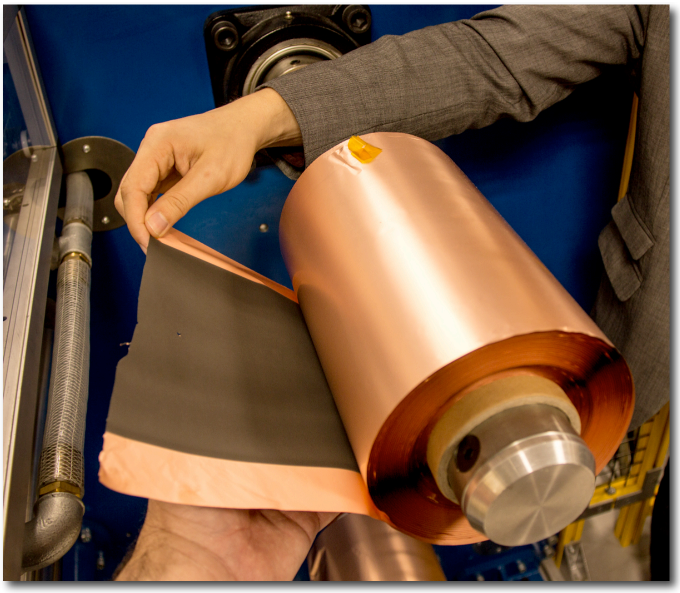
The impact of this market sentiment is being seen on a number of fronts. In the UK, a recently announced funding program called the 'Faraday Challenge' will support national applicants with a pool of £246 million dedicated to automotive electrification. Courtesy of its WMG industrial testwork program, Talga has attracted the attention of downstream battery sector stakeholders who are looking to partner with Talga via the Faraday Challenge. Talga has entered, as joint applicant, in multiple Faraday Challenge proposals with several industry leading groups. Outcomes of these applications will be known in November 2017 and further information regarding these programs will be disclosed when available.

Japanese Technology Company Partnership

In addition to industry collaboration through funding initiatives, Talga has commenced a development program with the battery technology arm of Recruit R&D Co Ltd ("Recruit R&D"), an engineering corporation that is part of the multinational Recruit Group. Recruit R&D employs more than 1,200 scientists and engineers operating with more than 400 partner companies and research organisations.

The program, being led by **Dr Claudio Capiglia**, will utilise Recuit R&D's deep knowledge and experience of battery supply chains to link Talga's material development with the specific needs of battery manufacturers. Dr Claudio Capiglia has over two decades of experience in advanced battery technologies in Japan and pioneered the development of the gel polymer electrolyte for Li-ion polymer batteries, first mass produced in 1999. Later, he was Senior Scientist at the solid state battery technologies project for Toyota's EVs, where he helped develop the all solid state battery concept.

Figure 4 *Graphite based anode formula coated onto copper for roll to roll Li-ion battery manufacture at WMG.*



This program represents a natural extension to the WMG work undertaken to date and will utilise the facilities of both Recruit R&D and WMG. Talga will benefit from Recruit R&D's extensive links into the Asian battery materials' supply chain and support to become a qualified supplier.

Recruit R&D's program manager, Dr Claudio Capiglia comments: "*Recruit R&D is excited about the opportunity to partner with Talga due to the tremendous potential of its unique graphite resource and processing technique. Recruit R&D see's a real opportunity to create a much needed local European source of advanced battery materials. The results from Talga's testwork demonstrates a very impressive reversible anode capacity and long stable cycling performances with high coulombic efficiency. We believe Talga's materials show real promise for next generation anode materials for Li-ion and post Li-ion battery technologies*".

Next Steps

Talga, with the support of Recruit R&D and WMG, will now undertake rate capability tests to analyse the behaviour of its Li-ion battery anode material across a range of different charge and discharge conditions (C-rates). This work, to be undertaken using WMG's manufacturing line and dry room facilities, will result in a full technical end-user level specification of the most promising anodes. The work will include measures to limit the first cycle irreversible capacity loss typically seen for advanced nanomaterials like graphene and silicon nanoparticles.

Thereafter, next steps include utilising environmentally friendly aqueous formulations for application on large roll to roll coaters commonly used in today's battery manufacturing processes, followed by fabrication and testing of larger scale 'pouch cells' at WMG (Fig 4).

The aim of Talga's work is to develop a value-added anode product with performance advantages to enter into a commercial agreement with a major customer in the battery/energy storage market.

For further information, visit www.talgaresources.com or contact:

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About Talga

Talga Resources Ltd ("Talga") (ASX: TLG) is a technology minerals company enabling stronger, lighter and more functional graphene and graphite enhanced products for the multi-billion dollar global coatings, battery, construction and carbon composites markets. Talga has significant advantages owing to 100% owned unique high grade conductive graphite deposits in Sweden, a test processing facility in Germany and in-house product development and technology. Advanced product testing is underway with a range of international corporations including industrial conglomerate Chemetall (part of BASF), Heidelberg Cement, Tata Steel, Haydale, Zinergy and Jena Batteries.

Forward-Looking Statements

TECHNICAL GLOSSARY

Anode	The negative electrode in a battery during discharge. It refers to the electrode in an electrochemical cell where oxidation takes place, releasing electrons across a load cell. In Lithium-ion batteries, it consists of graphite and other carbons coated on copper.
Aqueous anode formulation	A chemical formulation that contains graphite mixed in a water based solution which is suitable to be coated on copper and dried to leave a pure graphite based layer to form the Li-ion battery anode.
Battery efficiency	Refer to coulombic efficiency.
Battery module	An assembly of cells in series and parallel encased in a mechanical structure.
Capacity	The total battery or electrode capacity, usually expressed in ampere-hours or milliampere-hours, available to perform work. The actual capacity of a particular battery or electrode is determined by a number of factors, including the material properties, cut-off voltage, discharge rate, temperature, method of charge and the age and life history of the battery.
Capacity fade/ ageing	Permanent loss of capacity with frequent use or the passage of time due to unwanted irreversible chemical reactions in the cell.
Cathode	Electrode that, in effect, oxidises the anode or absorbs the electrons. During discharge, the positive electrode of a voltaic cell is the cathode. When charging, that reverses and the negative electrode of the cell is the cathode.
Charge	The conversion of electric energy, provided in the form of a current, into chemical energy within the cell or battery.
Cell	A closed electrochemical power source. The minimum unit of a battery comprised of 4 key components including cathode, anode, electrolyte and separator. Li-ion battery cells come in three different shapes (design architecture) being prismatic, cylindrical or pouch.
Coin cell	An electrochemical device, composed of positive and negative plates and electrolyte, which is capable of storing electrical energy. It is the basic "building block" of a battery in lab scale tests using circular half or full coin shaped cells.
Coulombic efficiency	The ratio (expressed as a percentage) between the energy removed from a battery during discharge compared with the energy used during charging to restore the original capacity.
C-rate	C-rate is a measure of the rate at which a battery is charged relative to its maximum capacity. A 1C rate means that the charge current will charge the entire battery in 1 hour (60 minutes), 0.2C means complete charging is made during 5 hours (60minutes/0.2 = 5 hours) and 5C means that complete charging was made in 12 minutes (60 minutes/5 = 12 minutes).
Cylindrical cell	Components of a battery assembled inside a cylindrical metal container.
Discharge	The conversion of the chemical energy stored within a cell to electrical energy, and the subsequent withdrawal of this electrical energy into a load.

Few layer graphene (FLG)	Stack of graphene having a total thickness of 5 layers or less.
Graphene	A single atom thick layer of crystalline carbon, with properties of strength, conductivity and transparency that stem from its unique 2D structure.
Graphene nanoplatelets (GNP)	Stack of Graphene having a total thickness of 5-100 layers and properties of strength and conductivity that far exceed that of Graphite.
Graphite	An allotrope of carbon in which carbon has sp^2 hybridisation. Can be found as a natural mineral or can be synthesised using great pressure and temperature. Natural Graphite consists of many stacked layers of Graphene, approximately 3 million layers of Graphene per millimetre of Graphite.
Lithium	A soft, silvery-white metallic element of the alkali group, the lightest of all metals.
Lithium-ion	Elemental Lithium devoid of an electron having an oxidation state of +1.
Lithium-ion battery	Rechargeable battery where lithium-ion shuttles between graphitic anode and cobalt, manganese, nickel and/or other metals in combinations as cathode.
mAh/g	Milli Ampere hours/ per gram – a unit for battery capacity/materials.
Milling	The process of breaking material into small fine parts by grinding following crushing, or machining/cutting material using rotating equipment.
Packaging efficiency	The mechanical structure used to contain and protect a battery's components (cells, electronic circuits, contacts etc.) – the efficiency with which the battery components can be packed in a given volume.
Pouch cell	Battery cell packaged into a flat-shaped flexible, heat-sealable foil pouch.
Prismatic cell	A slim rectangular sealed battery cell in a metal or inflexible case. The positive and negative plates are stacked usually in a rectangular shape rather than rolled in a spiral as done in a cylindrical cell.
Rate capability	A performance metric that measures the ability of the cell to retain capacity at different charge and discharge rates (C-rates). It is a measure of the currents that the battery materials can sustain without degrading and of the power that the battery can safely deliver.
Reversible Capacity	The capacity of the electrode that is retained after each subsequent charge discharge cycle
Roll to roll fabrication	Continuous fabrication of battery cells using rolled sheets of battery components and coating them with the active materials as they roll onto a spool for subsequent cutting and packaging into cells.
Shaping/ Spheronising	The milling of graphite flakes into sub-15 micron sized spherical shaped particles to reduce size and surface area to suit formulations for Li-ion battery anodes.
WMG	Warwick Manufacturing Group belonging to the University of Warwick, UK.