Talga Anode Outperforms Commercial Li-ion Cells In Electric Vehicle Endurance Test

- **Positive commercial qualification of Talnode™-C in tests for "Lacama" electric motorcycle by Italian manufacturer IV Electrics (formerly Italian Volt)**
- **Batteries containing Talnode-C outperform endurance of market leading commercial cells by up to 36% in fast charge/high power '*Stelvio*' test**

Australian advanced materials technology company, Talga Resources Ltd ("Talga")(ASX:TLG), is pleased to announce further results from development of its active graphite anode product for lithium-ion ("Li-ion") batteries, Talnode™-C.

Talnode-C is currently undergoing full-cell qualification with a range of technical and commercial partners as it progresses through validation processes. In new tests conducted by IV Electrics, formerly known as Italian Volt and manufacturer of the "Lacama" electric motorcycle (Fig 1), Li-ion batteries fabricated with Talnode-C anodes were subjected to benchtop tests designed to replicate extreme real world conditions and ensure high performance of the Lacama battery pack.

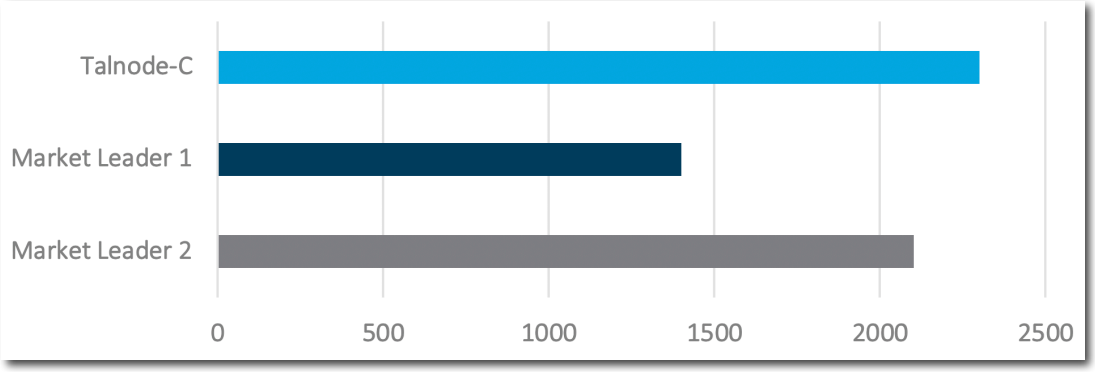
One of these tests is named '*Stelvio*', after the famously steep road through the Italian Alps (Fig 2) and simulates driving up a mountain at high speed. This cyclic test checks the ability of a battery to efficiently collect fast charge regenerative current (from braking) after a high-power discharge (acceleration) in low temperature conditions. Results in running time represents battery cell performance before limits in voltage drop or cell temperature force the end of the test.

Results show that Talnode-C containing battery cells outperform the endurance of market leading commercial cells by up to 36% (Fig 3). Furthermore, the tests confirm the fast charge, high power, and low temperature properties of Talnode-C anodes translate well to the full cell-level.

Figure 1 *The Lacama, developed by IV Electrics*

Figure 2 *The Stelvio Pass, Italy*

Figure 3 *Stelvio Test: time (s) for cell voltage to fall below 3.2V, at 14°C. Details of test cycle: discharge 3 seconds at 3C, charge 1 second at 1C, rest for 4 seconds and repeat until voltage or thermal limit.*



In effect this means that a battery pack manufactured with Talnode-C may need less thermal management and materials, reducing cost and weight, while increasing energy density (and therefore driving range) and safety of the battery pack.

Talga Managing Director, Mr Mark Thompson: *"We are delighted that Talga's Li-ion battery anode material has proven itself again in tests for a premium electric vehicle manufacturer such as IV Electrics and their high performance Lacama. We look forward to further development of our premium range of Li-ion battery products utilising Talga anode material technology and the unique intrinsic properties of our Swedish mineral resources."*

Talga staff will be presenting recently published performance results of Talnode™ products at the International Battery Seminar in Ft. Lauderdale, Florida on 28 March Australian time.

About IV Electrics

IV Electrics is an Italian company conceived in 2016 to develop and manufacture a new concept of electric motorcycle; the Lacama (see Figure 1). The Lacama is a tailor-made, customisable, fully electric roadster using 3D-printing, advanced technology and design excellence to achieve high performance, with an acceleration from 0 to 100 km/h in under 4 seconds and a top speed approaching 200km/h. The battery can be recharged in 40 minutes thanks to compatibility with fast charge columns.

About Talga

Talga Resources Ltd is an advanced materials technology company enabling stronger, lighter and more functional graphene and graphite enhanced products for the multi-billion dollar global battery, coatings, construction and composites markets. Talga has significant commercial advantages owing to its vertically integrated high grade Swedish graphite deposits and in-house process to product technology. Company website: **www.talgaresources.com**

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TECHNICAL GLOSSARY

Anode	The negative electrode in a battery during discharge. In Li-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 capacity	The total battery capacity, usually expressed in mAh/g available to perform work. The actual capacity of a particular battery 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.
Battery efficiency	Refer to coulombic efficiency.
Battery module	An assembly of cells in series and parallel encased in a mechanical structure.
Capacity	Capacity represents specific energy in ampere hours (Ah) or mAh/g. Ah is the discharge current a battery can deliver over time.
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.
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).
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.
Cycle	The discharge of a charged battery with subsequent recharge. The number of cycles a rechargeable battery can withstand before performance degrades is the accepted method of measurement for rating rechargeables’ expected life.
Cylindrical cell	Components of a battery assembled inside a cylindrical metal container.
Charge/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 1-10 atom thick layer of crystalline carbon, with superlative properties of strength, conductivity and transparency.
Graphene nanoplatelets (GNP)	Stack of graphene having a total thickness of 10-100 layers and properties of strength, conductivity and barrier properties that far exceed that of graphite.
Graphite	An allotrope of carbon in which carbon has sp2 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, the lightest of all metals
Lithium-ion (Li-ion)	Elemental lithium devoid of an electron having an oxidation state of +1.
Lithium-ion battery	Rechargeable battery where Li-ion shuttles between graphitic anode and cobalt, manganese, nickel and/or other metals in combinations as cathode.
mAh/g	Milliampere 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.
NMC	A Li-ion cathode consisting of Nickel Manganese Cobalt Oxide.
Packaging efficiency	The efficiency with which the battery components (cells, electronic circuits, contacts etc.) can be packed in a given volume.
Percolation	The process of a liquid moving slowly through a porous substance.
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	The rate capability specifies the speed a battery is charged or discharged.
Reversible capacity	The reversible capacity is the capacity that is available to the load after the electrode is formed.
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.
Solid Electrolyte Interface	A solid electrolyte interface (SEI) is a layer formed on the graphite anode that can act as a barrier, obstructing interaction and resulting in increased internal resistance and capacity loss.
Specific energy	Specific energy, or gravimetric energy density, defines battery capacity in weight (Wh/kg); energy density, or volumetric energy density, reflects volume in litres (Wh/l). Products requiring long runtimes at moderate load are optimised for high specific energy; the ability to deliver high current loads can be ignored.