Talga Graphene Agreement for Printed Battery Development in UK

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Corporate Information

ASX Codes	**TLG, TLGOA**
Shares on issue	**181.9m**
Options (listed)	**44.9m**
Options (unlisted)	**28.7m**

Company Directors

Terry Stinson
Non-Executive Chairman

Mark Thompson
Managing Director

Grant Mooney
Non-Executive Director

Stephen Lowe
Non-Executive Director

- Joint Development Agreement executed with Zinergy UK Ltd on development of ultra-thin, flexible, printed batteries
- Talga to supply value-added graphene and graphitic carbon ink formulations over an initial 12 month period
- Provides exposure to participants in the thin film, printed, flexible and organic electronics sector (market forecast 2017 – USD$29.3 billion[1])
- Agreement follows commercial progression of conductive ink research and battery testwork being conducted at Warwick University Energy Innovation Centre
- Represents the second Talga battery market development agreement direct with an end user

Technology minerals company Talga Resources Ltd ("**Talga**" or the "**Company**") (ASX Code: TLG) is pleased to announce it has signed a joint development agreement ("**JDA**") with Zinergy UK Ltd ("**Zinergy**") to co-develop and supply graphene conductive inks for electrodes in the world's thinnest, flexible printed batteries.

Under the terms of the JDA, Talga and Zinergy will collaborate to develop and trial graphene-based conductive ink formulations in components of the patented Zinergy ultra-thin printed battery. The development program will run for an initial 12 month period. Under the JDA, each company will contribute and retain its own intellectual property.

The market for flexible, light weight, and often disposable but eco-friendly batteries is growing rapidly and Talga's co-development with Zinergy targets a cost-value and performance solution for the mass production of printed power.

Flexible form factor and ultra-low weight printed batteries create functionality for a range of electronic products within fast growing markets associated with smart packaging, portable electronics, wearables, radio frequency identification devices (RFID) and sensors (broadly described as the 'Internet of Things').

Talga Managing Director Mark Thompson commented:

"In the global megatrend of energy storage devices, printed batteries stand out as a potent enabler of mobile electronic technologies, from smart packaging to wearables. We are delighted to partner with Zinergy on the development of their products and the exciting flexible battery market opportunity.

The JDA with Zinergy also demonstrates growing demand by industry to harness the properties of graphene, and supports the confidence held by others in our ability to functionalise graphene and create cost-effective high performance formulations. This further validates Talga's commercialisation approach and follows our other product development success in battery materials."

The partnership will see development of graphene-coated components targeting significantly enhanced longevity and performance of printed batteries. Graphene's renowned properties of high conductivity, chemical inertness and impermeability can provide an advantage over competing materials to enable eco friendly, low cost, scalable and corrosion resistant flexible battery components (Fig 1).

This alliance will expand Talga's potential for significant growth in the field of energy storage and shares close links with past and current battery test programs already underway within the Company and at the University of Warwick - Energy Innovation Centre. The conductive 'ink' materials to be tested represent variants of Talga's graphene value-added products currently being developed for metal coatings and water-based eco friendly lithium-ion battery anodes.

Zinergy CEO Dr Pritesh Hiralal commented:

"We are thrilled to partner with Talga to explore an exciting opportunity. We are constantly in the lookout to push the boundaries of printed electronics technology and this collaboration opens up such an opportunity from the ground up".

Figure 1 *Printed flexible electronic circuit.*

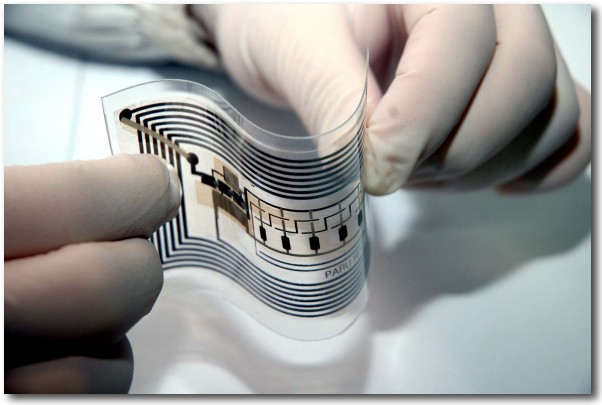
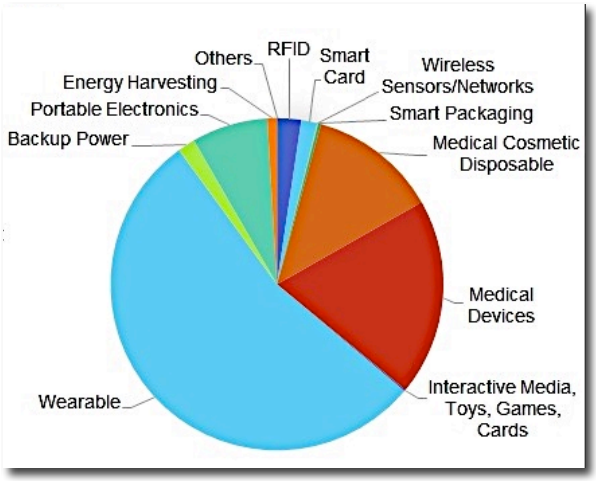


Figure 2 *Forecast 2025 market segments for printed batteries. Source: IDtechEX reports.*



Next steps

The preparation of Talga graphene materials will be conducted by Talga's dedicated energy products team at Talga Technologies UK Ltd led by Dr Sai Shivareddy. Initial test results are expected in 3Q CY2017.

Talga energy storage - commercialisation status

The execution of the JDA is in line with Talga's commercialisation strategies. Talga energy storage product development milestones to date include:

✓ **Internal validation**: Talga characterisation of graphene and micrographite particles from Talga's German test facility supporting lithium-ion anode preparation using 'un-milled' source ore;

✓ **Academic validation**:

- Testwork by Technical University of Dresden and the Max Planck Institute confirming lithium-ion coin cell energy capacity on par with commercial batteries that rely on highly purified spherical graphite anodes (*refer to ASX announcement dated 17 February 2016*);
- Follow up larger scale commercial tests at the University of Warwick EIC support prior German testwork and pouch cell tests commenced to include graphene aqueous anode formulations and pouch cells (*refer to ASX announcements dated 9 May 2016 and 10 October 2016 respectively*);

✓ **Prototype developed**: Internal water based graphene ink formulations developed and tested, prototypes underway pursuant to Jena Batteries GmbH collaboration and Zinergy JDA;

✓ **Secure industry partner**:

- Agreement reached with Jena Batteries GmbH to jointly explore the use of Talga graphene products in flow batteries (*refer to ASX announcements dated 15 September 2016*); and
- Agreement reached with Zinergy to co-develop graphene ink formulations for flexible printed batteries.

Talga's product development strategy, as distinct from its raw materials strategy, is designed to achieve production of prototype/demonstrator products in-house to attract industry partners to tailor and upscale demand for value-added graphene solutions for their products. Talga will also pursue licensing agreements where background and arising intellectual property is attributable to Talga.

About Zinergy

Zinergy UK Ltd. ('Zinergy') is an energy technology company based in Cambridge, UK with proprietary technology for ultra-thin printed batteries and supercapacitors for applications as varied as medical devices, smart packaging and "Internet of Things". Touted with having designed the thinnest printed battery in the world, Zinergy is now on customer trial stage and upscaling its patented technology.

About Talga

Talga Resources Ltd ("Talga") (ASX: TLG) is a technology minerals company enabling stronger, lighter and faster graphene and graphite products for the coatings, battery, construction and carbon composites markets. Talga has significant advantages owing to 100% owned unique high grade conductive deposits in Sweden, a test facility in Germany and in-house product development and IP. Advanced testing is underway with a range of corporations including industrial conglomerate Tata, UK listed Haydale and German based Jena Batteries.

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

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References

1. *Printed, Organic and Flexible Electronics (2017-2027).* IDTechEx Research 2017.
2. *Flexible, Printed and Thin Film Batteries (2016-2026):* IDTechEx Research 2016.
3. *Blue Spark Technologies/Industry-solutions/about-printed-electronics:* Blue Spark Technologies.
4. *The Applications and Limitations of Printable Batteries:* M. Delmanowski 2010.

APPENDIX

Summary of the flexible printed battery opportunity

Background

Printed electronics is the term that defines the printing of electronic circuits and components on common media such as paper, plastic, and textile, using standard graphic arts printing processes and press equipment. But instead of using standard inks, newly developed electronic inks are used to print active devices, such as thin film transistors and printed batteries.

Although the concept of printed electronics has been around for some time, recent advances in conductive ink chemistry and flexible substrates promise to deliver a flood of new markets and applications[3].

With the popularity of smaller wireless hand-held devices and more mobile and interactive lifestyles, it is becoming more and more important to find power sources that are smaller in size, yet that are still able to hold a longer charge. Thin-film and printed batteries with their customisable shapes, flexible form factors and ultra-low weight are enabling new functionality to be added to a broad range of electronic products thanks to the rise of 'Internet of Things'. These include smartcards, radio frequency identification devices (RFID) and sensors both increasing their usefulness and the size of their addressable market[4]. These applications require new features and battery designs that traditional battery technologies simply cannot provide[2].

Graphene Solution

One of the primary constraints of printable electronics are the issues caused by relatively large and inefficient power sources. Existing batteries used to power basic displays and electronics are still encased in metal canisters and are bulky in comparison to flat printed circuits (this includes small button cell zinc batteries). This significantly hinders the possibilities of flexible products, and requires the battery to be external with connecting wires.

To advance with viable printed electronics, new smaller power sources are being developed to make these products compact and flexible, tough, wearable and environmentally friendly[4].

Thin, flexible batteries have been available for over fifteen years, yet they have had limited commercial success due to premium pricing and the fact they offer lower capacity and have a shorter shelf life than regular button cell or larger batteries[2]. Many printed batteries today use printing only for the electrodes and then laminate the electrolyte in between these electrodes. These batteries typically involve liquid electrolytes, which so far have not provided an effective electrolyte layer via printing[4].

Conductive carbon inks are already being successfully employed by printed battery manufacturers however graphene holds promise to remove some of the documented shortcomings associated with electrode and current collector corrosion, ink formulation discrepancies, reliability and steady life cycle.

Graphene is inert, has a high surface area along with excellent barrier properties and enables a flexible form factor while providing good conductivity to the battery electrode unlike any other material. These multi-functional properties in a single material bring multiple benefits including better discharge rate, longer shelf life and improved durability of printed thin film batteries.

Market

IDTechEx predict the market for thin, printed and/or flexible batteries will grow to become a USD$471 million industry[2] by 2025 (Fig 2). This is a sub-sector of the much larger Printed, Organic and Flexible Electronics market which has a forecast value of USD$29.3 billion in 2017[1].

Apart from Zinergy other companies in the printed and flexible battery sector include, but are not limited to Apple, Bluespark Technologies, Samsung, LG Chem, Nokia, NEC and Varta.