Batteries meet SEMICONductors

S. Raithel
COO Gas Treatment
DAS Environmental Experts, Dresden, Germany

Biography

Stephan Raithel successfully completed his studies of Business Administration with a German Diploma degree and a bachelor of arts with honors in 2004. During and after his studies he was working for a professional trade show organizer and was in total responsible for 3 different products focusing on consumer goods, financial services and creative industries. In 2007 he joined the global semiconductor trade association SEMI in the Brussels office as Senior Manager Operations where he became a key staff in implementing SEMI Europe's strategy and enlarging SEMI's presence within Europe. In 2009 he opened a SEMI branch in Berlin, Germany, where he was the Managing Director for SEMI Europe, being at the same time responsible for all direct reports in Berlin as well as filling the role of the CFO for all European activities. Various responsibilities such as the European SEMI Standards program and the development of the International Technology Roadmap for PV (ITRPV) enriched his profile with technical skills in semiconductor and solar manufacturing.
In 2016 he joined DAS Environmental Experts – a leading supplier of industrial waste gas and wastewater treatment solutions. Since 2018 he represents DAS as the COO for the business unit gas treatment.

How battery pack evolutions create opportunities for power electronics companies

M. Rosina
Senior Analyst, Energy Conversion and Emerging Materials
Yole Développement, Power and Wireless, Villeurbanne (Lyon), France

Abstract

The market for Li-ion batteries for e-mobility and stationary energy storage is strongly growing, driven mainly by electric and hybrid electric vehicles (EV/HEVs). According to Yole Développement estimates, for the largest Li-ion battery market segment - battery electric vehicles (BEVs) - the market value will reach almost $52 billion by 2023.
There is no big technology breakthrough expected in coming years regarding battery cells. The product differentiation will be sought on the battery pack level, by optimizing the battery pack design and its components. The existing solutions from other applications will be modified to fit the EV/HEV requirements, such as low Electromagnetic Interference (EMI) issues and vibration resistance to vibrations. The bigger changes are associated with the battery pack voltage trends towards 800V for BEVs and towards 1,500V for stationary energy storage for grid applications. The use of higher battery pack voltage will impact the choice of electronic components in Battery Management System (BMS) and in car converters and inverters and battery chargers. Silicon IGBTs or SiC MOSFETs rated at 1,200V will be used with 800V vehicle battery packs. The electrical interconnections and connectors and safety devices such as fuses and contactors must also be adapted for higher voltages. The energy capacity of battery packs will continue to increase, resulting

in needs for faster charging capability. Ultra-fast chargers providing charging power up to 350kW have already been developed. The power electronic components and systems rated for high currents will enable fast vehicle acceleration. The battery pack as the key element of an electric vehicle is closely interlinked with other elements such as inverters and converters, and motors. The synergies between different sub-systems and mechatronics solutions are sought more than ever, to obtain compact, lightweight and reliable solutions and to reduce the system costs.

Biography

Dr. Milan Rosina is a Senior Analyst for Power Electronics and Batteries at Yole Développement. Before joining Yole, he worked as a Research Scientist and a Project Manager in the fields of photovoltaics, microelectronics, and LED. Dr. Rosina has more than 15 years of scientific and industrial experience with prominent research institutions, an equipment maker, and a utility company. His expertise includes new equipment and process development, due diligence, technology, and market surveys in the fields of renewable energies, EV/HEV, energy storage, batteries, power electronics, thermal management, and innovative materials and devices.

High-rate and durable Li-ion batteries by Spatial-Atomic Layer Deposition

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Abstract

The wide implementation of electric vehicles is at the moment hindered by (amongst others) the lack of intrinsically safe battery technology that could provide sufficient energy density as well as fast charging for many charge/discharge cycles. The battery industry heading towards solid-state configurations. The key challenges in next-generation all-solid state Li-ion battery technology development are related to the required energy and power densities, fast charging constraints, battery lifetime, and at the same time keeping the cost low by high-volume production. Such technology criteria require superior electrode as well as electrolyte materials (pinhole-free), and processing techniques enabling even advanced 3D designs.

We report on innovative materials and 3D architectural approaches that can disrupt current Li-ion batteries, especially combining high-capacity with fast-charging capability. However, newer architectures demand newer processing techniques. A technology researched a lot in this respect is the Atomic Layer Deposition (ALD), which is well-known for its superior material quality and layer conformality over ultrahigh aspect ratio topology. But, in applications outside the advanced micro- and nanoelectronics industry, ALD technology is impeded by the economics of the low film deposition rates. Here, the scalable atmospheric pressure Spatial-ALD (S-ALD) holds the best promise for sufficient deposition rates and large-area roll-to-roll processability, which is key to battery industry.

Presented will be the results on high-rate 3D Li-ion battery electrodes using S-ALD, which show charging rates of few minutes. Highlighted will be the development of new high-performance battery electrode materials (in-situ doped) by engineering material properties at the nanoscale. Next to it, we will present about the first-ever S-ALD based solid-state LIPON electrolyte material (<100 nm thick). More about our research and capabilities will be presented during the seminar.

Biography

Eric Meulenkamp received his PhD from Utrecht University in the fields of luminescence spectroscopy and electrochemistry in 1993. Joining Philips Research in Eindhoven, Netherlands, he continued to work in the fields of (nano-)materials, electrochemistry and applied physics, being project leader for polymer OLEDs for display applications from 2000-2004. The next 8 years he was Department Head of various groups in Philips Research in the Netherlands and the USA in the domains of solid state lighting and healthcare. From 2013 he was R&D manager at Philips OLED Lighting in Germany, and became Managing Director of the entity after its acquisition by OLEDWorks LLC. He joined TNO Holst Centre in Nov. 2017 as Program Director, having responsibility for batteries, spatial ALD, OLED lighting and various thin-film deposition technologies.

Towards on-chip 3D all-solid-state lithium-ion microbatteries

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Abstract

The upcoming Internet of Everything (IoE) devices demand miniaturized rechargeable batteries, who distinguish themselves through a high level of safety as well as increased energy and power density per footprint area. Thin-film all-solid-state lithium-ion batteries deposited on highly structured silicon substrates are ideal candidates to match these requirements. The technical transition to solid-state electrolytes means significant improvement of battery safety. Three-dimensional (3D) battery concepts, including deposition on structured surfaces with high aspect ratio, have been shown to improve both capacity and rate performance of all-solid-state batteries.

At Fraunhofer IPMS-CNT we are driving the development of functional layer stacks by atomic layer deposition (ALD) allowing direct integration into microsystems. ALD enables conformal, pinhole-free deposition of nanometer thin films and composition control on an atomic level. However, deposition of lithium-containing materials by ALD is a challenging task. In order to make the entire 3D battery by ALD, single layers, interfaces, and the whole layer stack have to be tailored.

For semiconductor compatible design and production we manufacture on 8 inch silicon wafers using standard industrial thin-film deposition equipment. For battery integration into silicon technology lithium-ion diffusion into the silicon substrate must be inhibited. Undesired lithium-ion outdiffusion would result in poor cycling stability and failure of neighboring devices.

In order to enable deposition on nanostructured silicon substrates, there is demand for as thin as possible non-active battery layers. In this work, lithium-containing functional layers and ultrathin lithium- ion diffusion barriers for on-chip 3D batteries were investigated.

Biography

RESEARCH

Fraunhofer Institute for Photonic Microsystems (IPMS) - Center Nanoelectronic Technologies (CNT), Dresden, Germany

Atomic layer deposition of Li-containing layers for thin film batteries

Energy devices for microelectronic systems, since 2015

Technische Universität Bergakademie Freiberg, Germany
Semiconductor optics, 2013-2014

EDUCATION

Helmholtz-Zentrum Dresden-Rossendorf, Germany
Technische Universität Dresden (TUD), Germany
Ph. D., Physics, 2015

Dissertation: *Relaxation dynamics in photoexcited semiconductor quantum wells studied by time-resolved photoluminescence*

Friedrich-Schiller Universität Jena, Germany
Diplom, Physics, 2006

Lund University, Sweden
Physics, 2002-2003

CMOS technologies for all solid state micro- and macro-batteries

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Abstract

Rechargeable Lithium ion batteries are key to cut the cord or the carbon emissions in various applications from Internet of Things, power tools, automotive, to balancing tomorrow's smart grid. These applications are ever more demanding in terms of capacity, charging rate, safety and battery life. Historically progress has primarily been achieved thanks to material innovations. But the materials are only part of the story. An electrochemical cell is a heterogeneous system. The interface is where it all happens, and where many of the issues such as limited lifetime and charging rates find their origin. As the industry is transitioning to solid electrolytes the interfaces become even more important.

In CMOS technology, interfaces are controlled at the atomic scale. This contrasts heavily with the micron thick interfacial layers in batteries due to electrolyte and electrode decomposition.

This talk will illustrate how CMOS materials and processing are put to use in thin film 3D microbatteries and how these microbatteries can be practically integrated in microsystems. We'll also show how thin film model systems allow to study interface-reactions independently; yield understanding of charge transport at interfaces; and can model particle to particle interaction. And we'll show how these insights drive innovation for large capacity powder-based solid-state batteries for automotive applications.

Biography

Bart Onsia is Business Development Manager at imec in the research lines of All Solid State Li-ion Batteries and Thin Film PhotoVoltaics. Bart Onsia holds a Master in Industrial Sciences (Chemistry) from KU Leuven. He spent 2 years with Bayer as an production manager in aTiO2-plant before joining imec in 1999 as a researcher in microelectronics cleaning process, and surface preparation for e.g. high-k gate oxides, Germanium surfaces, ... In 2007, he moved towards a Business Program Manager role in which he was responsible for creating impact with the local industry in the Flemish region, in the field of energy (photovoltaics, batteries). From 2017, he is developing the business for imec's thin film photovoltaics and solid state battery activities.