

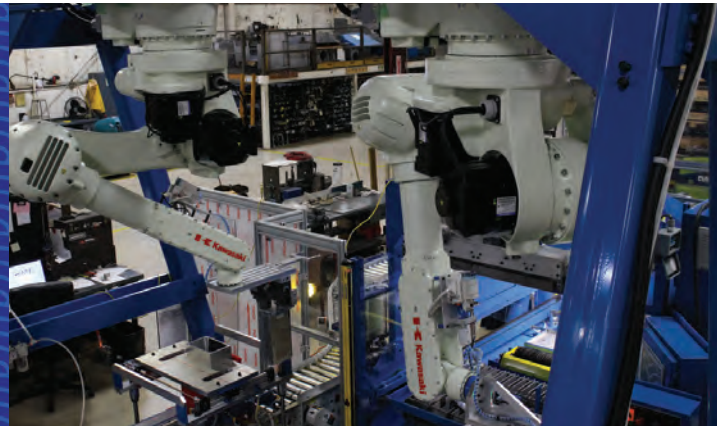
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19ABC, Virtual

November 3-5, 2021



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Post Covid: lead batteries power on

**Technology to the fore
as new advances listed**

**Full listing of speakers,
exhibitors, booths**

**Inside track on main
conference themes**

**The International Lead
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Sally Brodegan Mikosiewicz
INNOVATION AWARD
WINNER

Chad Schuchmann, president of Daramic, the giant separator firm, will provide a brief overview of the firm's perspective on the rapidly changing lead battery world.

The need for a global profile ...while maintaining a local presence

Daramic, now celebrating its 91st year, is in a unique position to comment on how the lead industry has evolved over time. And few are more qualified to speak about recent developments than the company's president, Chad Schuchmann, who has worked for the parent company, Polypore, since 2002.

Keeping the world in motion — the Daramic mission statement and key to understanding the company — is going to be the theme of the next 10 years, believes Schuchmann. He says it is clear that the main trend is going to be greater electrification of everything in the world's transition from fossil fuels.

Schuchmann sees climate change as both a challenge and an opportunity for the lead acid business: an opportunity because of the new and recharged business atmosphere following the pandemic. And a challenge because lowering levels of CO₂ in the atmosphere can only be achieved by putting an end to burning fossil fuels at the rate that we have been burning them.

For decarbonization to happen, the shift to renewable energies has to succeed: and the role of battery storage will be, he says, vital in allowing renewables to power the future.

The electricity of the future will not be generated by burning coal or gas, and the resulting challenges of supply intermittency — when clouds obscure the sun or the wind subsides — can only be met by batteries capable of stabilizing that intermittency. And this is a need that eventually will have to be provided in the hundreds and thousands of gigawatt hours of storage.

Lead's advantages over lithium batteries — price, safety and recyclability being key features — are too often neglected by utilities that assume the chemistry and the fundamentals of the battery are outdated.

Schuchmann says he's been impressed



In the past, battery development has mostly been driven by the US, which has then diffused into Europe and then into Asia. Now it's the other way about — Asia is setting the direction

by the technology advances of recent years but the need for lead acid batteries to innovate and improve will be a constant push in the years ahead. His goal and hopes are to see the lead battery achieve levels of performance similar to that now found in lithium.

Some of the themes of his opening address will also reflect on the changing pattern and growing importance of Asia's battery and OEM business.

In an interview earlier this year with Batteries International he said: "There's a new automotive world emerging. In the past, battery development has mostly been driven by the US, which has then diffused into Europe and then into Asia. Now it's the other way about — Asia is setting the direction in electric vehicles and electrification,

which is then diffusing into Europe and then to North America."

The developments of a lot of Daramic's latest product range, such as RickLife, HiCharge and XCharge, have been done in a way that's specific to Asian driving requirements. Much of the development has come from its Asian research centre, which is now located to Gujarat, India.

The developments include a reversal of imposing the standard western template on an Indian battery. So, for example, one key product in this range — known as DuraLife — followed the unusual pattern of being launched in the Asian market first and then two years later, in 2016, released worldwide.

Daramic's confidence in the future of lead batteries is evidenced by its commitment across Asia. Its global footprint means that it has five local manufacturing sites — in Thailand, China and India.

Schuchmann believes that Daramic's success in the region is because it is locally based. This gives it a clear understanding of the types of demands that batteries are put through — think heat, humidity and demanding cycling routines — and so can provide tailored separator solutions for its customers.

As a final note, Schuchmann is also widely expected to officially announce in his talk that his promise at ABC in 2019, that the new manufacturing lines Daramic invested in two years ago in Gujarat, India will be up and running.

The lines will double Daramic's PE capacity in India, which serves both increasing regional battery separator demand and also global customer demand. Schuchmann says its policy of being a global company with a local presence will help customers suffering the present logistics and supply chain chaos and reinforce the company's advantage in serving locally as a global firm. ■



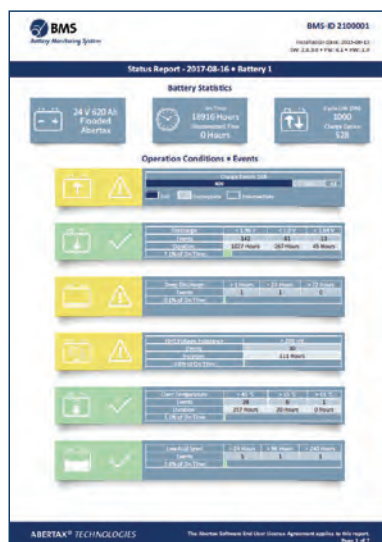
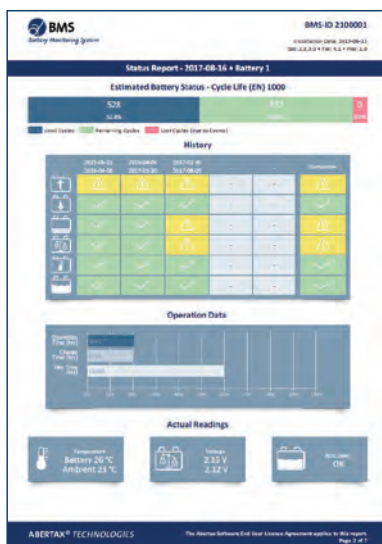
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WEDNESDAY 3 – FRIDAY 5 NOVEMBER 2021

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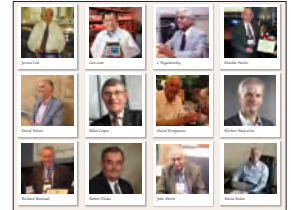
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Publisher

Karen Hampton
karen@batteriesinternational.com
+44 7792 852 337

Editor

Michael Halls
editor@batteriesinternational.com
+44 7977 016 918

Advertising director

Jade Beevor
jade@batteriesinternational.com

Deputy editor

Debbie Mason
debbie@batteriesinternational.com

Contributing editor

Frank Millard

Researcher, journalist

Hillary Christie
hillary@batteriesinternational.com

Finance administrator

Juanita Anderson
juanita@batteriesinternational.com

Subscriptions, enquiries

subscriptions@batteriesinternational.com
admin@batteriesinternational.com

Production/design

Antony Parselle,
aparselledesign@me.com

International advertising representation

advertising@batteriesinternational.com

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In defence of lead

Lead conferences have become a vital staple of the battery industry. We come to listen, to network, to do business and quite often as an addendum to the Asian Battery Conference to have an interesting time at an interesting venue.

This year travel restrictions around the pandemic have denied us the venue, but not the benefits of a successful conference. The networking will be more limited and the gala night — remember that sensational one in Bali? — won't happen, but we will come away refreshed, stimulated and hopefully with a fire in our belly to fight our defence of the lead battery.

One of the sub texts in the conference organizers' thinking has been letting people know how we plan to fight off the challenge of lithium batteries.

There are three prongs to this theme.

The first is technological progress. This year's ABC will again look at the rapid advances being made in taking lead battery technology to the next level. We're going to hear talk about the various projects that have been undertaken in the past two years to make batteries yet better.

And this won't be visionary nonsense culled from the fetid imaginations of start-up firms' PR departments. But concrete advances, new insights into our understanding of the electrochemical mechanisms within lead battery storage.

The second prong is communication. We'll also be hearing from bodies such as the CBI about how they are explaining some of their exciting projects to key OEMs. We should hear more too about the communication campaigns from trade organizations such as ILA and BCI.

The third prong is coming from an unusual part of the business. One lead battery manufacturer is working on a lead-lithium hybrid. We all know, that — without exception — every lead battery manufacturer of any size or repute has for years been building up their capabilities in making lithium batteries.

Yes, the bulk of lithium sales is coming from Asia but I doubt if there's not a single lead battery manufacturer outside of the region that is not already making lithium cells or has freshly finalized plans to do so.

So all credit for GS Yuasa for finding another line of defence for lead batteries. In one of the closing presentations Peter Stevenson will discuss another way of keeping lead mainstream — using them as a hybrid storage project with lithium.

The lithium battery part of the system does the rapid charging and discharging needed to keep a microgrid stable. The lead battery will provide long duration power.

Hybrid storage systems open up a clear path for combining the strong points of lead — price, safety, recyclability — with the strengths of other chemistries. Moreover, given the wider market's unflagging enthusiasm for all-things lithium, the mix with lead would seem an uncontroversial way for battery manufacturers to promote their lead products while tapping lithium's performance.

Unfortunately for the wider battery industry none of the major manufacturers are pursuing this approach — which is a shame.

They seem to believe two things. First, they are a producer of a product and not a technology developer — a distinction which their lithium rivals seem to happily ignore. And second that in the energy storage boom years that lie ahead there will be a need for all battery chemistries. A rising tide floats all boats, they believe.

And this is a shame. If we can chain a supercap to a lead battery — think the UltraBattery — why can't we do something similar with lithium ones?

You be the judge!

**Mike Halls,
Editor**

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It's going to be a busy three days with a tightly packed agenda looking across all aspects of the present lead battery market. *All times are Singapore Standard Time.* After the clocks change at the end of October/start of November it will be seven hours earlier in Germany ie 9am, eight hours earlier 8.00am in the UK and 12 hours earlier ie 3:00 am with EST in North America.

Three days of learning, networking but... fun too

Wednesday November 3

4:00pm	Conference opening. Mark Stevenson, director, Global Lead Technologies
4:05pm	Alive and kicking — lead no longer the forgotten battery metal? Neil Hawkes, principal analyst, base metals CRU
4:30pm	Lead: fighting fit or fighting fat? Farid Ahmed, principal analyst lead markets Wood Mackenzie
4:55pm	The improvement of utilization and durability of positive active materials for lead-acid batteries. Akihiro Watanabe, research engineer, Tooru Mangahara executive manager of R&D and Jun Furukawa senior adviser, The Furukawa Battery Co
5:20pm	Grid energy storage performance improvement using controlled overcharge Tyler Gray, director Electric Applications Inc
5:45pm	Break
6:00pm	Lead acid battery solutions for sub-MWh energy storage systems. Dipak Sen Choudhury, president for R&D, Exide Industries
6:25pm	Carbon fibre electrodes for battery energy storage applications. Shu-Huei Hsieh, vice president for R&D, National Formosa University/Department of Materials Science and Engineering
6:50pm	Electrolyte and positive active-mass additives to improve the PSoC cycling endurance of automotive lead acid batteries. Plamen Nikolov, head of Electrochemical Power Sources Department,
7:15pm	Assessment of carbon black-organic expander interactions on capacity, dynamic charge acceptance, cold cranking and partial state of charge life of lead acid batteries, Tim McNally, manager R&D, Carter Abney, research associate, Borregard.
7:40pm	Break
7:50pm	One-on-one chat: The life and times of a lead analyst. Moderator: Douglas Lambert, Wirtz Manufacturing. An exclusive and intimate chat with two eminent lead market forecasters — Neil Hawkes, CRU, and Farid Ahmed, Wood Mackenzie.

Thursday November 4

4:00pm	Welcome back
4:05pm	Observation and forecast from the LAB applications to battery market — under pandemic era change. Lu (Mark) Hsueh-lung, senior researcher/secretary-general, Industrial Technology Research Institute/Taiwan Battery Association
4:30pm	Innovation pathways for lead acid batteries: the CBI 2019-2022 technical program. Matt Raiford, senior technical manager, Consortium for Battery Innovation

Thursday November 4 (Continued)

4:55pm	Advanced tubular gel batteries for residential energy storage & solar applications. Amlan Kanti Das , senior vice president for battery operations & R&D, Luminous Power Technologies
5:20pm	Energy storage with lead-acid batteries: can they be cost-effective? Geoffrey May , director, FOCUS Consulting
5:45pm	Break
5:55pm	GravityGuard: an additive for EFB technology and deep-cycle applications for electrolyte stratification reduction. Thomas Wojcinski , R&D chemist, Hammond Group
6:20pm	Optimization of paste formulation for lead-acid batteries used for parking air-conditioners in heavy duty trucks. Pengfei Cui , product manager, Jinkeli
6:45pm	Fundamental understanding of the interrelationship of battery separator structures and properties with their electrical and physical performance. Sunho Choi technical manager
7:10pm	Lead-acid battery technology evolution and future challenges. Francisco Trinidad , director for battery technology, Exide Technologies
7:35pm	Break
7:45pm	One-on-One Chat, 'A look into the future'. Moderator: Douglas Lambert , Wirtz Manufacturing Hear the insights and directions of the Consortium for Battery Innovation (CBI) from director, Alistair Davidson and team.

Friday November 5

4:00pm	Day three welcome.
4:05pm	China's lead acid battery industry. Dong Li , chairman, Leoch International Technology
4:30pm	Improved high-rate discharge process in a production line. Michael Wipperfueth , sales manager, CMWTEC Technologie
4:55pm	Development of multi-panel stamped grid plate technology for motor cycle and small VRLA batteries – evolution, experiences and learnings. Senthil Kumar , executive, Amara Raja
5:20pm	Powering all our futures. Edric Koh , head of corporate sales for Asia, London Metal Exchange
5:45pm	Break
6:00pm	Optimization of grid configuration by investigating its effect on the positive plate of lead acid batteries via numerical modelling. Ali Alagheband Hosseini , Technical Manager, Sarv Sanat Toos
6:25pm	PowerFill separator for advancing faster acid-filling of AGM lead acid batteries. Zhiping Jiang , chief scientist, Hollingsworth & Vose
6:50pm	Subject to be announced. Paul Everill , chief technology officer, Black Diamond Structures
7:15pm	Operational experience and modelling of parallel connected lead and lithium ion battery energy storage components. Peter Stevenson , senior technical co-ordinator, GS Yuasa Battery Europe
7:40pm	Closing panel session – 'Ask us Anything' Closing panel session of industry experts. ABC's panel of experts will answer every and any question put to them. Panellists are: Geoffrey May, Boris Monahov, David Rand, Peter Stevenson, Francisco Trinidad

Conference organizer Mark Stevenson discusses the thinking behind pulling the 19th Asian Battery Conference together at a time when international travel is limited.

An important agenda with much to discuss

Welcome to the 19th Asian Battery Conference!

As most of the industry knows, due to pandemic restrictions we've had to put off our scheduled visit to Kuching — we'll visit there in two years' time — and instead we've had to create a virtual conference.

Sitting here, just a stone's throw from the studio in downtown Melbourne, where we'll host the convention, I'm acutely aware that a virtual conference is a half-way house in trying to match the underlying intentions behind the ABC in its 35 years of history.



While we've tried our best to achieve some of the more successful aspects to virtual networking — our Airmet virtual platform is cutting edge — we know it can never be quite the same as sitting with customers.

Our aims have always been to unify the industry by offering networking, technological insights and creating a forum for discussion.

Unfortunately, a virtual conference is a necessary compromise as we try to draw an entire industry together that continues to be unable to meet physically due to the restrictions on travel and general health guidelines.

The downside of the virtual format is of course that networking is a lot harder.

One of the strange facets of our meetings in the past has been the enormous amount of business that goes on in the sidelines. Literally tens of millions of dollars of deals are concluded over a beer or a coffee and it is hard to recreate this.

While we've tried our best to achieve some of the more successful aspects to virtual networking — our Airmet virtual platform is cutting edge — we know it can never be quite the same as sitting with customers. But until we can meet face-to-face rather than screen-to-screen, this still gives us the opportunity to bring the industry together, making new friends and networking.

That said we shouldn't forget that a virtual conference has its strong points too.

One of these is that we have a robust mixture of technical and market-oriented presentations which, by nature of the fact that they are virtual and distributed over the internet, means they can be looked at again and again in the future.

In fact our experiences and feedback from the 7th Secondary Lead Conference held this September was they often had a greater impact — we know of one firm that has played and replayed some of our presentations to their entire technical staff.

This has got to be a strong point in their favour and we are considering

recording to camera something similar in the next ABC in Kuching, East Malaysia.

While the ABC will continue to cover a multitude of themes and topics — ensuring there is something for everyone attending the event driven by the speakers — there are certain sectors of the industry which have been gathering momentum globally.

One of these notable trends is the increasing role of additives and separators — two subjects where we have some particularly interesting papers this year. The other, and probably the biggest, is large scale energy storage. This is now a huge topic globally and a growing sector with investment pouring into many aspects of it.

I know that a lot of conferences like to pick an overarching theme and revolve things around that. However, I prefer to ensure that we



cover a wider variety of topics and allow speakers and delegates to set the agenda in discussing what is happening in the industry.

Sometimes we need to mix things up to make them a little more eclectic!

But it is also true that sectors such as energy storage are topical right now and, to a certain extent, a rising tide lifts all boats in all chemistries. I see the energy storage phenomenon as very significant and similar in some ways to the e-bike phenomenon in China. But this is certainly not an Asian thing — it is a global sea-change.

While energy storage is being encouraged and backed by governments across the world, thereby kick-starting battery projects in many forms, its momentum will transcend that — and is relevant to every country on the planet.

My own view is that though we are expanding our understanding of the possibilities that lead batteries can offer, there is still a great deal more to go. I rather envisage our understanding of lead's possibilities to the sea of green on a pool table — where the balls are the areas of our understanding and the green is the possibilities still ahead.

One of the strange consequences

Sometimes we need to mix things up to make them a little more eclectic!



A NEW GENERATION OF EXPERTS NEEDED

As we get together in a virtual format, we also need to think of the future.

A whole generation of experts ranging from titans such as Ken Peters or Detchko Pavlov through to some extraordinary brains, think Mike Weighall, Michael Mayer, David Boden and the like, are no longer with us.

Some of these men — Dave Boden, for example — knew what to do when things went wrong. They were as able to talk to machine operators on the plant floor in fixing a problem as they were to explain to management the science behind the fix.

Too often nowadays we're seeing the electrochemist alone. The man in the white laboratory jacket rather than the person equally at home in overalls hunched over a casting machine in a suit and tie.

The main point here is that the well of knowledge is steadily being diluted and a lifetime of experience and experimentation is also vanishing. Talk to some of today's veterans and it is surprising to find that many of the industry's problems

had been investigated, tested and resolved years ago.

A case in point is Ken Peters, with whom I remained in close contact up until his death three years ago.

Ken followed with keen interest the research of the former ALABC, now CBI. His experiments working for Chloride a generation ago suggested to him that the ALABC should spend less time on positive grid corrosion related to weight loss, which he regarded as a waste of time. Instead he considered that positive grid failure/breakup was due to stress corrosion in grain boundaries or casting defects.

Whether he was right or wrong on this is less important than the fact that Ken, even at the age of 90, was keen to further the industry and mentor the next generation of experts to follow.

My question which we need to think about on the sidelines of our meetings is a simple one — where are our mentors for the future generation and where is the next generation of technical and practical experts coming from?



Stevenson: due to pandemic restrictions we've had to put off our scheduled visit to Kuching — we'll visit there in two years' time

I believe we've got the right mix of presentations this year — there will be a balance between the practical, the theoretical, the commercial without losing sight of the broader industry concerns

of the pandemic has been a general consolidation of thought.

The opportunity to learn, the opportunity to share their learning and, of course, to provide a venue where the commercial side of the industry meets its counterparts, its clients and we all get to understand the broader picture of the industry.

This is particularly important to me as I've spent some four decades within the industry and in the last few years I feel that parts of it are either burying their heads in the sand or are looking in the wrong direction while real challenges are knocking at our door.

So, yes, we've seen rival chemistries come and go. Most of us can remember when fuel cells or super-capacitors were going to put our lead world out of business.

But there's a threat ahead with the arrival of lithium batteries on a huge scale to the detriment of lead. In many ways we're reacting to this in the right way — I don't think I've ever seen such a boom of innovation and ideas.

And moving on to this year's meetings. I believe we've got the right mix of presentations this year — there will be a balance between the practical, the theoretical, the commercial without losing sight of the broader industry-concerns.

Last, despite the name of the event and the fact it is always held in Asia, the conference is effectively a world event. It just happens to be in Asia!

Most of the presentations and issues are global in their nature. Any of the trends you see on the global stage are reflected in what is happening in Asia and people continue to see great potential in this part of the world.

To some extent we are seeing more companies from outside the region attend this event as they see it as a good way to network with Asian executives and better understand the dynamics in this part of the world. ■

FROM THEN TILL NOW

The Asian Battery Conference has always been a maverick affair. As the earliest major conference that focused solely on lead batteries in the region it was the forefather, if by 18 months, of its European equivalent, the ELBC.

The origins of the ABC started in 1986 through an organization called ZALAS, the Zinc and Lead Asian Services, which was based in Singapore. It was sponsored by the major primary zinc and lead smelting companies of Australia and Pacific Rim countries.

ZALAS's main objective was to promote the use of zinc and lead through technically supporting customers and educating them around the use of the elements. They even started a zinc galvanising conference, which today is still running as the Pacific Galvanizers Conference.

Since those early days we've grown enormously.

When I took over as chairman 22 years ago, it was a very scientific/technical conference. It was a lot smaller and very much a cosy family affair, in fact at the closing event Colin Woodcock from Britannia would bring a guitar and it would turn into a sing-a-long of the national anthems of the represented countries.

Since those early days the battery business in Asia has changed

enormously — nowadays around two-thirds of the world's lead batteries are made in the Asian region.

At the time of the first ABC in 1986, the world's lead consumption was 5.5 million tonnes, with 65% of that entering the battery market. Today we consume more than 13 million tonnes, with 85% being converted into batteries.

The range and types of batteries we now produce have also changed during this period and, of course, the way we make the battery.

It's a far cry from that first conference when the market was dominated by the use of antimonial alloys and when many Asian producers were only starting to think about converting the negative into a calcium alloy and producing their first hybrid battery.

We have kept many of the early aspects to those conferences in place — we still strive to keep it a family affair, even though the family is much, much larger and spreads across the world.

It's important, too, that we keep that technical thread running through the majority of the presentations but balanced with an understanding of the future of the market, environmental aspects and of course ways to help the industry, such as product breakthroughs.



Stevenson: Speaking at 17ABC in Malaysia.

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What to expect — enter the virtual world



The 19th Asian Battery Conference and Exhibition will be held virtually for the first time this year. Welcoming some 350 attendees and hosting over 40 presentations, the 19ABC will offer, yet again, great opportunities for networking, sharing achievements and discussing developments in research.

We've all got the hang of virtual conferences now but ABC's organizers have gone to some lengths to make access to the presentations and the exhibitors in particular easy to do. Networking in particular should be far better than other virtual events because of the use of the cutting edge Airmeeet program.

Through Airmeeet, attendees can seamlessly interact with delegates through virtual booths via built in video, direct phone calls, text chats, polls and surveys.

Registration is open online and includes full access to the event platform to view live presentations, industry keynotes, the virtual exhibition hall and the virtual networking lounge. Attendees can also access full on demand content

after the event closes.

Conference presentations will start each day at 16:00 Singapore Time), although attendees are encouraged to join the event early to meet and do business with exhibitors.

CONFERENCE BEGINS AT:	
Sydney	19:00
Beijing	16:00
Singapore	16:00
Delhi	13:30
Paris	09:00
London	08:00
New York	04:00
Los Angeles	01:00

Days one and two will finish with exclusive one-on-one chats with industry experts; day three will wrap up with a Q&A panel session where questions will be answered live.

Attendees can also submit questions ahead of time on the 19ABC website: <https://asianbatteryconference.com/agenda-2/>.

Virtual 19ABC will also have a conference first with two exclusive One-on-One chat sessions scheduled for day one and day two.

The first is called the life and times of a lead analyst where lead market forecasters Neil Hawkes and Farid Ahmed, discuss their own particularly idiosyncratic view of the lead market. Having spent a lifetime studying the price of lead including the incredible nuances of supply and demand —

sometimes for absurd reasons which they'll happily recount — they're both well able explain regional market fundamentals influencing trade and price dynamics.

The second session will be held at the end of day two, where CBI's Alistair Davidson will provide unique access to the consortium's perspectives on the future of energy storage. Some of his conclusions may well be startling. ■

TIME TO PULL UP A CHAIR ...

The conference will be delivered on the Airmeet virtual event platform, access to which will be emailed to all sponsors, exhibitors and partners by Friday October 29. Delegate access to Airmeet will be emailed Monday November 1.

Virtual booths can also host downloadable resources and can be connected to social media platforms.

Delegates will have access to insights on booth visits, leads and other analytics throughout the conference.

ALL HAIL THE 'UNDER-ACHIEVERS'!

The ABC organizers have joined with Sorfin Yoshimura in an industry first — a virtual conference game that gives out prizes in the real world.

Called 'Win Big with SY' the aim is to enjoy the content of the virtual convention by earning so-called "leaderboard points" through participating in the conference and exhibition.

An ABC spokesperson says points will be collected by scanning QR codes while in a sponsor or exhibitor meeting or when joining a session. For the sporty minded, here are the ways to win prizes.

"20 points: have a meeting with our platinum sponsor, Daramic," says the spokesperson.

"15 points, have a meeting with one of our gold or silver sponsors; 10 points, have a meeting with one of our

exhibitors; five points, join the hidden QR code search; three points, attend a session; and two points, ask a live question during a presentation."

The prizes given to 'over-achievers' include Amazon gift cards and VIP treatment at the next ABC to be held in Kuching, Borneo in 2023.

For the less dutiful of us — in a category called 'the general under-achievers' — there are still prizes to be won. Sorfin Yoshimura says it will be randomly drawing five prizes post event for those with ranking positions between 11 and 25.



The prizes given to 'over-achievers' include Amazon gift cards and VIP treatment at the next ABC to be held in Kuching, Borneo in 2023.



The table networking feature within the virtual booths allows attendees to claim a seat that provides a direct link to a delegate's video feed.

The award ceremony and presentation of the international lead medal has always been one of the highlights of the ABC meetings. Because this cannot happen this year, we bring you a selection of some of the more recent winners...

Heroes from the past re-united

This year there will be no ceremonial award of the International Lead Award. “Unfortunately we’ve had to make this a virtual conference,” says Mark Stevenson, one of 19ABC organizers and part of winning the medal is the peer recognition at the event. But I can guarantee that there’ll be excitement in Kushing over the presentation of the award when we meet in 2023.”

The International Lead Award was conceived with unanimous support from the lead and lead-acid battery industry in 2002 and presented for the first time in 2003. Its role is to recognise individuals who have made major contributions throughout their working life to the lead or lead-acid battery industries.

The official description used in the selection process describes it as:

“A prestigious award for exceptional service to the lead industry as related to the production, processing or use of the metal in areas such as:

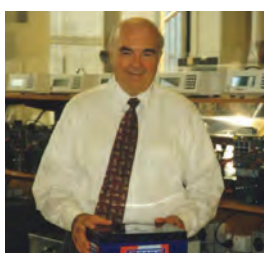
- Promoting increased use or awareness of lead
- Improving lead’s image
- Encouraging individuals to excel
- The award should honour and recognize above-average personal achievement.”

The award winners are named each year at either the Asia Battery Conference or the European Lead Battery Conference which both work on a two-year cycle. ■

ROLL OF HONOUR

2003	John Manders
2004	Jerome Cole
2005	Lan Lam
2006	David Prengaman
2007	John Devitt
2008	Allan Cooper
2009	L Pugazhenthly
2010	Detchko Pavlov
2011	Robert Flicker
2012	Norbert Maleschitz
2013	Brian Wilson
2014	Richard Amistadi
2015	Bob Nelson
2016	David Wilson
2017	Herbert Giess
2018	David Boden
2019	Frank Fleming
2020	Virtual conference
2021	Virtual conference

...and a snapshot of some of the other winners



Jerome Cole



Lan Lam



L Pugazhenthly



Detchko Pavlov



David Wilson



Allan Cooper



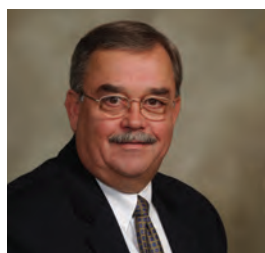
David Prengaman



Norbert Maleschitz



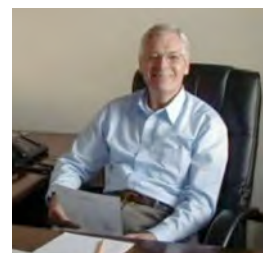
Richard Amistadi



Robert Flicker



John Devitt



David Boden

Brian Wilson was honoured with the International Lead Award at 15ABC in Singapore in 2013

For the past 20 years Brian Wilson has been at the forefront of international campaigning to make the recycling of lead batteries acceptable from an environmental and humanitarian point of view.

As part of this he has travelled the world on a mission to educate governments, NGOs and individual industry bodies on how recycling lead batteries is not just an issue of public health and environmental responsibility but an economic concern. For the past several years he has worked with the ILA to help the association conduct environmental audits for prospective members.

Brian's original career took a turn in his 30s when, after spending 15 years in the oil business, he moved to Britannia Refined Metals — part of MIM Holdings, the Australian mining firm which is now a Glencore company. Over the next 18 years his work spanned smelter operations, industrial relations and human resource management.

“My time there gave me a full insight into the issues that the lead industry faces, and the way it tackles them,” he recalls. “It was a great preparation for the huge variety of work we do in the International Lead Management Centre.”

He was seconded to the ILMC in 1996 from Britannia as program manager, where he remains today, tasked with promoting the sound environmental management of lead.

ILMC is a key programme of the International Lead Association's Lead Action 21 sustainability initiative. Brian's work has taken him around the globe for extended periods, spending months at a time promoting the safe use of lead. Some of this has required intensive work at a local level involving liaison with governments, local communities and NGOs.

“It's difficult to explain how satisfying the work can be — but also how it can also be heart-breaking,” he says. “One particular example — but it's just one of many — sticks in my mind. When I was working in Senegal I came across a mother who had lost three children through lead poisoning. She was part

of a small lead smelting outfit and she was trying to feed her family and eke a subsistence out of battery recycling. I particularly remember that they were a warm, upright family — but all earning less than a dollar a day.

“Although this was just one case of many in the country, following the efforts of the ILMC we can now be thankful that not a single case of lead poisoning like this has happened since our intervention in 2008.”

In a world used to talk of leadership from the top, Brian has always adopted a collegiate approach.

“Put simply, we don't enter a country and impose our own ideas of how to remedy any problems they have with lead,” Brian says. “Although, of course, we have solutions in mind. Rather we try to get everyone to find, through our guidance, their own answers to dealing with the challenges that face them.”

And this has required liaisons at all levels of the industry.

“Brian has developed a huge body of risk management literature,

worked with industry, governments and inter-government organizations to set up practical risk management programmes in a wide range of countries,” said David Wilson, when presenting the award in 2013.

“And overall he has helped create a better image of the lead and lead-acid battery industries by demonstrating that lead can be produced, used and recycled safely and provides enormous benefits to society.”

Brian Wilson, an engaging, warm and modest figure, says that part of his enjoyment of his job has been to meet and work with “some of the most remarkable figures in our industry and related to our work”.

“I'm delighted to see Brian's tremendous contribution to improving the management of lead recognized by this award,” says Andy Bush, head of the ILA. “His passion and dedication to the work of the ILMC is extraordinary and a great example of the lead industry's commitment to taking responsibility for its products throughout the world.” ■



“It's difficult to explain how satisfying the work can be — but also how it can also be heart-breaking. Following the efforts of the ILMC we can now be thankful that not a single case of lead poisoning like this has happened since our intervention in 2008”

Bob Nelson was honoured with the International Lead Award at 16ABC in Bangkok in 2015

Bob Nelson, a major figure in the battery industry for the past four decades, is known for his deep technical knowledge and his understanding of the commercial implications of battery technology.

Bob was the leading figure in the early 1990s, with Jerry Cole, in the creation of the Advanced Lead Acid Battery Consortium, better known to the world then as ALABC and now CBI.

Bob and Jerry's mission was to get lead-acid battery manufacturers, their suppliers, smelters, research institutes and others to join together and fund a programme dedicated to exploring the untapped potential of lead as a source of motive power — and give a future to the industry after the first attacks on the technology started.

While Jerry tried to tap funding at government level, Bob had the harder task of getting battery makers to agree a common purpose for the industry. And then to fund it.

Over the next three years Bob, Jerry and Dave Prengaman crisscrossed the world trying to put and then keep the consortium together.

They needed a master plan to underpin their goal, which in turn was refined to research in three areas: active materials and cycle life; grids/alloys/top lead and materials; and charging, battery management and electric vehicle battery testing. This approach has broadly remained in place to this day.

Perhaps a key policy decision was that ALABC would be an open consortium with free sharing of research among members, and steps taken to protect proprietary product information.

"The high point of my association with the ALABC was to see different lead-acid companies from different countries sitting around one table joining an international effort to improve lead-acid batteries," Bob says. "In those days most companies jealously guarded their secrets and were loathe to interact with other manufacturers on serious technical matters."

Born in 1940, Bob obtained



"The high point of my association with the ALABC was to see different lead-acid companies from different countries sitting around one table joining an international effort to improve lead-acid batteries"

his first degree in Chemistry in 1963 and followed that up with a PhD in Analytical Chemistry/ Electrochemistry at the University of Kansas before teaching for 11 years.

Bob's special moment came in 1977, when he was offered a position with Gates Energy Products, a now legendary firm that only a decade or so before had been famous for its tyre and autoparts distribution business.

Gates, largely through the research efforts of VRLA developer John Devitt, who had left the firm, was sitting on a gold mine but didn't know it.

"When I joined they had patents

they didn't even understand and were manufacturing the batteries way too early," says Bob.

Bob became a key figure in a turnaround of Gates Energy Products. He looked at improving the manufacturing processes, working first with Hollingsworth & Vose on AGM separators. Gates worked on flat plate design in Denver and then shipped manufacturing to UK firm Varley with disastrous results. Bob was re-assigned to work in London to sort out the problems.

It was a period that with his wife Elizabeth he describes as one of the best in his life, both professionally and otherwise.

"It was fun to be the only Yank in a firm of 300 Brits!" he says.

The UK firm was eager to get into flat plate manufacturing as well as work out separator systems using glues and dyes for AGM batteries.

"It was one of the first mature VRLA techniques to emerge," Bob says. "I was particularly proud of the way we started to work with thin plate technology. Gates had the patent for the infamous '861' glass separator more accurately known as patent US 3862, 861 courtesy of John Devitt and Don McClelland. People at the time scorned it, saying the plates would always be more prone to corrode, being thinner. We proved the opposite."

In his late 50s, Bob moved into consultancy work.

"In the past 15 years we've moved away from trying to make better lead-acid batteries using just better materials or improved manufacturing techniques. Now the future is in combining this with accurate and better plate design and processes," he says.

He continues his work for China's Chaowei, the third largest battery manufacturer in the world.

Perhaps one of the nicest tributes came from John Devitt: "Bob is one of the top electrochemists we have. He is as good as it gets for present-day lead battery consulting. I'm pleased for him that his great contribution to this industry is being recognized." ■



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Rectifiers Suitable For S.L.I-A.G.M.-V.R.L.A-S.L.A Batteries Formation

Herbert Giess was honoured with the International Lead Award at 17ABC in Kuala Lumpur, Malaysia in 2017

July 21, 1969 is etched in the annals of history as the day when man first landed on the moon. It is also the day that Herbert Giess was interviewed successfully for a research post in the Batelle Center in Geneva. The job would set the direction of the then 24-year-old's life and be crucial to the future development of the lead battery.

It was at the Batelle Center the young Giess had his eureka moment. "I finally found my true love, the lead-acid battery!" he recalls.

The early 1970s were exciting times for the industry. In 1971 Delco-Remy, a division of General Motors USA, introduced the first maintenance-free SLI battery, the Delco-Freedom Battery, made with expanded metal lead-calcium grids.

Other lead battery firms were trying to compete with Delco and produce equivalent battery types, but the absence of antimony in the positive grid alloy created massive amounts of early capacity failures.

Battelle Geneva, as a contract research organization, offered its services to solve the problem and gathered, in a multi-year collaborative research project, 12 lead-acid battery manufacturers from Europe, Japan and the US to carry out a fundamental research study — *The Shedding and Aging of the PbO₂ Electrode*.

It was the ALABC before its time.

The Battelle team showed the importance of tin in preventing the passivation of the positive lead alloy grid after a deep discharge. Since then, the presence of at least 0.2% tin in the lead alloy for positive grids has become the rule.

The team pinpointed the so-called antimony-free effect at the heart of many early battery failures and provided recommendations for production changes.

"We identified three modes of negative impact of the absence of antimony on the behaviour of the positive PbO₂ electrode and coined in 1977 the terms Sb-1, Sb-2 and Sb-3 to describe the failures in performance," recalls Herbert.

"These investigations were again picked up anew in the ALABC consortium about 15 years later and the terms 'premature capacity loss PCL



"I witnessed the birth of the Absolyte VRLA/AGM cells, and I convinced Accu Oerlikon management that another momentous change in lead-acid battery design was in the making"

1 and PCL 2' were coined."

His research work brought him in contact with Gould, Inc where he worked on advanced lead-acid batteries for US Navy submarines.

His team was able to develop a highly corrosion-resistant, titanium wire-reinforced large-size positive grid for 5000Ah capacity cells destined for back-up power in nuclear submarines.

"The idea of reinforcing the grid with bare high-purity titanium wires came when, after months of frustrating efforts to incorporate bundles of alumina fibres as reinforcement, and looking out of the lab window to a nearby construction site, it dawned on me that steel-reinforced concrete structures would be a good example for a strong grid," he recalls.

"Titanium is perfectly passivated at the potentials of the positive electrode and thus doesn't corrode when exposed directly to the acid. We needed less than 10% in volume of titanium in the volume of the lead-tin alloy grid

to resist creep, corrosion-induced grid growth, as also the forces expected from an enemy depth charge."

Giess later joined Accumulatorenfabrik Oerlikon, one of the oldest lead-acid battery manufacturers in the world, and moved to Zürich, Switzerland.

Accu Oerlikon was renowned for the Oerlikon Battery, with a gelled electrolyte, that had been developed in the 1930s. The gelling was done with a slurry of asbestos fibres and a sodium silicate solution.

This prevented acid spillage when the battery glass jars broke, and the solid gel also averted short circuits between the hanging, separator-less battery plates.

Even a reduced frequency of water additions was claimed as an additional benefit, or a Sonnenschein Dryfit, before its age.

"As head of R&D in Rolling Meadows I witnessed the birth of the Absolyte VRLA/AGM cells, and I convinced Accu Oerlikon management that another momentous change in lead-acid battery design was in the making with the advent of the Gould/GNB Absolyte and the Chloride Powersafe VRLA/AGM stationary batteries," he recalls.

"We then brought on to the market the successful Compact-Power VRLA AGM range, going from 12V-26Ah monoblocs all the way to 2V-3000Ah single cells.

"The ride was not always smooth and we were, as early adopters of this technology, plagued by the VRLA/AGM characteristic negative terminal leakage and strap corrosion.

Herbert then worked in IEC lead-acid battery standardization, becoming chairman of IEC TC21 Secondary Cells and Batteries.

The technical excellence of the VRLA/AGM cells and monoblocs had in the meantime spread to China, and after many technical, organizational and cultural challenges the venture led to a China job, when Accu Oerlikon set up a production line near Hangzhou, the famous Lin'an of Marco Polo.

The latest chapter of Herbert Giess's career began in 2006, when he left Accu Oerlikon to become an independent consultant. ■

Frank Fleming was honoured with the International Lead Award at 18ABC in Bali, Indonesia in 2019

For the past 40 years Frank Fleming has been at the sharp end of the research, manufacture and commercial development of the lead battery business, widely admired for his ability to turn theoretical lab-tested work into practical solutions that can be transferred to the manufacturing line.

Frank's first real battery experience was during a gap year at college when — as was the custom at that time — students took a year's work experience as part of their degree course.

In those days Chloride was one of the three top battery manufacturers in the world, and it was there that Frank came under the influence of Ken Peters — nowadays the man recognized as being the pioneer of VRLA batteries and turning the technology into a commercial phenomenon.

After taking a PhD in solid state proton conduction, Frank returned to work for Chloride, which later became Hawker Batteries, and for the next 19 years the firm was an integral part of his life.

His initial work was as an applied scientist for Chloride Technical, the R&D arm of the group. Oddly, for a man whose career has been almost exclusively spent in the lead industry, for a time he studied secondary lithium batteries with Salford University and the Danish Energy Research Laboratory. This work resulted in the development of a lithium/PEO/V6O13 secondary button cell.

As his experience grew, Frank became a member of a team of on-site troubleshooters, whose role was to resolve local processing problems and to understand the unique electrochemical phenomena that disrupted Chloride's manufacturing.

As well as gaining a thorough

knowledge of the design and processing of AGM products it was a tremendous team-building period that finally convinced him that lead-acid battery manufacturing was going to offer him an interesting career and a useful life.

During this time, he spent extended periods working in the South Africa and US manufacturing facilities on the Torque Starter, one of the first AGM batteries.

The early AGM batteries were plagued with problems—it was not just a Chloride difficulty but a worldwide one — which became labelled PCL — premature capacity loss. It was found that cycle life decreased spectacularly in the early months of the batteries' use.

Frank, with what became a legendary group of people including Kathryn Bullock, Ken Peters, David Rand, Michael Myers, Pat Moseley and Russ Newnham, was one of the team recruited by the then newly formed ALABC to solve the problem.

Around this time, Hawker acquired the Gates Company and Frank became involved in the development and manufacturing of TPPL batteries — a crucial interest in the latter part of his career. Thin plate pure lead batteries offer greater cycle life and deeper power.

Perhaps a key post in his career development was his appointment as technical director for Hawker Energy Products in 1989. Hawker was one wing of Chloride's battery group and an iconic brand. Here his managerial skills were brought out in one of the toughest assignments of his early career—the relocation of an entire manufacturing facility from London to Newport in Wales.

In 2000 Frank left Hawker to become chief technical officer for NorthStar

Battery. He was also the firm's co-founder, with three Hawker Battery colleagues, Jerry Hoffman, Joel Gibson and Scott Erwin.

It was clear to Frank and his cofounders that telecommunication standby power was moving away from centralized locations to distributed sites because of the vast coverage requirements of cellular phones. They also realized the technical advantages of thin-plate pure lead technology.

The first batteries found a ready niche with telecoms giant Ericsson. NorthStar went on to become a highly successful manufacturer of advanced lead-acid batteries for telecommunication, UPS and transport applications. In 2019 NorthStar was acquired by EnerSys.

In 2017 Frank became a partner in Electric Applications Inc, working on a US DoE sponsored project between Argonne National Laboratory and a consortium of US lead-acid battery manufacturers. The project — arguably the most exciting for a generation — uses cyclotron technology to look at, real time, the charging and discharging of a lead battery.

Most recently Frank has become a partner in EAI Grid Storage, a new business that advises and designs grid-level battery energy storage systems.

"I'm excited to still be contributing to an innovative industry which continues to push the boundaries of research and development," Frank said when accepting the medal in Bali.

"I think advanced lead batteries are key to the future of battery energy storage and electrification as the demand for safe and reliable battery storage is growing so rapidly. As an industry we must recognize these opportunities and ensure our technology is part of the solution." ■



"I'm excited to still be contributing to an innovative industry which continues to push the boundaries of research and development. I think advanced lead batteries are key to the future of battery energy storage and electrification as the demand for safe and reliable battery storage is growing so rapidly. As an industry we must recognize these opportunities and ensure our technology is part of the solution"

Time to leap into the fray!

The complete details of many of the presentations are given on the 19ABC website — asianbatteryconference.com — but below is our more idiosyncratic choice. Some presentations we've expanded and you will see them in full elsewhere in this supplement.

The range of presentations is, as ever, topical, market focused in a practical way and frequently technical. A balanced mix, in fact.

Wednesday 4.55pm

The improvement of utilization and durability of positive active materials for lead acid batteries

Akihiro Watanabe, research engineer, The Furukawa Battery Co

Increasing utilization of the positive active material (PAM) is a key target for cost, size and weight saving. In general, it is well known that PAM subject to a high utilization shows poor durability and thereby adversely affects the cycle-life of lead acid batteries.

The use of new additives is a promising approach for maximizing the trade-off between utilization and durability of PAM. This presentation will report the effect of new additives on the characterization, utilization, durability of PAM.

The use of new additives is a promising approach for maximizing the trade-off between utilization and durability of PAM.



Akihiro Watanabe,
The Furukawa Battery Co

Wednesday 6.00pm

Lead acid battery solutions for sub-MWh energy storage systems

Dipak Sen Choudhury, president for R&D, Exide Industries

In rural India, a typical off-grid microgrid solution with a dedicated solar plant has been used to demonstrate a back-up power system. This involves a grid-integrated small ESS serving a limited community of users who experience significant demand fluctuation with peaks arising at around the same time on each day.

The presentation reports the overall economics of the system — in terms of upfront storage block capex as well as an indicative levelized cost of energy.

The key target is to improve the life of present battery technology to 3,000-4,000 cycles at a given depth-of-discharge. The role of a battery management system as opposed to a battery monitoring system' is examined.



Dipak Sen Choudhury,
Exide Industries

Wednesday 6:25pm

Carbon fibre electrodes for battery energy storage applications

Shu-Huei Hsieh, vice president for R&D, National Formosa University/ Department of Materials Science and Engineering

This presentation introduces a TPPL (thin plate pure lead) configuration that is bonded with a carbon fibre/cloth bone structure and called a 'carbon fibre electrode'. Under special partial state-of-charge/discharge cycling, the TPPL is corroded into lead nanoparticles in deep layers. These react in equilibrium with the electrolyte during charge/discharge process to form a nanoporous structure.

Carbon fibre electrodes have been used as positive and negative electrodes to form a lead acid cell that demonstrates long cycle-life and high rate charge/discharge ability. The coulombic efficiency is almost 100% without heat loss on 2C-charging and 10C- discharging.



Shu-Huei Hsieh, National Formosa University/Department of Materials Science and Engineering

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The test cells with the studied additives sustained more than 2,000 cycles. This performance corresponds to a notable two-fold improvement in cycle-life compared with the control cells.

Wednesday 6:50pm

Electrolyte and positive active-mass additives to improve the PSoC cycling endurance of automotive lead acid batteries

Plamen Nikolov, head of Electrochemical Power Sources Department, at the Institute of Electrochemistry and Energy Systems-BAS

The discharge capacity fading of the positive active-mass during PSoC operation has not been well studied. PAM has a complex structure and charge discharge reactions proceed through many elementary processes and phenomena that involve several electrochemically active species and intermediates. The study has evaluated these structural changes during PSoC operation of automotive lead acid batteries: to improve the cycling performance of the PAM, the effect of adding (i) an inorganic phosphorous-containing substance as to the sulfuric acid electrolyte solution and (ii) a clay mineral substance to the positive plate paste.

The studied materials are natural inorganic substances that are environmentally friendly and widely available at low cost. PSoC cycling of flooded-type 2V, 4Ah test cells at 17.5% DoD provokes considerable



Plamen Nikolov, Institute of Electrochemistry and Energy Systems-BAS

changes in degree of crystallinity of the beta-PbO₂ phase, the content of the alpha-PbO₂ phase, the PAM pore volume and surface area, as well as the size and shape of individual PbO₂ particles.

The two additives are able to suppress and delay the processes that cause deterioration of the PAM discharge performance. The test cells with the studied additives sustained more than 2,000 cycles. This performance corresponds to a notable two-fold improvement in cycle-life compared with the control cells.

Wednesday 7:15pm

Assessment of carbon black-organic expander interactions on capacity, dynamic charge acceptance, cold cranking and partial state of charge life of lead acid batteries

Tim McNally, manager R&D, Borregard

This presentation concerns an investigation of the interaction



Tim McNally, Borregard

of lignosulfonate expanders Vanisperse A and Vanisperse DCA with eight commercially available carbons. The carbons' surface-area ranged from 75 m² g⁻¹ to 1400 m² g⁻¹. Where a general correlation was established between the carbon specific surface-area and the effective dose, nonlinearities in lignosulfonate adsorption suggested secondary factors, for example carbon surface groups or size exclusion due to carbon pore structure, might also play a role.

Furthermore, the fact that the relative mass of the lignosulfonates adsorbed varied with the carbon suggested that lignosulfonate structure might also influence adsorption. Subsequent battery tests also revealed strong correlations between effective lignosulfonate dose and battery performance, though again the extents of these correlations were complicated by secondary effects or intrinsic lignosulfonate / carbon synergies.

Nevertheless, it can be concluded that the effective dose of lignosulfonate is contingent on the carbon specific surface area and a minimum threshold effective dose of lignosulfonate is necessary to preserve or improve key battery performance metrics.

The effective dose of lignosulfonate is contingent on the carbon specific surface area and a minimum threshold effective dose of lignosulfonate is necessary to preserve or improve key battery performance metrics

Thursday 4:05pm

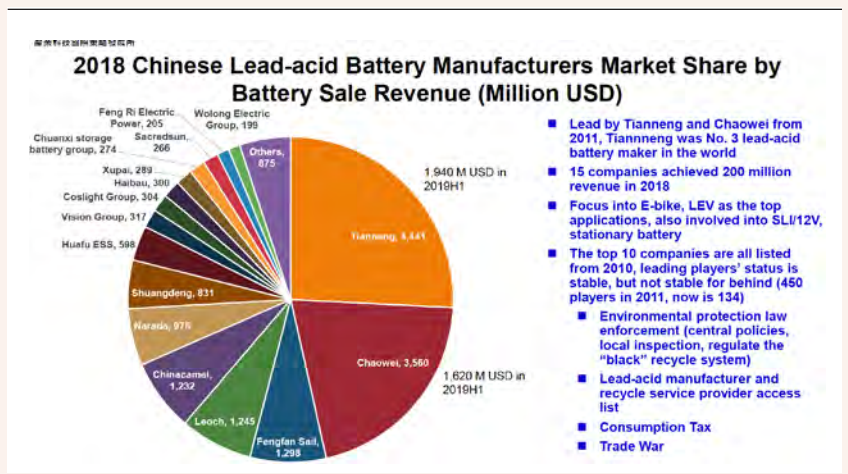
ONE TO WATCH

Observation and forecast from the LAB applications to battery market — under pandemic era change

Lu (Mark) Hsueh-lung, senior researcher/secretary-general, Industrial Technology Research Institute/Taiwan Battery Association

One of the highlights of 18ABC in Bali was Mark Lu’s outstanding presentation on the scope of the world battery market by type and application and how China’s own battery sector fitted in to these trends.

The scope of the information and the depth of the research was widely rated as extraordinary — this presentation will be one that people will want to take home and study carefully.



Thursday 4:30pm

Innovation pathways for lead acid batteries: the CBI 2019-2022 technical programme

Matt Raiford, senior technical manager, Consortium for Battery Innovation

During the last 10 years, a significant increase in lead acid battery performance has been observed in automotive, stationary and industrial applications. New plateaux of

service life, reliability, and charge-acceptance have been reached by a renewed focus on innovation in the industry. The Consortium for Battery Innovation over the last three years has developed a technical programme centred on improving lead acid battery performance in key markets, mainly 12V automotive and ESS applications.

The programme consists of projects across the UK, EU and US that are focused on applied and fundamental science. This presentation will



Lu (Mark) Hsueh-lung, Industrial Technology Research Institute/Taiwan Battery Association



Matt Raiford, Consortium for Battery Innovation



Geoffrey May, FOCUS Consulting

provide an overview of the CBI technical programme, as well as a summary of the new 2021 roadmap and the market trends influencing CBI research efforts.

Thursday 5:20pm

Energy storage with lead acid batteries: can they be cost-effective?

Geoffrey May, director, FOCUS Consulting

Although lead acid batteries are successfully applied for energy storage both in front of the meter and behind the meter, there is a range of competing technologies, such as lithium ion, sodium sulfur and flow batteries, for this service.

Lead acid batteries can provide long cycle and calendar lives and have been adapted for shallow cycling applications where the battery is not routinely brought back to a fully-charged condition. Li-ion batteries have advantages in terms of specific energy but for static applications this is not important in the same way as for electric vehicles. Other technologies are also better suited to static service.

The selection of preferred technology for battery energy storage depends on overall lifetime costs and this will be discussed to show that lead batteries are cost-effective.

Hammond Group research team, Marvin Ho, Maureen Sherrick, Jason Trgovich, Gordon Beckley and Thomas Wojcinski, have come up with a new way of mitigating the destructive effects of acid stratification within the battery.

Lead silicate as a performance additive for lead acid batteries

Modern battery applications demand robust performance under adverse external conditions and rigorous duty cycles. One factor affecting performance and service life is stratification of the battery cell electrolyte.

Acid stratification has been a known issue which affects battery life, especially for batteries under heavy cycling or PSoC cycling applications. The increased concentration of sulfuric acid at the lower portions of the battery active material plates promotes the formation of a surface layer of passive lead sulfate and reduces plate activation.

Stratification produces inflated open circuit voltage measurements, reduced battery performance and unequal charge across the plates, each of which can lead to reduced battery life.

Ideally, the electrolyte should be a homogenous mixture of water and sulfuric acid. Due to the exchange reactions of the charge/discharge cycle, a flow of sulfate (SO₄⁻) and hydrogen (H⁺) ions occurs between the active material surface reaction layer and the bulk of the electrolyte. During the charge/discharge cycle of the battery, acid is absorbed and released by the active material.

The mobility of the H⁺ ion can cause an increase or decrease in acid concentration (specific gravity).

Under ideal recharge conditions, evolved gasses will properly mix the electrolyte on a frequent basis. During insufficient recharge or extended periods of inactivity, the denser acid will settle to the bottom of the cell creating a density gradient.

This ultimately leads to reduced battery performance through unequal charge across the plate, increased corrosion, sulfation, and active material loss at the bottom of the plates.

Currently accepted methods to combat acid stratification include the addition of “equalization” charges where the battery is charged at a voltage above the gassing limit (2.43V) to induce the electrolytic formation of hydrogen/oxygen gas bubbles. Similarly, air can be mechanically bubbled through the cell to mix the electrolyte.

Alternate VRLA battery architectures such as AGM or gel batteries seek to prevent stratification through immobilization of the electrolyte.

In both architectures, the normally free electrolyte is trapped in either a porous glass fiber mat or transformed into a silica-sol gel by the addition of silica to the sulfuric acid. The silica reacts with the hydrogen ions of the acid to produce a gel network of O-Si-O bonds.

Compared to flooded batteries, VRLA architectures have some disadvantages including increased vulnerability to thermal runaway during abusive charging and the inability to diagnose life-reducing improper charging via electrolyte hydrometer testing.

Overcharging a VRLA battery leads to premature failure and a much shorter service life compared to a properly maintained wet-cell battery. Additionally, AGM and gel batteries are typically twice the cost of flooded batteries.

Hammond's additives

In search of an innovative solution to the problems of acid stratification, the Hammond R&D team has recently patented the use of novel lead silicate additive compounds in the positive and/or negative electrodes

Stratification produces inflated open circuit voltage measurements, reduced battery performance and unequal charge across the plates, each of which can lead to reduced battery life.

PUTTING IT ALL TOGETHER

Through experimentation with novel lead compounds, Hammond Group Inc has developed a new lead acid battery additive for both the positive and negative electrode active materials. This lead silicate additive has been shown to react with acidic compounds such as the sulfuric acid battery electrolyte to form both gel-like domains of Si-OH (silane) as well as lead sulfate.

Cells constructed with the additive demonstrate electrical performance similar to the controls, except for an increase in the overall cell voltage

during formation and cycling, a decrease in capacity at increased additive loading, and a slight increase in CCA seconds to 1V per cell.

Most importantly, results from full-scale battery testing show that an increase in the additive loading level impacts the degree of acid stratification observed during duty life. It is hoped that further optimization of the additive will achieve greater benefit in the ability to control or reduce acid stratification.

to improve the retention and distribution of H⁺ ions within the active material.

These additives provide numerous benefits through the following mechanisms:

- A network of silica gel (structure) is created inside PAM or NAM,
- Mass transfer of acid from the active material to the electrolyte is reduced during charging

The additive material consists of a Pb-Si glass frit. The frit is formed by melting silicon rich quartz glass (sand) and incorporating lead oxide molecules in the form of low metallic yellow litharge (PbO) into the structural lattice.

Pure silica has a tetrahedral structure, and in its crystalline form, silica molecules directly bond to each other via oxygen atoms located at the corners of each tetrahedral pyramid.

Introducing PbO to molten silica causes the partial breakage of the original direct silica interconnections. The resulting lead silicate combines the properties of the two materials and allows the battery's active material to exhibit the acid-absorbing properties of Si.

Key material characteristics include a high composition of PbO relative to SiO₂, similar material density to lead oxide, and low levels of harmful impurities. These properties make the material suitable for use as an additive to lead acid batteries.

Additionally, and most importantly, is that in acidic aqueous solutions such as battery electrolyte, the previously mentioned "chain disruption" of the tetrahedral silica molecules by Pb ions deteriorates the chemical durability of the material.

This allows the H⁺ ions to replace the modifier cations (Pb⁺) in the glass network, forming Si-OH (silanol) groups which behave like fumed silica. The additive therefore binds with acid protons in the active material creating pockets of silica-acid gel and combating stratification. The by-products of this reaction are harmless, common chemical species typically found in the battery's active material such as lead sulfate.

During development of this additive, Hammond's research team characterized the interaction between lead silicate and the acidic electrolyte solution. Examination of the material's ability to react with and retain sulfuric acid were carried out in the laboratory. Lead silicate was tested for solubility in both

deionized water and 1.4 sg sulfuric acid.

Test results showed lead silicate is negligibly soluble in H₂O, however a considerable amount of weight gain (~22%) was observed after reaction with acid. This weight gain was theorized to be caused by the retention of acid in a silica-gel structure and by the formation of lead sulfate.

Examination of the additive before and after acid treatment by SEM-EDS using a Phenom Pro benchtop instrument identified a change in the overall

morphology of the starting material as shown in Figure 2.

In the image, one can see the formation of fine granular lead sulfate crystals and smooth greyish regions of exposed silica that occurs after the material reacts with sulfuric acid. EDS probing of these new morphological formations confirms the presence and absence of silicon in each formation.

Electrical examinations

To confirm the findings of the material characterization analysis

The 2V test cells were tested at Hammond's R&D laboratory for electrical performance characteristics and compared to a control. Four replicate cells of each variable were constructed and tested with the results of the electrical testing comprised of an average of these four cells.

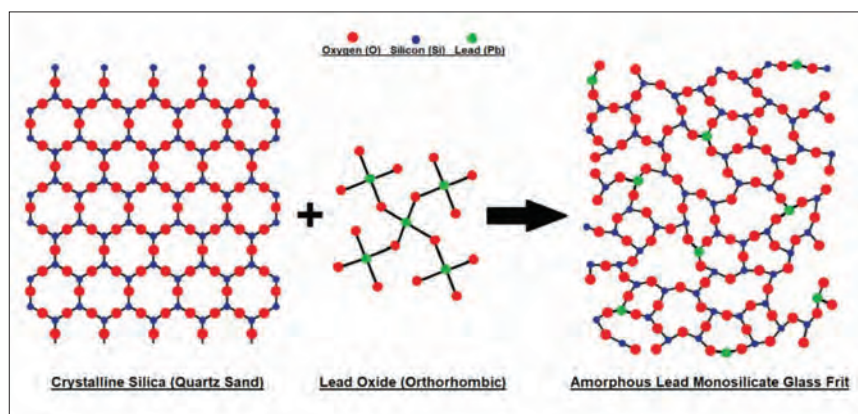


Figure 1. Illustration of the formation of lead silicate

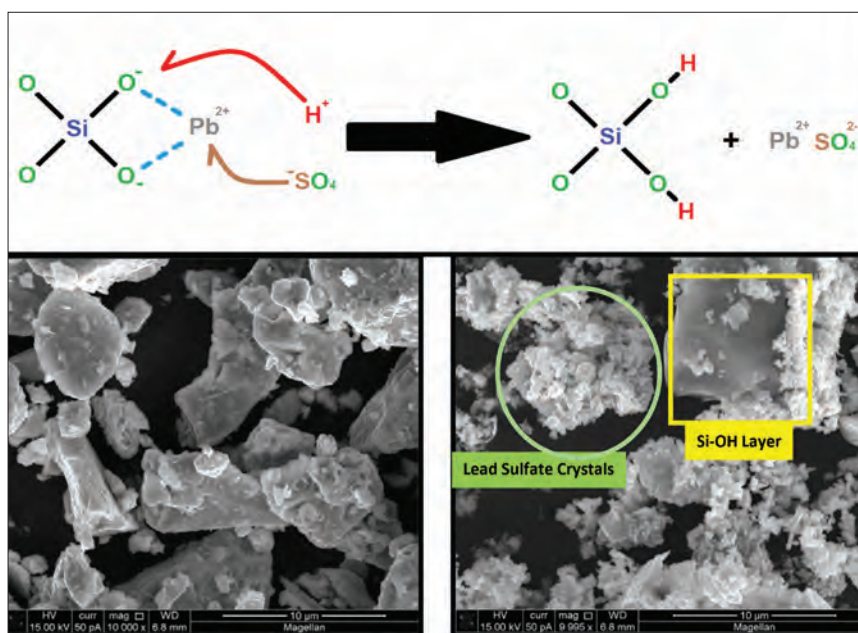


Figure 2. Chemical reaction and SEM images of lead silicate before and after reaction with sulfuric acid

an experimental test plan including several 2V cells were constructed at Hammond's research center as well as a full sized group of 27 batteries made with an industry partner. These cells and full-scale batteries were built to evaluate the lead silicate additive in both the positive and negative electrodes both in performance and in the degree to which acid stratification is mitigated.

The additive was added to both the positive and negative electrode pastes in a range of between 1% to 3% versus leady oxide. It was noted that the additive modifies the crystal morphology of both the positive and negative active material during curing, reducing the amount of tetrabasic lead sulfate produced in the positive and slightly increasing the amount of tribasic lead sulfate produced in the negative.

These changes also effect the BET surface area of the dry cured electrodes.

The 2V test cells were tested at Hammond's R&D laboratory for electrical performance characteristics and compared to a control. Four replicate cells of each variable were constructed and tested with the results of the electrical testing comprised of an average of these four cells.

The following electrical testing regime was employed to examine the additive: Reserve Capacity & 20-hour Capacity followed by Cold Crank (-18°C). Results of the reserve capacity and 20-hour capacity tests show that at higher loadings of the

Examination of the additive before and after acid treatment by SEM-EDS using a Phenom Pro benchtop instrument identified a change in the overall morphology of the starting material.

additive in either electrode there will be a slight decrease in initial capacity at both high and low rates.

However, at lower additive loadings the results of the capacity tests at both high and low rate are comparable to the control.

Cold cranking measurements were performed on experimental cells with the results of these tests showing a slight improvement (+10%) in the "Seconds to 1 Volt/Cell" in both positive and negative electrode variables containing lead silicate. These results confirm there is little detriment of the additive to overall cell performance at these loadings.

The effect of the additive upon acid

stratification was examined in full-sized Group 27 flooded batteries.

Table 1 presents a summary of the stratification evaluation results conducted on these batteries. Note that stratification was considered to have occurred in the batteries if the difference in specific gravity between top and bottom of the cell was greater than 0.015 (15 points).

The control battery shows acid stratification after the C20 and C100 discharges. The recharging profile of 115% charge returned + 15Ah boost charge is not sufficient to mix the acid well enough in these two cases. As can be seen, the impact on the acid stratification reduction is as follows: Additive in both PAM and NAM > NAM only > PAM only > Control. Based on the discharge data, lower capacity was observed if lead silicate was added to the PAM only, which agrees with prior cell testing data discussed above.

The height of the plate in the Group 27 batteries is 5" (12.7cm). Tall industrial sized battery types will typically see more serious acid stratification and potentially greater benefits from use of the lead silicate additive to reduce this issue. ■

These cells and full-scale batteries were built to evaluate the lead silicate additive in both the positive and negative electrodes both in performance and in the degree to which acid stratification is mitigated.

Table 1. Results of acid stratification measurements during cycle life of Group 27 batteries

Group 27 Flooded Battery (w/ plate height: 5")	Control	PAM w/ 1% PbSiO3	NAM w/ 1% PbSiO3	Both PAM and NAM w/ 1% PbSiO3
Battery #	D3	A10	B2	C6
Acid stratification after C5* discharge and recharge** (Δ S.G. between top and bottom)***	0.012	0.005	0.006	0.001
Acid stratification after C10* discharge and recharge** (Δ S.G. between top and bottom)***	0.014	0.010	0.007	0.004
Acid stratification after C20* discharge and recharge** (Δ S.G. between top and bottom)***	0.022	0.013	0.008	0.002
Acid stratification after C100* discharge and recharge** (Δ S.G. between top and bottom)***	0.035	0.024	0.017	0.007

* Before discharge, more charging steps were applied to ensure no acid stratification. Specific gravities (top & bottom) were measured before discharge.

** Recharge profile: 115% of discharge energy + 15 Ah (boost charge step)

*** Specific gravity (SG) was measured by digital hydrometer in two cells. The results reported are the averaged value.

Thursday 5:55pm
ONE TO WATCH

GravityGuard: an additive for EFB technology and deep-cycle applications for electrolyte stratification reduction

Thomas Wojcinski, R&D chemist, Hammond Group.



For complete details go to full article on page 24

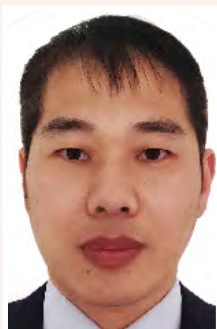
Thursday 6:20pm

Optimization of paste formulation for lead acid batteries used for parking air-conditioners in heavy duty trucks

Pengfei Cui, product manager, Jinkeli

In recent years, a new design of the lead acid battery has been introduced for parking air-conditioners. The battery offers power for AC service, electric blankets, and other devices on the vehicle. Unlike traditional SLI batteries, they operate under PSoC conditions and a high deep-discharge cycle performance is required.

At present, the products on the China market are suffering from a rapid drop in capacity and a short life. To meet customers' needs, research conducted by Jinkeli has led



Pengfei Cui, Jinkeli

to optimization of the formulation of both the positive and negative pastes for the parking AC batteries.

This development has improved battery charge acceptance and significantly increases cycle-life under low voltage charge and discharge.

Thursday 6:45pm

Fundamental understanding of the interrelationship of battery separator structures and properties with their electrical and physical performance

Sunho Choi, technical manager, Microporous

Despite the relatively long history of the development and production battery separators, there are still significant opportunities for further investigation towards optimizing separator performance. For instance, it has been a challenging question to the battery separator industry on how to attain both low electrical resistance and high oxidation resistance simultaneously. Microporous has investigated the problem by using fundamental knowledge of the interrelationship of composite structure to properties of the separators.

Because the separators are composites of multiple constituents such as ultra-high molecular weight polyethylene, silica, oil, rubber, etc., their properties are not a linear function governed by a single factor, but rather by a multi-variable question affected by many factors, for example pore characteristics, polymer rheology and surface chemistry. Through a systematic approach, it was found that the chemical, electrical and mechanical properties of separators are largely affected by their microstructures.

The variables include the composition of the constituents, processing conditions, etc. This presentation introduces a new separator product — CellForce HT — of which the microstructure of the separator is engineered to accomplish low electrical resistance as well as enhanced oxidation resistance. This product is the most recent outcome of continuous efforts toward innovative battery separators, which are designed to exceed the market requirements of automotive EFB applications.



Sunho Choi, Microporous

Thursday 7:10pm

Lead acid battery technology evolution and future challenges

Francisco Trinidad, director for battery technology, Exide Technologies

Lead acid battery performance has steadily improved during the last century through incremental developments that have accelerated in the last two decades.

Among these technological evolutions, the following advanced designs have been introduced:

- Thin-Plate VRLA batteries (with sealed inter-cell connectors) that allow precise internal gas pressure control with individual valves, thereby improving gas-recombination efficiency and state-of-charge balance in every cell.
- Lead carbon electrodes developed by carbon suppliers that enable the battery industry to improve charge acceptance with new additives or innovative current collectors
- Hybrid capacitors that were originally developed as a capacitor



Francisco Trinidad, Exide Technologies

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electrode directly connected to the negative plate, but more recently have evolved to a double layer electrode where the external surface of the lead plate is covered with a carbon dispersion

- Bipolar plates, a technology still in development but with significantly improved designs that by using new materials (polymer lead composites or silicon metal coatings) have the potential to eliminate the top lead connectors, thus reducing weight and improving specific energy.

The key to the long-term survival of lead acid batteries is the ability of the industry to adapt to the new market requirements with incremental future innovations. Enhanced Flooded Batteries with carbon nanomaterials, either inside the active mass or attached to the separator, are probably the next step to keep lead acid as the preferred technology in the automotive 12V market, which includes the auxiliary batteries for hybrid and electric vehicles.

The presentation will discuss innovations that may help lead acid batteries to face future challenges and compete with other advanced technologies.

Friday 4:05pm

China's lead acid battery industry

Dong Li, chairman, Leoch International Technology

The presentation briefly describes the status of the Chinese market for lead acid batteries in 2020, as well as the challenge from lithium batteries.

A detailed analysis of China's market size and market demand has

been undertaken. The study includes a separate list of both the top manufacturers and the top customers in the different applications such as network power, SLI, and motive power.

In addition, there is a focus on the market situation in China from different aspects such as the top manufacturers, annual sales and exporting status.

Finally, attention is given to the development trend of both the lead acid battery and the lithium battery, as well as their respective opportunities in China.

Friday 4:30pm

Improved high-rate discharge process in a production line

Michael Wipperfueth, sales manager, **Tony Schröer**, business development, **Mohammed Al-Ogaili**, project manager development, **CMWTEC Technologie**

Before shipment all automotive batteries are subjected to electrical load tests that are performed in accordance with industry accepted standards. It is essential that the energy discharged from the battery during testing is minimized to avoid the cost and delay associated with recharge. These basic requirements must be considered when defining the ideal high-rate discharge test process.

Immediately after formation, and preferably after post cleaning, the batteries are discharged at high current for a few seconds. The voltage under load at the end of test is determined and compared with nominal values to reach a pass/fail decision.



Michael Wipperfueth,
CMWTEC Technologie

This presentation outlines a new approach to a high-rate discharge machine in terms of its assembly, programming flexibility and the ability to discriminate accurately between acceptable and unacceptable batteries. It will be shown how supplemental evaluation criteria such as direct current internal resistance, alternating current internal resistance and a constant current constant voltage discharge curve versus time can be implemented.

The presentation demonstrates how the new generation of the HRD machine allows a simplified programming of customized test and evaluation profiles to improve the reliability of the results.

Friday 5:20pm

Powering all our futures

Edric Koh, head of corporate sales for Asia, London Metal Exchange

LME has been working closely with the electric vehicle and battery industries to identify and develop



Dong Li, Leoch International Technology



Edric Koh,
London Metal Exchange

Neil Hawkes, principal analyst for base metals at CRU, opens the ABC presentations with an overview of present trends in the lead market.



Alive and kicking – lead no longer the forgotten battery metal?

The two first presentations of ABC's opening day looking at the future direction of prices in the lead market will be followed with interest, given the uncertainties over its price in the past year. The two lead analysts — Neil Hawkes from CRU and Farid Ahmed from Wood Mackenzie — intend to dissect different aspects of the sometimes puzzling metal.

Hawkes' initial point is that supply shortages are — for the moment — now the order of the day and price rises for lead will continue in the near term.

Secondary lead supply in Europe has been hit by this summer's floods. Ecobat's smelting plant at Stolberg in western Germany had to declare *force majeure* in July and will be shut down until the spring. The Stolberg plant has a capacity of around 150,000 tonnes a year, so this is a major blow to European battery manufacturers.

Primary lead supply is also suffering. Mining giant Trafigura has cut zinc production by around 50% this year. As lead is typically extracted with zinc, volumes of lead entering the market will also be hit.

Oddly, however, there is no global shortage of lead. The present trend is one of regional imbalances rather than scarcity. There are large stocks available in China but delivery of the metal to battery manufacturers around the world is under pressure.

"We don't have a pinch-point, as such," says Hawkes. "The pinch point is the entire supply chain!"

The major source of the problem is shipping and a crisis in container ship availability.

"There's a lot of factors here," says Hawkes. "Before the pandemic, supply and demand in the world's container fleet were mostly in tune with each other. However, since the easing of pandemic restrictions there's been a huge rise of pent-up consumer demand. The average cost of shipping a standard 40 FEU large container is

now four times higher year-on-year.

"Because of Covid restrictions and labour shortages, shipping times are roughly twice what they used to be. Moreover, inland freight is also struggling with a lack of truck and train capacity to meet strong demand."

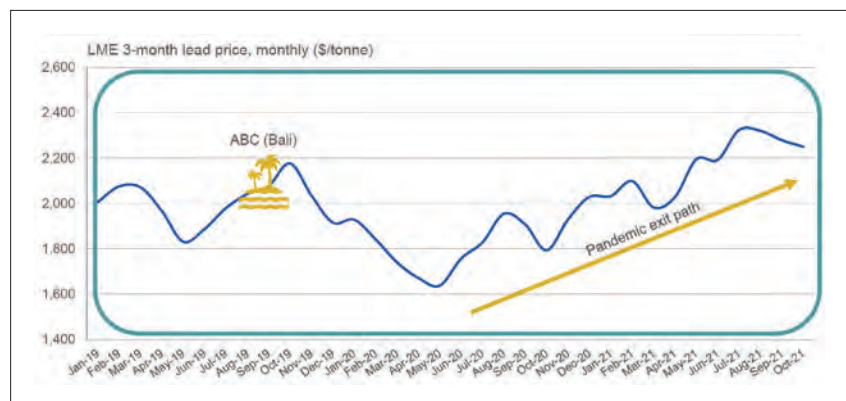
With shortages of supply being met by increased demand, the price of lead will inevitably rise again. Hawkes believes that this will beat the 2019 pre-pandemic peak and lead will return to the middle ground of pricing.

However, put against the huge volatility and price spikes seen on other metals quoted on the LME, lead looks to be reassuringly stable — so a rise in the cost of lead is likely to be

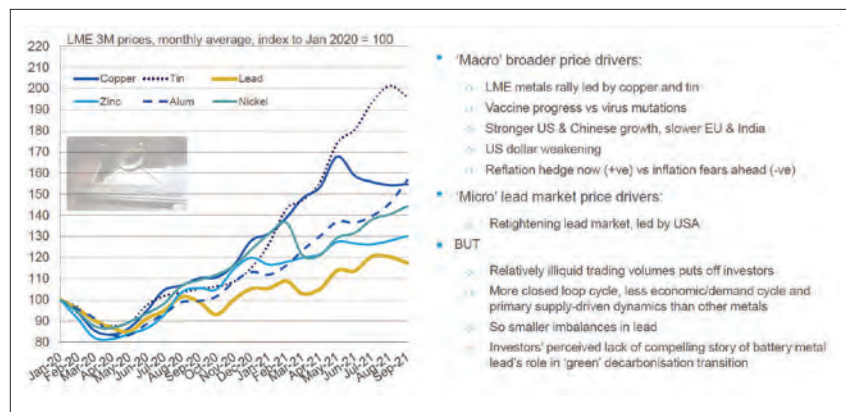
more measured in the present shorter term business cycle.

Talk about a supercycle is highly unlikely, says Hawkes. Partly this is a question of terminology — a business cycle is normally reckoned to be for around three to five years, a long run business trend will be up to 20 years and a supercycle for over two decades. In fact since the record highs of 2007 in the China boom, the long pricing trend is downward — most of the time the price peaks are declining.

In the longer term CRU estimates that lithium will steal market share for batteries from lead but the boom in energy storage will still allow lead demand to continue. ■



Bumpy upward price path from spring 2020 lows to surpass 2019 peak.



Lead less volatile in broader LME metals price rally.

Graph Data: LME

risk management solutions that are tailored to their requirements. This presentation will share such solutions available to LME for EV metals and battery materials. Metals are an essential enabler of a sustainable future, and as global demand for metals increases so will the expectations on sustainable standards.

This presentation will also give an overview of the LME's strategy on sustainability and how it will support the metals industry in this aspect.

Friday 6:00pm

Optimization of grid configuration by investigating its effect on the positive plate of lead acid batteries via numerical modelling

Ali Alagheband Hosseini, technical manager, Sarv Sanat Toos

New applications of lead acid batteries involve higher discharge rates during their lifetime. Consequently, ohmic voltage losses in current-collecting systems become more important. In this study, 3D numerical modelling methods using COMSOL software have been employed to investigate the effect of grid configuration, lug position, diagonal wire angles and the tapering of wires towards the lug on the performance of the positive plate.

This involved modelling the current and potential distribution through grid wires, active material, and adjacent electrolyte to the surface of each grid. The six different grid configurations were Conventional Side-lug, Conventional Middle-lug, Diagonal Side-lug, Diagonal Middle-lug, Double-diagonal Side-lug, and Double-diagonal Middle-lug. Differences in maximum

and minimum potential values in each model indicated that Double-diagonal Middle-lug grids possess the most uniform potential distribution through the whole grid with just 90 mV difference between the highest and the lowest potential values.

Friday 6:25pm

PowerFill separator for advancing faster acid filling of AGM lead acid batteries

Zhiping Jiang, chief scientist, Hollingsworth & Vose

One challenge faced during AGM battery assembly is the slow filling of acid electrolyte into the batteries. This problem slows down the battery assembly speed and results in an uneven acid distribution in the plates that potentially causes dry spots on plates and dendrite formation during battery formation.

This presentation shows that a key factor in affecting the acid filling speed is the gas pocket trapped toward the central area of the plate + AGM. The

gaseous species in the pocket are the air and possibly CO₂ generated by the reaction of the acid with carbonate species in the plates. Unless these gases are expelled from the battery, they tend to hinder the flow of the acid into the central area.

Hollingsworth & Vose has recently developed the PowerFill AGM separator to solve the issue by modifying its surface to create open channels.

With these channels, the gaseous species in the pocket can escape more easily from the battery during the acid filling process, thereby allowing acid to flow quickly into the central area and enabling even acid distribution within the plates and AGM.

The PowerFill technology can be applied to various types of AGM, and the resultant separators still retain the same strength and compression retention behaviour of the base AGM.

These and other properties of the PowerFill AGM separator, as well as its potential applications, will be discussed in detail. ■



Ali Alagheband Hosseini, Sarv Sanat Toos



Zhiping Jiang, Hollingsworth & Vose

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Operational experience and modelling of parallel connected lead and lithium ion battery energy storage components

Peter Stevenson, GS Yuasa Battery Europe

Hybrid storage systems open up a clear path for combining the strong points of lead — price, safety, recyclability — with the strengths of other chemistries. Moreover, given the wider market's unflagging enthusiasm for all-things lithium, the mix with lead would seem an uncontroversial way for battery manufacturers to promote their lead products while tapping lithium's performance..

But it's a direction that only a couple of firms seem to be moving in. Eagle Picher, in 2011 looked, for a while, at mixing lead and lithium batteries and even studied incorporating supercaps as part of the package.

Battery manufacturer GS Yuasa has taken the idea further and is now on its third project working at incorporating the two with a special dual system. Principal architect of this is the firm's chief technology coordinator Peter Stevenson who spent the first years of his career investigating and developing lithium batteries for Ever Ready and the past 30 with Yuasa working on lead batteries.

For the past three years Yuasa has partnered with the University of Sheffield, and Infinite, a renewable energy developer, in creating a battery management system called ADEPT.

The first project Yuasa worked on was PESO — Port Energy Systems Optimization — at Portsmouth International Port in southern England. The project, which first saw the light of day in early 2020, was sized in kW and kWh and was essentially to validate the concept of a larger integration of solar panels with a dual battery system and artificial intelligence.

The storage system and the integration of artificial intelligence in it was developed by Anthony Price, the head of Swanbarton, a consultancy. "The lithium battery part of the system will do the rapid charging and discharging needed to keep the microgrid stable. The lead battery will provide long duration power," he told Batteries International at the time.

"One advantage of the combination of the two is that of minimizing expense," he said. "Despite the price falls we have seen in recent years for

lithium batteries, they are still more expensive than lead. The combination of the two and the AI protocols we are introducing will reduce the cost of energy management."

The proof-of-concept trial was seen to be commercially viable and since then the ADEPT system has been taken further with two other projects.

This June GS Yuasa itself started the installation process of lead and lithium batteries to back up power generated by a 1MWh rooftop solar array at its own battery factory at Ebbw Vale in Wales. In a second stage a wind turbine will be installed to supply electricity directly to the site.

The solar panels supply around 5% of the factory's needs, and excess energy will be stored in the hybrid battery system, which will be housed in a battery container to complete the microgrid.

In mid-August, project partner In-

finite announced that with GS Yuasa and the University of Sheffield they had won a tender for the installation of the ADEPT system at the British Royal Mint in Wales.

The energy centre will comprise a 2MW solar farm, wind turbine, hydrogen-ready combined heat and power unit, and the hybrid battery.

The concept of an energy centre with all components on one site, supplying industrial estates with local renewable energy, is a UK first.

The energy centre will generate around 18,000MWh a year, which means that with annual demand around 25GWh, it will provide around 72% of the Mint's electricity.

"The battery size will be 800kW but the final design specification, including the lithium/lead split, will be subject to future analysis of the Mint's current demand profile," Infinite said at the time. ■

THE PRESENTATION ITSELF

Peter Stevenson says his presentation will show how different technologies with different operational characteristics can obtain an overall improved storage performance.

The first section of this paper presents the operational history and general performance data for a dual chemistry energy storage system. The ADEPT system is a 100kW grid-connected hybrid battery system which uses two types of battery chemistry: lead acid and lithium ion in the same unit, connected directly on the DC bus.

The project has been commissioned in early 2019 and has been in continuous operation with a few months break in the second half of 2019. The general operational pattern has been charging the system overnight at around 20kW and discharging it at 100kW, maximum inverter power, during evening peak hours.

Performance results will be presented and discussed including power and current sharing between the strings, overall efficiency and

general observations about the lead acid and lithium ion hybrid behaviour.

The second half the paper details the lead acid and lithium ion dual battery system modelling with the aim of gaining a better understanding the DC linked hybrid battery behaviour. Two types of GS Yuasa batteries, LEV50 and SWL3300, have been tested in the laboratory at the University of Southampton to gather data for modelling purposes.

Two types of tests have been performed, pulse discharge and constant current charge/discharge, at different C rates. The results are used to extract the parameter of equivalent circuit models for both battery cells types.

These circuit models are used in Matlab/Simulink simulation studies of different lead acid and lithium ion hybrid battery systems with different number of strings for each chemistry and the number of cells per string to provide further insights into the behaviour of the battery and aid the optimisation of its configuration for given applications.

Farid Ahmed's presentation at the 19th Asian Battery Conference focuses on the opportunities and challenges facing the lead industry as lithium gains ground in both the EV and energy storage markets.

Lead: fighting fit or fighting fat

"I'm frustrated rather than despairing," says Ahmed, who is lead analyst for Wood Mackenzie, the research consultancy. "I see great progress and improvement in the industry, but we need to champion lead's capabilities — and fast. Lithium is not on the horizon; it's sitting right outside the gate."

Lead is still resting on decades of market dominance and healthy industry-wide growth. Wood Mackenzie forecasts a 1.5%-2% annual growth rate up to 2040 — figures that perhaps give a false confidence to those in the lead business who are still only partly unmoved by the challenge lithium presents.

Ahmed likens it to battle between Betamax and VHS in the 1980s: a story highlighting the dangers of market ignorance and lack of diversification.

"Betamax was clearly the better product, but the market isn't always driven by superior quality. Growth is often driven by cheaper materials, adaptability and compatibility. Lead may be the firm favourite, but the market moves fast and lead needs to keep its horse in the race."

One area of threat to lead is in EVs. There has been increasing noise by EV manufacturers removing the lead auxiliary battery — used in all EVs — in favour of lithium. Tesla announced this February it will replace the lead batteries with lithium in future versions of its models S and X.

"We don't see EVs losing the lead auxiliary yet, primarily because of cost," says Ahmed, "and lead is closing the performance gap to the few lithium batteries that do compete in cost, such as lithium iron phosphate. If the advancements in oxide and bipolar chemistries continue, then we could be on par with LFP while retaining, as always, an intact ethical reputation."

An even bigger threat to lead is the storage industry in renewable energy.

Power utilities needing an energy storage solution often look to lithium



"Much of the industry has had it easy for too long. They've made good money and now that competition is on their doorstep, they don't have the mindset or the capability to deal with it."

because the marketing is more prominent, the technology is seen as future-proofed and the installations come as a complete package, whereas lead installations are often batteries only, requiring additional infrastructure.

Unlike EVs, energy storage installations aren't restricted by a need to save space or limit weight, so lead battery technology will often make better sense, especially in terms of safety, price and reliability.

"Lithium seems to be the go-to in recent energy storage solutions, but there have been great advancements in bipolar batteries and some brilliant work in oxides resulting in deeper cycles and longer service life, which means the gap between lead and lithium is closing," says Ahmed.

The problem is promotion, and with lead it is two-fold: poor public perception and lack of initiative. It's clear that lead needs a rebrand, but it isn't clear who should be responsible.

Lead's reputation has been damaged by a history of ground contamination and the legacies of leaded petrol and lead paint.

"People don't realise the majority of damage done by lead was historical, more than half a century ago," says Ahmed. "Regulations are — quite rightly — much stricter these days and emissions are heavily controlled."

Promotion is tricky in an industry both misunderstood by the greater public and taken for granted by those on the inside. The people with money to invest simply aren't aware of lead's capabilities. They see lithium's advances in chemistry but don't realize that a promising chemistry doesn't always mature into supply-chain-ready technology.

"We're not going to get anyone outside the industry to champion us; we need to do it ourselves," says Ahmed. "Some organizations — the ILA, BCI, the Association of Battery Recyclers in America — are doing this well, but much of the industry has had it easy for too long. They've made good money and now that competition is on their doorstep, they don't have the mindset or the capability to deal with it."

Ahmed remains optimistic, particularly in the progress of bipolar batteries, a technology Ahmed wishes was 'here yesterday', and developments in oxides, low carbon and low pollution processes, proving that lead is adapting to the requirements of the future. It's just a matter of spreading the word, he believes.

"Lead needs to be on everyone's radar before it's dismissed altogether and left behind." ■

With nearly 30 years' experience in the lead industry under his belt, Wood Mackenzie's Farid Ahmed has worked in most aspects of lead — from production to sales to reporting on the market as a whole.

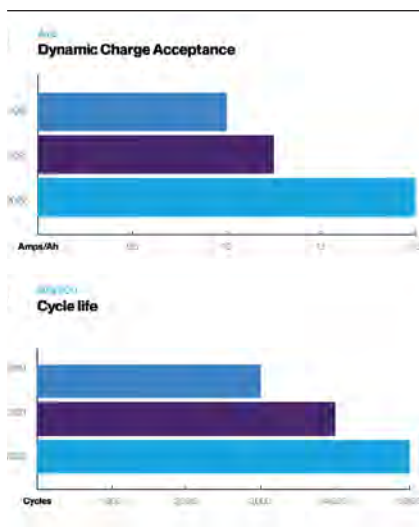
Economies need batteries and lots of them. It is clear through intensive market-driven analysis that end-users across the automotive, energy storage, industrial and motive power sectors want greater performance from all battery technologies.

A new phase of innovation for advanced lead batteries

In collaboration with our members, CBI has developed a new Technical Roadmap, shedding light on the necessary improvements and research pathways for all the applications lead batteries are used in.

Two years ago, CBI set out the highest priority research areas for the technology, focusing on Dynamic Charge Acceptance (DCA) for the automotive sector, which is a critical parameter enabling a battery to accept charge through regenerative braking, and cycle life performance in renewable and utility energy storage applications.

Significant progress has been made since the launch of these targets in 2019 and the global lead battery industry is on track to deliver on both goals in 2022.



Progress in DCA and cycle life improvements in lead batteries since CBI's 2019 Technical Roadmap

This year we have unveiled our new research priorities in a newly launched 2021 Technical Roadmap. This builds on the progress made within the industry through CBI-driven research, but also drastically expands our research targets to cover the expansive application space for advanced lead batteries.

The automotive sector remains a critical market for advanced lead batteries, spanning conventional, start-stop and micro-hybrids to full electric vehicles (EVs). The micro-hybrid market alone is forecast to represent over 80% of new car sales in Europe by 2030, and their reduced carbon emissions and higher fuel efficiency relies on advanced lead batteries.

But the advanced lead battery is also critical for the electric vehicle revolution, providing power for critical on-board safety. CBI is working with car manufacturers, researchers and our membership to target enhancements for batteries in both these applications:

- **Start-stop and micro-hybrid applications:** Ensure that recent improvements in (DCA) are maintained, whilst improving high-temperature durability and maintaining Cold Crank Amps (CCA) and water loss.
- **Low-voltage EV applications:** Improve DCA and charge acceptance, whilst increasing charging efficiency and lifetime.

Ensuring lines of communication stay open and data centres are reliably powered is vital for societies around the world. With safety and reliability key credentials of advanced lead batteries, they are a premier choice for providing critical back-up power for UPS applications, including for hospitals. Battery enhancements for these sectors consist of:

- **Industrial applications:** improving cycle life whilst reducing battery costs.

Energy policies in the US and Europe are increasingly focused on a distributed, dynamic grid, with a gradual shift to incorporating renewables. Batteries are a central player in this shift, and advanced lead batteries are already a major player in this field. The innovation journey for the technology needs to continue and expand and our roadmap is highlighting the

research pathways needed to ensure the technology underpins future decarbonization efforts:

- **Energy storage systems:** Reducing acquisition and operating costs of ESS by increasing cycle life and efficiency.

In a new addition to the roadmap, CBI examined the shift to electrification in the e-bike, e-trike and e-rickshaw market, which is dominant across Asia. With the market estimated to be worth US\$2 billion and consisting of more than 300 million micro-mobility vehicles, we have highlighted key areas for innovation for this application:

- **Micro-mobility applications:** Improving gravimetric energy density, recharge capability and service life.

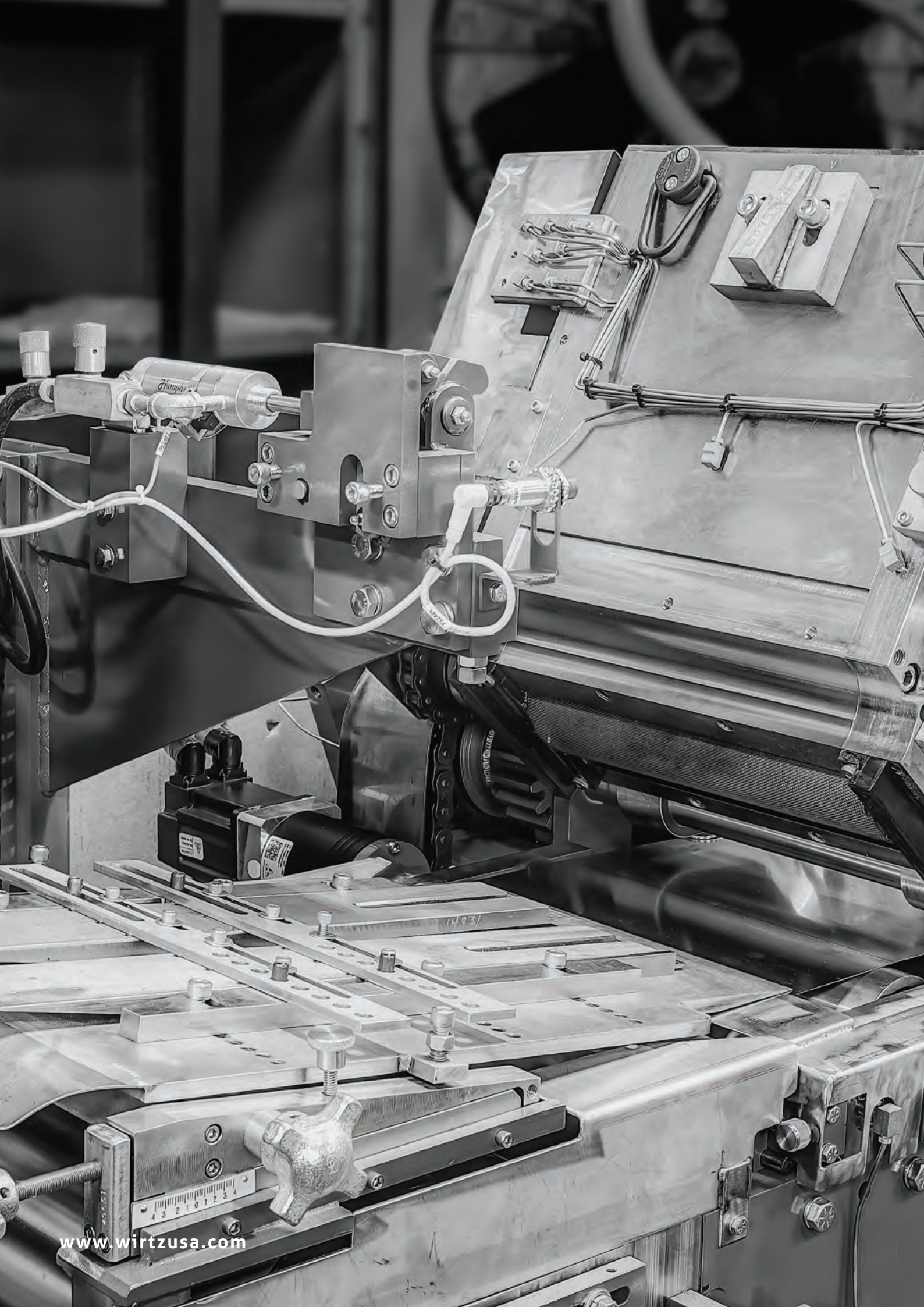
Motive power remains a market where lead batteries are the dominant technology, currently representing 90% of battery demand with a growth to 34.3 GWh predicted by 2030. As with other areas, continued innovation is critical to meeting evolving technical demand:

- **Motive power applications:** Lowering TCO by increasing cycle life, recharge time, and producing maintenance-free batteries.

The Consortium's 2021 Technical Roadmap was developed with customer requirements as a central focus, to reflect current and future market needs.

Using market-driven analysis to feed into our scientific vision for the technology, CBI will use the innovation pathways identified as the basis for future research and launch projects with our members and partners to deliver the performance metrics necessary for future advanced lead batteries.

Continued innovation will ensure advanced lead batteries can provide a sustainable, reliable and high-performing solution for the ongoing electrification and decarbonization transition. ■





WIRTZ NEW PATENT FOR CONTROLLING THE PASTING PROCESS DELIVERS PRECISELY PASTED PLATES. AUTOMATICALLY.

You may think of Wirtz as experts in grid making but we're really the leaders in plate pasting too. We introduced the steel belt paster and received our first steel belt paster patent in 1986. We have supplied hundreds of steel belt pasting systems to the industry over the last 30 years.

The Plate Pasting Process is now a Process Under Control.

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Wirtz Closed Loop Automatic Caliper

This programmable process maintains plate thickness during your entire plate making run. Adjustments on the fly do not interrupt production or cause line stoppages.

Plate Thickness Control To Exact Tolerances. Plate Thickness can be controlled to a ± 0.001 inch or 0.025mm during production all day long. In a closed loop system, adjustments are made continuously as paste density and fluidity changes and will not interrupt production or require line stoppages. The adjustments can be made in increments as ± 0.0005 inches or 0.012mm.

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INNOVATION. PERFORMANCE. RELIABILITY.

A brief history of lead battery time...



To the outsider the lead battery business seems to live in a tranquil landscape where nothing seems to change ... or not rapidly enough to notice.

But, in reality, the history of the battery business is more a series of torrid episodes resembling scenes from Peyton Place rather than Little House on the Prairie!

It's also a strange industry. Competitive to its core in product delivery but more than gracious in helping competitors when sudden crises emerge.

2001

• Russian scientists 'work on developing a lead carbon battery comes to the start of commercialization and eventual creation of **Axion Power**. The PbC battery is similar to a standard one but uses a standard lead acid battery positive electrode and a super-capacitor negative electrode.

The specific type of activated carbon it uses has an extremely high surface area and has been formulated for use in electrochemical applications. During charge and discharge, the positive electrode undergoes the same chemical reaction that occurs in a conventional lead acid battery.

The main difference in the PbC battery is the replacement of the lead negative electrode with an activated carbon electrode which, being a supercap, does not undergo a chemical reaction at all.

Ultimately Axion Power struggled for a decade and a half but never succeeded in commercializing its product.

• **FRÖTEK** opens office in Manchester, UK.

• Proposed 42V standard dominates debate on future of lead batteries. Arguments to resolve the issue versus 48V technology take almost two decades to be resolved.

• **Invensys** acquires Mexican facility in Tijuana.

2002

• **Johnson Controls** acquires the Varta automotive battery division, based in Germany. Sales exceed \$20 billion.

• Former **Exide Technologies** bosses Arthur Hawkins and Douglas Pearson found guilty of fraud.

• **Exide Technologies** files for Chapter 11 bankruptcy after racking up a debt of \$2.5 billion as a result of the recent acquisitions. It would be two years before the company would be free of the bankruptcy protection.

2003

• Jim Gilmour takes over as president of **Farmer Mold & Machine Works**.

• Birth of **Sorfin Yoshimura Qingdao** in China.

This is the first regional joint venture company for SY Group.

SY had been formed in 1986 from a partnership between Tom Yoshimura, who started Yoshimura Products in 1981, and Paul Fink.

• Chinese battery manufacturer **BYD** buys 77% stake in Xi'An Qinchuan Autostate car firm.

2004

• **Richardson Molding** acquires **Hardigg Battery Products**, giving it

the largest product line in US SLI and industrial batteries.

• **EnerSys** completes IPO. Acquires Fiamm Motive Power business (2005), Gaz Modular Energy, ATK and CFT (2006), Leclanché (2007), Energia (2007). Forms joint venture with As-sad (2008).

• **Johnson Controls** ventures into lithium hybrid vehicle batteries following an order from the US Advanced Battery Consortium.

• **Trojan** develops and launches its new line of spill-proof maintenance-free AGM batteries.

• International expansion of **FRÖTEK** continues with work in Ukraine, China (2005), South Africa (2006), US (2009).

• CSIRO researchers Nigel Haigh, Lan Lam, Christopher Phyland and David Rand awarded patent for the **UltraBattery**.

This is a hybrid device that combines ultracapacitor technology with lead-acid battery technology in a single cell with a common electrolyte.

The UltraBattery technology suffers less from the development of permanent (or hard) sulfation on the negative battery electrode – a problem commonly exhibited in conventional lead acid batteries.

Another patent is awarded to Lan

Lam and Jun Furukuwa in 2008 for the final development of the battery.

2005

- US firm **Firefly Energy** receives first of several US patents for its carbon-graphite foam lead acid battery technology based on a material sciences innovation discovered by Caterpillar Inc.

Unlike conventional lead acid batteries, this lasts longer, is smaller, weighs less because of the reduction of lead, sheds heat more effectively and can be re-charged faster.

- **TBS Engineering** buys Daga from Daramic.
- **Fiamm** establishes joint venture with Chen group in China.
- **Exide Technologies** announces closure of UK automotive battery factory.
- **Källström**, the Swedish battery filling company, moves from Malmö to its new base in Eslöv.
- **Johnson Controls** acquires Delphi's global automotive battery business.
- **Sovema** acquires Accuma Engineering.

2006

- **Daramic** expands into China by forming a joint venture. The following year it acquires a plant in Tianjin, China.

- After an 18-month hiatus **Batteries International** is relaunched by new owner and life-long journalist Michael Halls.

- **Trojan Battery** breaks ground on new plant in Sandersville, Georgia.

- **Johnson Controls** and **Saft** agree to collaborate in a venture that falls apart acrimoniously five years later over "a fundamental disagreement" about the direction and scope of the JV.

2007

- Separator firm **ENTEK** sold to its senior manufacturing team.

- **Spectrum/Rayovac** reorganize in hunt for profitability.

- The race into China heats up. **Johnson Controls** forms a joint venture with China's Fengfan to make sealed lead acid batteries. This is the start of

a huge investment made into the People's Republic in future years, including troubled relations with government agencies in the early 2010s.

- European Chemicals Agency announces **REACH** requirements as previous EU directives are bound into the one legislation.

2008

- **Sovema**, Italian battery machine manufacturer, acquires **Bitrode Corp**, a leading manufacturer of battery testing equipment. It marks the first major move into the US market.

- Greek battery giant **Sunlight** makes €50m investment in lead recycling plant.

- **GS Yuasa** forms Thailand joint venture with Siam Motors.

- Polypore International, owner of separator giant **Daramic**, acquires **Microporous**. It would take five years for the US Federal Trade Commission to rule that the acquisition had been uncompetitive.

- Scott Fink and Taro Yoshimura become presidents of **Sorfin Yoshimura NY** and Tokyo respectively and transformation to the second generation formally takes place.

2009

- **Zesar** launches **EVOLINE**, low cost, high performance assembly line. The product is first fruit of involvement in 3D computer aided design work.

- **Eternity Technologies** is founded as part of Al Dobowi Group. It is based in Ras Al Khaimah in the United Arab Emirates and is the region's first modern battery manufacturer.

2010

- **Firefly Energy**, developer of an advanced lead battery, files for bankruptcy but is bought by Indian firm later that year.

Although it announced a distribution agreement in Australia three years later little has been heard of it since.

2011

- David Wilson, head of the **International Lead Association**, steps down after 35 years. He leaves ILA work fully in 2016. Incoming managing director is Andy Bush.

- **Sovema** moves into the lithium

business with creation of business unit called Solith.

- Birth of **SY Europe** focuses on growing sales, marketing and logistics competency in the EMEA region. This is followed by SY Brasil and SY India regional offices (2014) and SY Thailand (2015).

- **EnerSys** hits the acquisition trail, once more acquiring **ABSL Power Solutions** (2011), **Ergon Batteries** (2011), **GAIA Akkumulatorenwerke** (2011), **EnerSystems** (2011), **Energy Leader Batteries** (2q012), **Purcell Systems** (2013), **UTS Holdings** (2014), **ICS** (2015), **Enser** (2016), **Alpha Technologies** (2018), and **Northstar Battery Company** (2019).

- **Daramic India** relocates to new, larger facility in Bangalore, India. It had been acquired in 2008.

- **Penox** makes first move into Asia and sets up commercial branch in South Korea. By 2015 the firm is producing and selling high grade lead oxides to Asia. In 2017 Penox acquires all the shares of Penox Korea.

- **Daramic** establishes Xiangyang, China plant.

- **Johnson Controls** forms a joint venture with Colombia's MAC.

2012

- **Johnson Power Solutions** opens its first US battery recycling centre in Florence, South Carolina.

- **Emerson** completes acquisition of **Chloride Group**, the end of one of the most famous brands in lead battery history but one that had lost its way a quarter of a century before.

- **Exide Technologies'** recycling plant in Frisco, Texas is closed, followed by Vernon, California the year after. The issue of lead contamination of the surrounding areas continued to be a problem for Exide until it was sold this year. It also closes its plant in New Zealand.

2013

- **Exide Technologies** files for bankruptcy protection a second time. As with first Chapter 11, it will take two years before it is able to trade again.

- After 22 years of struggling, bipolar start-up **Atraverda** goes into receivership.

- At the end of the year Seven Mile Capital Partners buys **Microporous** from **Polypore/Daramic** for \$120 million. A new management team is set up early in 2014.

- Charlesbank Capital Partners makes initial investment in **Trojan Battery**. The firm had been in the Godber family since its foundation in 1925.

- **Ador Digatron** joint venture goes ahead between German headquartered Digatron and Ador, a well respected Indian firm and a further move by Digatron to expand its presence in Asia.

- **Hammond** releases K2 range of expanders, offering a step change in lead acid battery performance, particularly in terms of cyclability in partial state of charge and offering performance benefits that can be adjusted to varying temperature ranges and demands. Initially most suited for stop-start and micro-hybrid applications.

- **Atomized Products Group** sets up new \$4.3 million operation in Chesapeake in US state of Virginia.

- South Africa's **Metair** buys 100% of Turkey's **Mutlu Holding** and a 75% stake in **Mutlu Akü**, the lead battery maker. It was already lining up taking a stake in German battery manufacturer Moll (2015), which gives it a part stake in Chaowei, a Chinese battery firm.

2014

- **Aqua Metals** demonstrates a novel way of recycling lead acid batteries without the use of smelting. Commercialization of the technology stalls later on. After the initial public offering peak of \$21 a share, the price trades close to \$1.

2015

- **Zesar** invests in new factory in Manisa, near Turkey's port city of Izmir. Later expanded to another factory. Plans are to double the firm's manufacturing area to 10,000m².

- **GS Yuasa** acquires Turkish battery firm and boosts stake in Malaysia, expands further in Indonesia.

- **C&D Technologies'** CEO plans revamp aimed to restore lead battery reputation the firm had in the 1990s and 2000s.

- **ALABC** restructuring approved by its members and **ILA**.

- Bipolar batteries make a spectacular return to the limelight with two firms, in particular **Advanced Battery Concepts** and **Gridtential**, providing viable alternatives to regular lead batteries.

- **ABC develops GreenSeal** technology, a full suite of patented technologies and simplified production processes, to enable the construction of reduced lead content, high performance, lower cost lead batteries in existing formats for today's and newly enabled future markets. Commercial adoption follows.

- **Gridtential** introduces its Silicon Joule technology. This is a substrate that replaces the grid in a battery, resulting in a large reduction in the amount of lead required and better performance. Like ABC's bipolar batteries most of the regular production of the battery can be built on existing plate-making lines, modified assembly lines and existing formation/finishing lines.

- **Asahi Kasei** acquires Polypore International, the parent company to Daramic and affiliates.

- Death of **DeLight Breidegam**, charismatic founder of East Penn Manufacturing and creator of largest family owned battery business in the US.

2016

- Tactical tax reasons are involved in the creation of **Johnson Controls International** based in Ireland and formed through a merger of Johnson Controls and Tyco International.

- Four lead association bodies **BCI**, **ILA**, **EUROBAT** and **ABR** agree to kickstart a global pro-lead battery campaign. This is the first attempt at full coordination between the organizations.

- End of a legend. **Ann Noll**, one of the great institutions of Battery Council International, retires after 37 years with the council. Greatly missed by North American battery firms as well as worldwide.

- **BCI** launches innovation award. **Hammond** wins award for further development of its K2 range of expanders and opening up its E=MC2 laboratory to serve the battery industry.

- **Cellusuede** moves into new base and 125,000sq ft factory at Rockford in US state of Illinois.

- **Ecoult**, the East Penn subsidiary,

installs UltraBattery in smart grid test bed in Dublin.

- Founder of ALABC **Michael Mayer** dies.

- A watershed moment for lead battery research when **Argonne National Laboratory**, **RSR Technologies** and **East Penn Manufacturing** agree to work together under a standard US government cooperative research and development agreement.

RSR and East Penn to use Argonne's state-of-the-art analytic technologies to accelerate lead battery research. These same technologies have already been used by lithium battery researchers in previous years.

Tests undertaken will investigate the fundamental transport processes in lead batteries, using a variety of characterization techniques available at Argonne.

Scientists at Argonne who will be assigned to the project have extensive experience in synchrotron X-ray techniques, in particular for characterizing materials under controlled electrochemical conditions.

2017

- **ENTEK International**, battery separator designer and producer, signs an agreement with Separindo, the Indonesia-based polyethylene battery separator producer and Japanese glass company NSG Group, to make and sell PE separators across Asia. Breaks ground on new plant for this in 2019.

- **BCI** leads the way with pushing for lower blood lead levels for workers in battery plant.

- **Doe Run** announces plans to expand lead mining on back of higher lead prices.

- **Monbat** buys Italian recycling firm Piombifera Italiana.

- **Penox** opens new product development centre in Germany.

- Chinese e-bike lead battery maker **Danneng Power International** expands output with \$870m sales.

- **BM Rosendahl** opens development centre.

- EC fines lead cartel Recyclex, Campine, Ecobat Technologies for fixing lead prices.

- **Exide Industries** opens \$100m plant in Bengal.

- **Belectric**, a UK lead acid/lithium battery firm, is bought by German utility Innogy SE (previously RWE).

- **Black Diamond Structures** opens battery testing for nanomaterials technology facility in Texas.

- **Exide Technologies** waives the right to use Exide brand name in perpetuity to Indian battery giant Exide Industries. This follows a 20-year dispute over the issue.

- Death of **Detchko Pavlov**, Bulgarian academician and probably the greatest expert on the lead battery that has ever lived. Over his lifetime his research contributed to much of our present understanding of how lead batteries work. He is particularly remembered for the generosity of spirit in sharing this knowledge around the world.

- **Daramic** greenfield plant in Gujarat, India finished and operational.

- **NorthStar** wins BCI award for its remote monitoring technology. This allows battery users to review the battery's health and status at any time from anywhere. The embedded battery sensor communicates with both site technicians and power systems to ensure correct installation and settings. The device was launched for the telecom sector, but will be expanded to new segments.

2018

- **Batek Makina** opens 43,000 sq ft plant in Dilovasi in Turkey.

- **Furukuwa Battery** partners Vietnam's **Pinaco** in UltraBattery manufacturing deal. Furukuwa already had operations in China, India, Indonesia and Thailand.

- **C&D Technologies**, a portfolio company of KPS Capital Partners, acquires **Trojan Battery Company**.

- Proposal for new body to replace ALABC mooted at Vienna ELBC. **The Consortium for Battery Innovation** emerged the following year.

- **SY Innovations** formed, designed to support SY Group and explore new markets, products and sales/marketing techniques.

- **Gridtential** wins BCI award for its bipolar battery solution but automation problems on the production line dog adoption despite backing from well-known battery manufacturers.

- Chinese battery firm **Leoch** makes undisclosed investment in UK firm **DBS Energy**.

- **Hollingsworth and Vose** invested in capacity expansion in raw material and global separator production to support the AGM market.

- **Duracell** unveils new lead battery, citing cost benefits against lithium.

- Solar power company **Mobisol** partners African lead battery firms for storage component to its offering.

- Canada's **Discover Energy** buys Korean lead manufacturing business **iQ Power Asia**.

- India's **Exide Industries** moves into lithium with **Leclanché** in joint venture.

- Innovative New Zealand lead battery pioneer **ArcActive** partners **East Penn**.

- **Amara Raja, Gravita** sign recycling deal. **JCI**, which has worked with Amara Raja for 20 years, formalized an agreement between the two this year.

- **Narada** inaugurates first of five grid-scale lead carbon ESS in Germany.

- **EnerSys** buys Canada's **Alpha Technologies** for \$750m in push into energy storage markets.

- Korean lead battery maker **AtlasBX** gets go-ahead to build lead battery plant in US.

- **Trojan Battery** sold to **C&D Technologies** as last remaining link with Godber family cut.

2019

- **RSR Technologies** wins BCI award with possibly the most important advance in lead research this side of the century.

RSR, working with East Penn Manufacturing and the US Argonne National Laboratory, used Argonne's Advanced Photon Source synchrotron to look at, in real time, the crystallization of lead plates at the atomic level during the charging and discharging process.

The results of the research enable the firm to develop its alloy, known as Supersoft-Hycycle, which enhances lead battery performance.

Tim Ellis, president of RSR Technologies, said: "With this we can compete and win against lithium in many applications with higher performance."

"The work at Argonne has helped us understand the physical processes taking place in real time inside batteries to develop higher performance advanced lead batteries. Our Supersoft-Hycycle lead really improves cycle life as validated by many of our customers, especially in higher temperature and extreme operating conditions."

The alloy is already being used by South African battery firm **Auto-X**, the maker of the Willard brand of batteries.

- **Microporous** forms joint partnership with Chinese firm **Zisun**, the largest fully integrated producer of glass micro-fibres and media in Asia, allowing **Microporous** to add AGM separators to its product range.

- Specialist battery machine maker **Wirtz Manufacturing** invests in nickel-zinc battery maker **ZAF Energy Systems**.

- **Johnson Controls Power Solutions** — the former battery division of **JCI** bought by Brookfield Business Partners for \$13 billion — launched itself with the name **Clarios**.

- Lead batteries in India lose subsidies under new **FAME-II** regulations.

- **East Penn** takes stake in lithium battery maker **Navitas**.

- **Exide Industries** moves into e-rickshaw battery manufacturing.

- **Water Gremlin** moves back to full production after agency shut-down.

- **Upside Group** switches on 25MWh lead carbon system in Germany.

2020

- **Hammond Group** completes the first step to employee ownership.

- Covid-19 claims first lead battery insolvency victim, **Moll**, but outlook for the firm brightens later.

- **Exide Technologies** (and four subsidiaries) files for Chapter 11 bankruptcy protection to facilitate the sale of its North American assets. In July Exide sells its North American assets to **Atlas Holdings**.

- German formation firm using acid recirculation technology **Inbatec** and **Kustan** become equal and independent subsidiary of new firm **RedDotPlastics**.

- **ArcActive** wins BCI innovation award with technology to replace

negative battery electrode with non-woven carbon fabric that achieves high DCA with minimal loss. Later in the year ArcActive is very close to full commercialization of the product.

- Neutron diffraction is used for the first time in a project to improve lead battery performance, says **Consortium for Battery Innovation**. The project, launched in Spain under the CBI's technical programme, uses hi-tech neutron diffraction techniques to explore the fundamental processes that occur inside lead batteries as they charge and discharge.

Exide Technologies and the Institute of Materials Science of Aragon work with the CBI on the project.

"This project, the first to be launched in Europe, demonstrates the kind of cutting-edge research now being undertaken by the advanced lead battery industry," says CBI director Alistair Davidson.

"Neutron diffraction probes deeper than X-rays and can provide another perspective into improving the performance of lead batteries. The analysis we're conducting in Spain will help us develop new high-performing lead batteries."

- The International Lead and Zinc Study Group says global demand for lead will fall by 6.5% to 11.4 million tonnes in 2020 because of the drop in car production, with the biggest drop in lead use in Europe, with a 9.7% fall. In July 2021, Wood Mackenzie predicts lead demand will surge again as the batteries sitting idle in vehicles during lockdowns need replacing. The analysts predict a 6% leap in demand for lead for that purpose in 2021.

- The most significant EU legislation on batteries since 2006 is launched in December. It is largely met with approval from lead battery industry associations, even though they do warn against over regulation and complexity. EUROBAT calls it 'a crucial piece of legislation that will define our industry for the next 15 years'. It should come into force in January 2022.

- Separator firm Daramic marks its 90th anniversary.

2021

- The Vernon lead battery recycling saga rolls on, with the California Department of Toxic Substances Control filing a sweeping court action against major battery firms for the cost of the clean-up of the former Exide Technologies site. Clarios, Trojan Battery and

Quemetco are among the defendants listed on the court documents. One of the defendants, NL Industries, launches a countersuit in August, claiming there is evidence that the soil contamination near the former site is not because of Exide's operations.

- A white paper is published by the World Economic Forum, Pure Earth, the ILA and the Responsible Battery Coalition to address the 'safe and environmentally responsible management of LAB recycling'. It comes five months after a damning report by Pure Earth and Unicef, that claims lead poisoning is more widespread than documented.

- US president Joe Biden gives a specific mention to the battery industry in the 'Build Back Better Recovery Plan', which industry leaders hail as a boost to their sector.

- India lead battery giant Amara Raja says it will begin work on developing lithium-ion battery cells in February. In April the company is hit with a shut-down order for polluting air and causing high blood lead levels in employees in Andhra Pradesh. However following appeals to the high court, a stay of execution is issued. In June, Clarios sells 10% of its 24% stake in Amara Raja, causing shares to tumble. Later that month, the firm announced a new chairman, Jayadav Galla, son of outgoing founder Ramachandra Galla.

- CBI, Hammond and East Penn launch a research project into how lead-acid batteries can compete with other chemistries to provide utilities with grid-scale storage. The research will focus on enhancing cycle life and performance using expanders in the batteries' electrodes.

- ILZDA demands that proper procedures are implemented to deal with ULABs in a country dogged by informal recycling practices that pose a danger to health and the environment.

- Moll Batterien, one of Europe's best-known family lead-acid battery businesses, is taken over by a consortium of investors led by the CEO of BAE Holding, Jan Ijspeert, who is also the CEO of BAE Batterien. Moll had been struggling because of coronavirus lockdowns, which had forced the firm to file for insolvency a year before.

- East Penn CEO Chris Pruitt becomes new president of BCI, as term of office ends for EnerSys CEO Dave Shaffer.

- BCI achieves a major victory as lead-acid batteries are removed from the

DTSC danger list of potential 'Priority Products', which could have had huge implications for lead batteries and their use.

- Separator firm ENTEK announces the purchase of NSG Group's battery separator division, which will result in ENTEK becoming the first firm to make separators in all three primary battery technologies. The deal is finalized in September. In June, the firm signs an MoU with gigafactory builder Britishvolt, which means separators will eventually be produced in the UK right next to the production line.

- Bulgarian lead-acid and lithium battery maker Monbat agrees a deal to buy 60% of Tunisian battery firm Nour, saying the transaction is in line with objectives to set up production in North Africa and the Middle East.

- The world's largest lead battery manufacturer, Clarios, signals its intent to go public with the submission of a draft registration statement for a proposed Initial Public Offering. Just two months later, in July, Clarios pulled out, citing market volatility.

- Greek lead and lithium battery maker Systems Sunlight says in June it will expand in the US with a series of mergers and acquisitions over the next two years. Its first step, it says, will be to open the firm's first lead and lithium battery assembly hub in the US.

- Japanese materials producer Showa Denko says it will sell its lead-acid battery operations to investment fund Advantage Partners and financial services company Tokyo Century. Market opinion is divided over the sale's significance to the larger battery industry.

- US Congress approves a \$7 billion boost for battery makers and recyclers in package of infrastructure measures which has been approved partly thanks to work by Battery Council International and its members.

- India opens doors for more than 50GWh of energy storage, putting up billions of dollars for tenders and incentives.

- The first in-person BCI convention since 2019 is held in San Diego in September with new president Chris Pruitt voicing confidence in the industry. David Weinberg and Howard Meyers are presented with Distinguished Service Awards, and Hammond Group wins the Innovation Award for the second time. ■



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