International Battery Seminar Showcased High-Performance Batteries And Latest Instruments To Test Them

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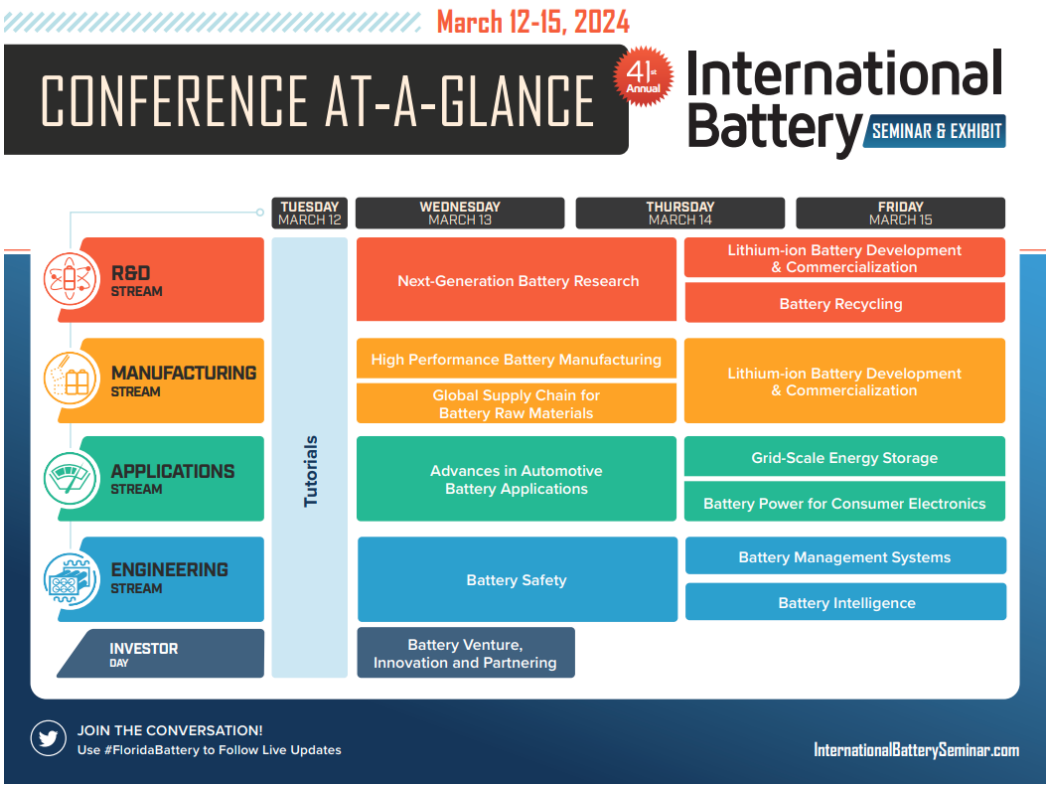
At the 41st annual International Battery Seminar, which was held March 12-15 in Orlando, members of industry and academia presented the latest research and development work relating to battery materials, design, manufacturing, recycling, safety and other areas. Topics such as battery charging and battery management systems, and battery applications in automotive, consumer, and grid-scale energy storage were also addressed at the conference. Note that those battery markets were just the ones highlighted in the program—industrial and military applications were also noted on event's website. As with other conferences, the program contained multiple parallel tracks of sessions, which were preceded by a day of tutorials. The table below gives an overview of the subject areas addressed, but to see the full list of talks and speakers, see the 2024 Conference Programs page.

Meanwhile, the International Battery Seminar also hosted an extensive exhibition with companies representing seemingly all areas within the battery development and manufacturing ecosystem. Among these exhibitors were suppliers of high-performance batteries and the test equipment used by battery researchers, cell and pack makers and their customers to analyze and/or verify battery performance. In this article, I will discuss some of the notable battery products and power-related test equipment on display in this year's exhibits.

But before proceeding I'll note that the exhibition was much broader than what I'll be covering here as there were many suppliers of battery materials; a much wider range of test instruments, software and systems for battery development and manufacturing than those reported here; and various other types of components, equipment and services relevant to the battery industry and its customers. The breadth of products and services is vast in subject matter and scale, from the materials experts working at the atomic level to the company planning battery-manufacturing gigafactories.



But even within the narrower realm of batteries and power-related test instruments, there were many interesting products in the exhibition that illustrate where companies are advancing the state of the art in commercially available (or soon to be available) products.

For example, in this year's exhibition, I encountered lithium-sulfur batteries promising high gravimetric energy density, a high-performance LFP Li-ion prismatic cell for energy storage applications, and a Li-ion cell that leverages a silicon anode structure to provide "an ultra-high energy density" of 400 Wh/kg while also delivering a 10-C continuous discharge rate. This last one targets electric vertical takeoff and landing (eVTOL) and unmanned aerial vehicle (UAV) applications.

One of the material suppliers highlighted the silicon oxide material it manufactures here in the U.S. This material has enabled development of what the company describes as "the world's most dense cell"—an 800-wh/l, 18650 cylindrical. Already qualified in DOD battery packs, this cell will target both military and commercial applications.

On the equipment side, as discussed in my article about last year's exhibition,[1] vendors in this year's exhibition showed many dedicated battery test instruments such as battery cyclers but also some general-purpose lab-grade power supplies. Among the products I learned about this time were a multichannel 200-mA per channel battery analyzer and a 200-A per channel battery cycler, each with impedance measurement on every channel; and a triple-output battery tester capable of delivering 10 kW per channel, and having unique features resulting from the ability to measure internal and external sense lines independently.

Other instruments seen in the expo included a series of "ultra precision battery cyclers," featuring built-in data analysis software; an integrated battery cycler and environmental test chamber tailored to the U.S. market; and a series of multi-channel battery cell testers, offering various options ranging from 20 mA per channel for coin cells all the way up to 300 A per channel for testing higher-capacity cells and packs. Among the general-purpose lab-grade power supplies, I found news of a 45-kW bidirectional dc power supply in a 4U enclosure.

The Batteries—Pushing Beyond Li-ion

At its booth, Lyten displayed some of its lithium-sulfur batteries. This battery chemistry offers lighter weight and higher gravimetric energy density than Li-ion batteries. These benefits make lithium sulfur desirable for use in aerospace applications and EVs, said Lyten's Hee Jung Chang.

While the chemistry is not new, Lyten is one of the first companies to have an automated pilot line producing lithium-sulfur batteries. Lyten is primarily a materials company that produces a product called 3D graphene (a form of carbon). This three-dimensional graphene serves as the basis for its lithium-sulfur batteries as well as sensors that detect toxic gas and lightweight composites for military applications.

Lyten recently set up its pilot production line for its lithium-sulfur batteries in San Jose, Calif. This pilot line has the capacity to produce 2 MW of batteries, although the company is not selling these batteries yet.

In an announcement made during the International Battery Seminar, the company discussed advantages of their version of the chemistry:

"Lyten's lithium-sulfur battery chemistry utilizes no NMP (N-methyl-2-pyrrolidone) in the cathode manufacturing process, eliminating the potential health, safety, and environmental impacts of the highly toxic solvent standard in today's lithium-ion batteries. Additionally, the lithium-sulfur battery cell has proven to be highly tolerant of metallic contamination, significantly reducing the capital equipment and operational costs associated with preventing metal contamination in today's leading battery chemistries, namely NMC and LFP.

'To achieve mass market adoption, lithium-sulfur must be able to be manufactured at enormous scale and at a price immediately on par or better than today's already scaled up lithium-ion batteries. The complete elimination of NMP and its ability to tolerate metallic contamination and defects creates a cell that is highly manufacturable. Lower cost production that is better for the environment is a win every way you look at it,' added Celina Mikolajczak, chief battery technology officer at Lyten.

Lyten's lithium-sulfur battery contains no nickel, cobalt, manganese, or graphite in the cathode and anode, enabling an entirely locally sourced and manufactured battery. Lyten expects to achieve 98%+ yields at scale and will begin delivering commercial lithium-sulfur cells for non-EV customers in aerospace and government applications in 2024 from its San Jose pilot production facility. Lyten is executing engineering and design, procuring equipment, and evaluating locations to rapidly scale up lithium-sulfur manufacturing to meet growing interest from EV, trucking, space, aerospace, and government customers."

According to Chang, the company plans to make its lithium-sulfur batteries commercially available this year. Stay tuned for another announcement about these batteries this summer. For more information, contact Lyten.

Leveraging its ability to engineer and produce its own carbon in a form called 3D graphene, Lyten has begun producing lithium-sulfur batteries in its San Jose pilot line. These batteries offer lighter weight than Li-ion batteries of equivalent capacity.

Another company, Zeta Energy Systems, also had an exhibit for Li-sulfur batteries. Their signage advertised "next-generation lithium-sulfur batteries" with "450 wh/kg energy density," "no thermal runaway," "up to 10C charge rate," ">1500 cycles," "<<$60/kWh projected cell cost" and no cobalt, nickel, manganese or graphite.

Since I did not get to speak with their booth staff, the meaning behind these numbers was not clear. However, an article in best mag, titled "Zeta Energy's Li-S batteries ready for commercialization,"[2] discusses the technology, and sheds light on the above specifications and status of the company's battery products. As noted in the article, "Zeta's 450-Wh/kg, 2-V pouch cells—planned to be commercially available in 2025—will have gravimetric energy density 1.7 times larger than Tesla's 260-Wh/kg, 3.6-V NMC cells despite the Tesla cell's 1.8 times higher voltage."

Other vendors presented advances in Li-ion batteries using silicon anodes. At its booth Amprius showcased its SiMaxx 400-Wh/kg cell capable of delivering a 10-C continuous discharge rate, which was recognized by the International Battery Seminar with a Best of Show New Product Award,[3,4] as voted on by energy industry professionals attending the conference.

This product exploits the company's SIMAXX Silicon Anode Structure to achieve what's described as "ultra-high energy density" in a Li-ion cell as previously shown in their 500-Wh/kg cell, which won the seminar's Best of Show New Product Award last year. According to Katie Maze, director of strategic accounts, the new 400-Wh/kg cell is unique in its ability to achieve both high power density and high energy density simultaneously. As Maze explained, most Li-Ion cells are typically under 300 Wh/kg and one that can deliver a 10-C discharge rate continuously "won't even touch 300 Wh/kg." In addition, the new cell can charge at a high rate, going from 0 to 80% in <6 min. At 100% depth of discharge with 1-C charge and 3-C discharge, battery lifetime is rated at 220 cycles.

The SiMaxx 400-Wh/kg cell targets electric vertical takeoff and landing (eVTOL) and unmanned aerial vehicle (UAV) applications. As the company notes, its 10-C continuous discharge rate and ability to increase flight range by up to 50% "are significant developments enabling electric aviation." The cell also targets high-performance EVs, which like the aircraft, are looking to minimize weight. The cell is currently is in a pre-production phase, but will be shipping this year. For more information contact Katie Maze.

Another company in the exhibition developing silicon anodes was Nanograf. According to the company, "its proprietary silicon-based anode powder is a scalable, low-cost enabler of the world's most powerful and longest lasting-cells." At the same time, it's advertising the company's technology as "U.S. innovation enabling [a] resilient U.S. battery supply chain".

This DOD-funded company, which also partners with the DoE, is targeting the North American markets (military and commercial), as it manufactures both its silicon oxide material and (through a partnership with a contract manufacturer) its cells in the U.S. At its manufacturing facilities in Chicago, the company says it will produce 35 tons per year of its silicon oxide material at its original facility. With the recent opening of a second facility, the company plans to increase this output to 85 tons and create 60 jobs when the new site opens in 2025.

This material enables what Nanograf describes as "the world's most dense cell"—an 800-Wh/l, 18650 cylindrical. This cell is qualified in DOD battery packs, and offers better performance at cold temperatures and faster charging. Its high energy density is said to enable +20% increase in range in EV applications and over 8-hr runtime in portable devices. For more information, see the website or contact Jeff Helm, VP of sales and marketing.

Other exhibitors showed advances in standard Li-ion cells. For example, EVE Energy, a maker of both NMC and LFP Li-ion batteries showcased its 628-Ahr, high energy density, long cycle life, super-sized LFP prismatic cell.

Referred to as Mr. Big, this cell uses a stacked construction internally rather than the rolled construction used previously in the company's prismatic cells. The company integrates its prismatic cells into battery packs and then uses the packs in energy storage systems (ESSs), said Felix Lyu, electrical engineer, EVE Energy North America. For more information, email Felix Lyu.

Cell Model	Capacity (Ah)	Nominal Voltage (V)	Max. Cont. Charge/Discharge	Pulse Charge/Discharge	Pulse Charge/Discharge Duration	Dimensions W*T*H (mm)	Weight (g)	25°C Cycle Life
MB56	628	3.2	0.5P/0.5P			352.3*71.7*207.2	10700	8000

Battery Test Equipment— More Features, Higher Power Density

There were a number of instrument makers in the exhibition showing battery cyclers and testers. These instruments differentiate by their levels of precision, current capacity per channel, numbers of channels,

measurement capabilities and other features. Some of these instruments have other applications in electrochemistry beyond batteries.

In terms of added features, there were products such as Ametek's SI-6200 multichannel battery analyzer, which the company showed at its booth. One of the Ametek's newer products (introduced last June), this lab-grade instrument performs characterization of cells, impedance and dc testing. Its 200-mA/channel capacity makes it suitable for testing coin cells.

According to Ametek, the SI-6200 is unique in that it has impedance test on every channel, rather than using the multiplex approach. This capability results in faster throughput.

The company also displayed a product with uses beyond batteries, the SI-9300R battery cycler, which is for testing bigger batteries as well as fuel cells and electrolyzers. This battery cycler offers 200-A/channel capacity. Introduced about 18 months ago, this instrument can be used for testing the types of batteries used in EVs, PCs or power tools. Like the SI-6200, it offers impedance measurement on every channel, which is the company's main differentiator, according to the company.

The SI-9300R is regenerative, returning power to the grid. For more information on these two products see the SI-6200 page and SI-9300R page, or contact the company.

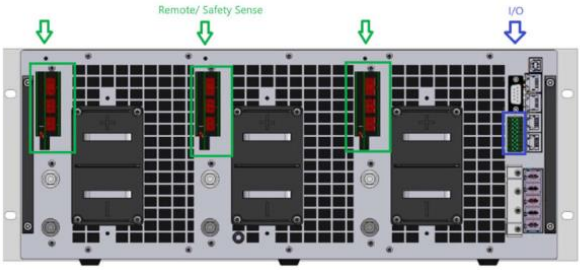
As with power supplies in general, higher power density is advantageous in battery test instruments. The BT 20000 battery tester with triple output from exhibitor Elektro Automatik is an example. According to Steven Soria, applications engineer at Elektro Automatik, power density is the main advantage of this bidirectional instrument, which is capable of 10 kW per channel and can be used for battery testing, battery simulation and battery recycling.

Per the company's website, this unit can simultaneously test up to three battery packs with a power of 4 kW/channel, 6 kW/channel and 10 kW/channel. It can measure battery state of health (SOH) and end of life (EOL), measuring voltage and current with the required accuracy.

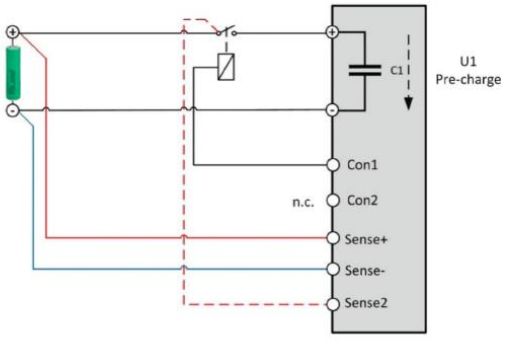
However, the BT 20000 also has a unique feature—its ability to measure internal and external sense independently using two sense lines—one for the battery side and one for the contactor side. With this feature, it can check for agreement on polarity and, if there is, close a relay contact to activate the battery test.

This provides the ability to actively pre-charge the power supply, supports dynamic sense regulation, and ensures the best current rise time in dynamic tests. It also permits cable and connection check for cable losses or bad connections, and enables warning of cable overloads and protection against the same.

Another differentiator, the BT 20000 features a wide input range. When powered from a 480-V ac three-phase source, the tester can deliver the max power of 30 kW. However, when connected to a 208-V three-phase source, the tester still operates, with max output power derated to 18 kW. According to Soria, this unit will be available for purchase in the next couple months. For more information see the website or contact Steven Soria.



Each area in green is the remote sense for each channel



The EA-BT 20000 with triple output is designed for battery testing, battery simulation and battery recycling. With its bidirectional operation, it can provide both charging and discharging of batteries.

In the expo at last year's International Battery Seminar, Unico, discussed its BAT100 series of battery cell testers, which was announced in 2023, but did not have a full product on hand, observed Tom Kadow, technical sales engineer at Unico. At this year's show the company displayed a "half rack solution," which accepts four plug-in modules or "devices". Each "single device" contains multiple channels for testing cells over one of four possible current ranges, depending on the product type selected.

For example, with the Type 1 version, a single device features up to 128 channels capable of supplying up to 20 mA per channel, which is suitable for testing coin cells. With the Type 2 version, a single device has 64 channels capable of supplying 10 A each, which could be used for testing cylindrical cells. Type 3 reduces that to 8 channels with 150-A capability, while Type 4 has 8 channels with 300-A capability, both enabling testing of higher-capacity cells or packs.

With a half-rack solution, the number of channels is multiplied by four for each type, and with a full-rack solution, there are eight times as many channels, as shown in the image and table below. For more information, see the BAT100 series brochure.

Available Current Ranges

	Type 1	Type 2	Type 3	Type 4
Parameter	**Coin Cell**	**Low**	**Med**	**High**
Voltage Range	10VDC	10VDC	10VDC	10VDC
Current Range	20mA	10A	150A	300A
Power Per Channel	200mW	100W	1500W	2000W
Channels Per Device	128	64	8	8
Channels Per Cabinet	**1024**	**512**	**64**	**64**

Configuration options for the BAT100 series of battery cell testers.

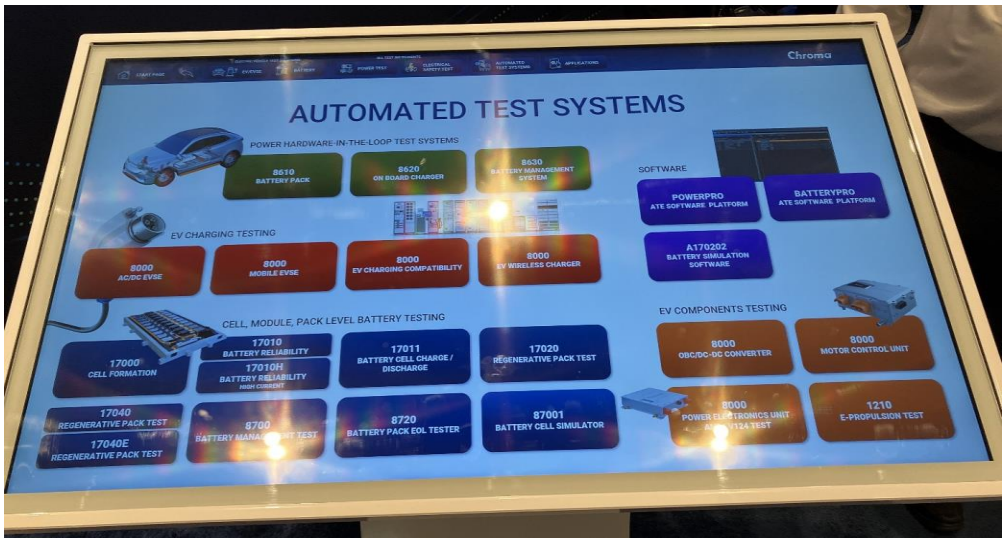
The company also showed its new IDAC power platform, which integrates power conversion, isolation, and dc output management into one package, for use in electric propulsion and energy storage applications. Among its intended uses are battery cell formation, battery cell and module testing, and on-board charging in EVs.

As noted on the vendor's website "the IDAC sets itself apart with versatile, isolated, dc outputs that can cater to up to four outputs, each with specific range needs such as 0 to 10 Vdc for cell testing and formation, 0 to 100 Vdc for module testing, and up to 0 to 500 Vdc or 0 to 1000 Vdc for EV on-board charging. Its flexible input options support a broad range of ac or high-voltage dc inputs, ensuring compatibility with worldwide power systems and easy integration into different tech setups."

As Kadow explained, IDAC is a "very flexible platform," which offers small size, high performance and a low price point. For more information see the IDAC Power Platform page. Or for more information on either the Bat 100 series or IDAC, contact Tom Kadow.

Another vendor, Neware, offered an integrated battery cycler and environmental test chamber, which it describes as an "all in one testing system." The original version of this product developed for the battery test market in China operates off of 220 V. However, according to Jade Zhao, overseas sales at Neware Technology, the company has recently developed a version for the U.S. market that operates from 120 V. For more information, see the website or contact Jade Zhao.

At its booth Chroma promoted its automated test solutions relevant to battery testing. These included its products for cell, module and pack level testing, as well as its battery simulation software as called out in the signage below. However, when asked about new products, Jonathan McCallie, ATE sales director, Automated Test Systems and Instruments, said that the company plans to introduce a new version of its 62000D series of bidirectional dc power supplies.



Chroma's automated test systems for batteries and related applications.

The existing 62000D power supplies are general-purpose instruments meant for testing renewable energy power systems such as PV, storage, and EV inverters as well as a wide range of bidirectional power conditioning systems (PCSs). The 62000D can also be used in testing power components in electric vehicles as well as bidirectional onboard chargers, bidirectional dc converters, and dc-ac motor drivers. Additionally, they can be used as battery simulators or to perform power conversion tests of Li-ion batteries in both charge and discharge directions.

The existing 62000D products deliver 18 kW in a 3U enclosure. However, in the second half of this year, Choma will introduce a 45-kW version in a 4U package, says McCallie. Applications for this more powerful version of the 62000D include testing of dc-dc converters and EV charging stations as well as batteries. For more information, email Jonathan McCallie.

References

1. "International Battery Seminar Showcased Advances In Fast Battery Charging And Battery Test Equipment" by David G. Morrison, How2Power Today, May 2023.
2. "Zeta Energy's Li-S batteries ready for commercialization" by Frank Lev, best magazine, Winter 2024.
3. "Best of Show Finalists Named for the 2024 International Battery Seminar" Allison Proffitt, Battery Power Online, March 4, 2024.
4. "Amprius SiMaxx 400 Wh/kg Cell Capable of Delivering a 10C Continuous Discharge Rate Wins Best of Show New Product Award at 2024 International Battery Seminar," Business Wire. March 18, 2024.