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Guest Editorial

Introduction to Batteries at Johnson Matthey

It may surprise some readers to see an edition of this journal dedicated largely to lithium-ion batteries, but this is a technology that Johnson Matthey considers a major new business area for the company. Johnson Matthey has been involved in research and development (R&D) in the battery materials space for several years and launched its commercial business operations in the sector in 2012. Since then, the company has made a series of acquisitions to establish itself both as a global supplier of cathode materials and of advanced battery systems. Complemented by its lithium-ion battery research group at the Technology Centres in Sonning Common, UK, and in Singapore, the Battery Technology business of Johnson Matthey sits within its New Business Division. It represents a further expansion of the company's core strengths and expertise in chemistry and advanced materials to develop new, high technology products.

Johnson Matthey Battery Technologies

Johnson Matthey Battery Technologies brings together the company's activities in lithium-ion and next generation batteries and operates at two points in the value chain for lithium-ion batteries (**Figure 1**).

Through a combination of in-house R&D and acquisition the company is establishing itself as a significant player in the sector. From an initial position in lithium iron phosphate materials, further investments in the coming years will expand the product range, working with cell developers to commercialise improved and next generation materials.

There are big challenges to deliver the performance required for advanced lithium-ion cells, not just initial performance but durability and long term safety, as well as cost. Good cell design and efficient manufacture are critical elements but the functional materials used are also important contributors and big improvements are still required. We believe that Johnson Matthey's deep understanding of functional materials design can be applied to some of these challenges and we think that solving them is a huge opportunity.

At the other end of the chain we will continue to work on the design and supply of complex, high performance battery systems for demanding customers in both automotive and non-automotive sectors. In addition to

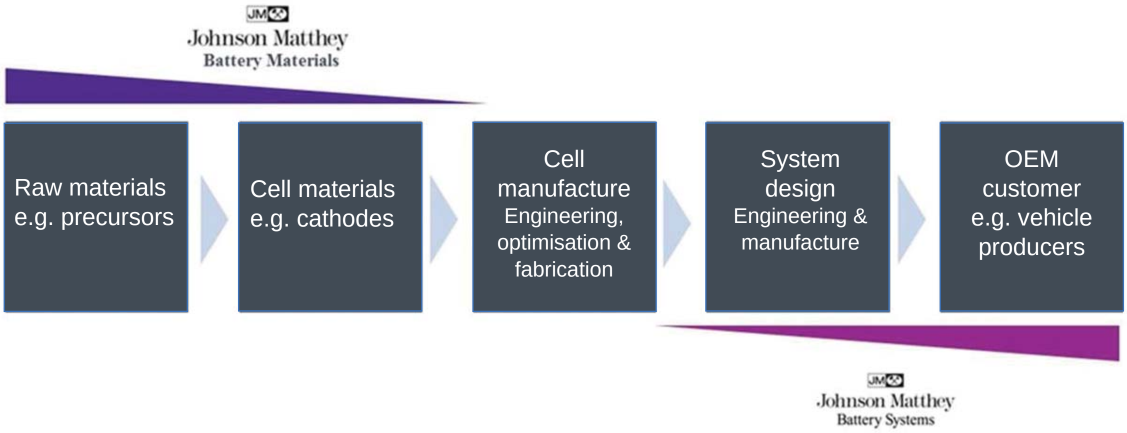

Fig. 1. Johnson Matthey Battery Systems' input into the value chain for lithium-ion batteries

being an attractive growth sector in its own right the battery systems activities help define future materials requirements through providing deep applications knowledge in the sector.

Taken together Johnson Matthey's Battery businesses will have three major manufacturing operations in China, Canada and Poland together with R&D facilities in the UK, in Germany and in Singapore.

As well as looking at today's lithium-ion chemistries Johnson Matthey continues to invest in longer term research in the sector, covering next generation lithium-ion and also other systems such as metal-air and metal-sulfur chemistries.

Research and Development

Examples of collaborative, EU-funded programmes in which Johnson Matthey is involved include the Lithium Sulfur Superbattery Exploitating Nanotechnology (LISSEN) project. This project is aimed at the identification and development of nanostructured electrode and electrolyte materials to promote the practical implementation of the very high energy lithium-sulfur battery. It is expected that this battery will offer an energy density at least three times higher than that available from the present lithium battery technology, a comparatively long cycle life, a much lower cost (replacement of cobalt-based with a sulfur-based cathode) and a high degree of safety (no use of lithium metal). The project will benefit from the support of a laboratory expert in battery modelling, large research laboratories having modern battery production facilities and chemical and battery manufacturing industry partners.

Stable Interfaces for Rechargeable Batteries (SIRBATT) is a multisite collaborative project consisting of 12 full partners from the European area (six universities, one research institute and five industrial partners). Collaboration with leading battery research groups in the USA and Japan is also considered. SIRBATT will develop microsensors to monitor internal temperature and pressure of lithium cells in order to maintain optimum operating conditions to allow long-life times that can be scaled for use in grid scale batteries. The scientific aim of SIRBATT is a radical improvement in the fundamental understanding of the structure and reactions occurring at lithium battery electrode/electrolyte interfaces.

The Practical Lithium Air Batteries (PLAB) project brings together a range of academic and industrial partners with complementary skills to work on improved lithium-air battery single cells and assess their feasibility in future battery pack and system design, compact air purification approaches and general viability for use in automotive applications. Academic partners Queens University Belfast and Liverpool University, both in the UK, will work on synthesising and characterising the new electrolytes, whilst Johnson Matthey Technology Centre will produce novel cathode and anode materials, optimise electrode structures and perform electrochemical testing. The participation of Jaguar Land Rover as an end user and Johnson Matthey Battery Systems (formerly Axeon) will provide an applications focused approach and they will perform a paper feasibility study on how high performing lithium-air single cells would be incorporated into automotive systems in the future. The final output will assess the feasibility for lithium air battery systems to achieve a 400 Wh kg^{-1} power density.

MARS-EV aims to overcome the ageing phenomenon in Li-ion cells by focusing on the development of high-energy electrode materials (250 Wh kg^{-1} at cell level) *via* sustainable scaled-up synthesis and safe electrolyte systems with improved cycle life (> 3000 cycles at 100% depth of discharge (DOD)). Through industrial prototype cell assembly and testing coupled with modelling MARS-EV will improve the understanding of the ageing behaviour at the electrode and system levels. Finally, it will address a full life cycle assessment of the developed technology. MARS-EV brings together partners with complementary skills and expertise, including industry and covering the complete chain from active materials suppliers to cell and battery manufacturers, thus ensuring that developments in MARS-EV will directly improve European battery production capacities.

Johnson Matthey is excited to be involved in these and many other projects in the field of lithium battery research. We hope that readers will enjoy the articles about lithium batteries in this issue, and look out for future articles and reviews on this topic in future issues.

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