SAFT international magazine

The magazine for Saft's customers and partners

JUNE 2017
#36

Le Bourget: a century of innovation

ATR 42-600
Amakusa Airlines

The new age of space exploration

Three battery technologies that could power our future

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Ghislain Lescuyer,
CEO

The sky's no longer the limit!

Welcome to this special edition of Saft International Magazine. This is the first time we are dedicating an entire edition to a specific sector. This aerospace edition is to celebrate Saft's long association with the aviation and space industries, and especially with the Paris Air Show.

In the 1930s, seaplanes were used to deliver airmail from France to South America, relying on Saft batteries for engine starting and other critical functions. Today, email is delivered using satellite communications powered by Saft batteries. As mankind has evolved and innovated since the dawn of flight, so too has Saft. Today Saft equips 80% of commercial airliners as well as many business jets and military aircraft.

We've also been innovating since the dawn of the Space Age. Over 50 years ago, on 17th February 1966, our battery launched into space powering the Diapason 1A, a small cylindrical satellite, 20 cm long and 50 cm in diameter used for taking measurements of the earth. Today, there are 200 satellites in orbit powered by Saft lithium-ion batteries, known for their performance, long life and reliability.

The first Paris air show was held in 1909, just a few years before Saft came into being. We can trace our participation back to at least 1959. We're very proud to exhibit at the show and we will continue to showcase our technology innovations there for years to come. Here's wishing the show – and all our aviation and space customers and partners – a long and successful future.

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Success in Japan

Saft receives the "Product/Service of the Year" Award from the French Chamber of Commerce & Industry in Japan

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During the 6th edition of the French Business Awards, Saft Japan received the best "Product/Service of the Year" Award from the French Chamber of Commerce & Industry in Japan. The award recognizes Saft's high technology batteries designed for industry markets.

"Last year Saft established its own subsidiary in Tokyo. Our goal is to strengthen our leadership position in Japan with an increased focus on transportation, telecom and grid, as well as civil electronics markets. But most of all we want to be more responsive to the needs of our Japanese customers," said Satoshi Okuyama, Saft Japan Sales Manager.

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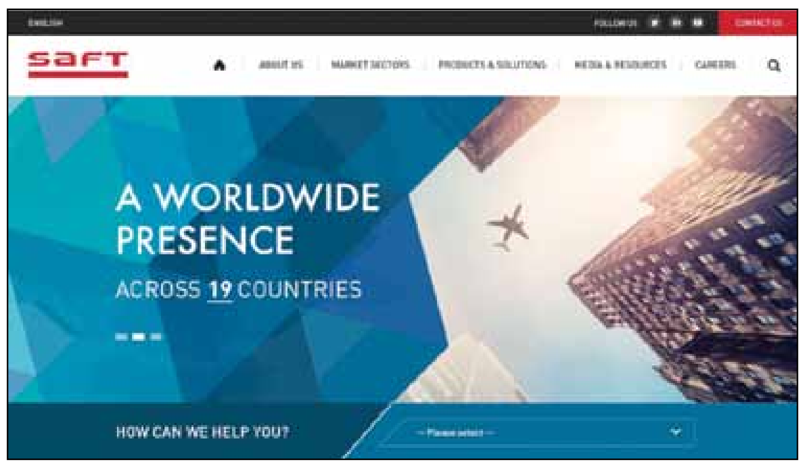
Brand new look for a brand new website

Saft has a brand new website designed with you in mind. We've worked hard on the user journey, making it easier for you to find what you're looking for, with multiple routes to product and market sector information. We also want to make it easier for you to get in touch with us – you'll find contact points all over the site.
Our new website contains lots of stories about how Saft's batteries and systems make a difference in today's world. We hope you'll enjoy them.

Our web address remains the same:
www.saftbatteries.com



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Sharing results from our magazine survey

Thanks to our 100 customers and partners for sharing their views on our last Saft International Magazine edition. While 70% of you enjoy reading our magazine, a majority wants more details on battery technologies and their future applications. You're also keen on reading more articles on your own sector. We have listened to you! This issue is dedicated to aerospace and we've added articles on our new battery technologies. We will continue our efforts to improve in future issues.
Congratulations to Eloi Klein from Thales Alenia Space who was the lucky winner of our prize, an iPad Pro.

Safety first within Saft

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How do you get workers to improve safety in a 100-year-old company with a good record? It's a program that Gilles Tardivo, leader of Saft's World Class team for continuous improvement, has launched. "I have a challenging new target this year to improve Saft's Total Recordable Incident Rate, or TRIR, a metric used for the number of recorded incidents per million hours worked." Everyone recognizes and understands the importance of continuous improvement with regard to Health & Safety.

The first priority is to increase the sharing of information between Saft's 14 different manufacturing sites and more than 4,000 employees. Up to now each site has operated its safety operations largely in isolation, but in January Gilles Tardivo started to bring all the safety experts together. There is also a chat group using an internal social network.

In addition, Gilles Tardivo is leading a review of safety at all Saft's manufacturing sites in partnership with an external expert. They have already identified six risks that represent most of Saft's incidents – including tripping, heavy lifting and machine operation. From the review, action plans have been drawn up and implemented on each site.
Since July 2016, Saft is a wholly-owned subsidiary of Total and is making use of Total's 12 Golden Rules, applying to everything from protective equipment to change management.

Saft also had its first company-wide Safety Week in April, when employees at 17 locations around the world organized events focused on increasing awareness and improving safety.

New Incubator Director

Nicolas Evanno joined Saft's Bordeaux incubator at the end of 2016. He started his career at the National Physical Laboratory in the UK and held several research and innovation leading roles in the aviation and space and defense divisions at Rolls Royce.

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Arnaud Boissières #10 on the Vendée Globe

@caliboissieres

Arnaud Boissières made it to the top! He crossed the finish line of the eighth Vendée Globe round-the-world sailing race at 8:26 AM on February 17th and earned an excellent tenth place. Arnaud and Armel Le Cléac'h, the winner of the Vendée Globe, were the only two solo racers to complete three Vendée Globe races in a row.

Saft batteries have kept their promises. They have played their part in powering all the onboard electronics for three months while withstanding the oceanic extreme conditions.

"Today is a day for sharing. For me and all those who have supported me since the start, that's a huge victory. When things weren't going well, I kept thinking of these people" said Arnaud once arrived. Congratulations to our favorite skipper!

LE BOURGET

Le Bourget: a century of innovation

Every two years the aviation world shows off its latest innovations at the Paris Air Show at Le Bourget. And for Saft's team, it's a highlight of the calendar.

The sleek, dart-shaped Concorde made its first public appearance at the International Paris Air Show in 1969, roaring into the air under the power of four large Rolls-Royce engines.
The supersonic airliner, which used a Saft battery to start the engines and to provide emergency backup power, became a popular Paris air show attraction.

1969: a landmark year for commercial aviation

The Paris Air Show began as the Aero Exhibition at the Grand Palais, Paris in 1909. It moved to Le Bourget in 1953, where Saft has exhibited for more than 60 years.

That 1969 show was notable not just for the Concorde appearance. The Boeing 747 also made its public debut that year – and it too is powered by a Saft battery. And the show saw the signing of the agreement that led to the creation of Airbus, which has become a commercial aviation giant.

Memories of Saft at Le Bourget

Bernard Weber, former commercial aviation director at Saft, was at Le Bourget in 2005 when Airbus showed off its 'superjumbo', the A380. He says: *"The first flight of the A380, which had a Saft battery in it, was something everyone wanted to see. All the booths were deserted when it was flying."*

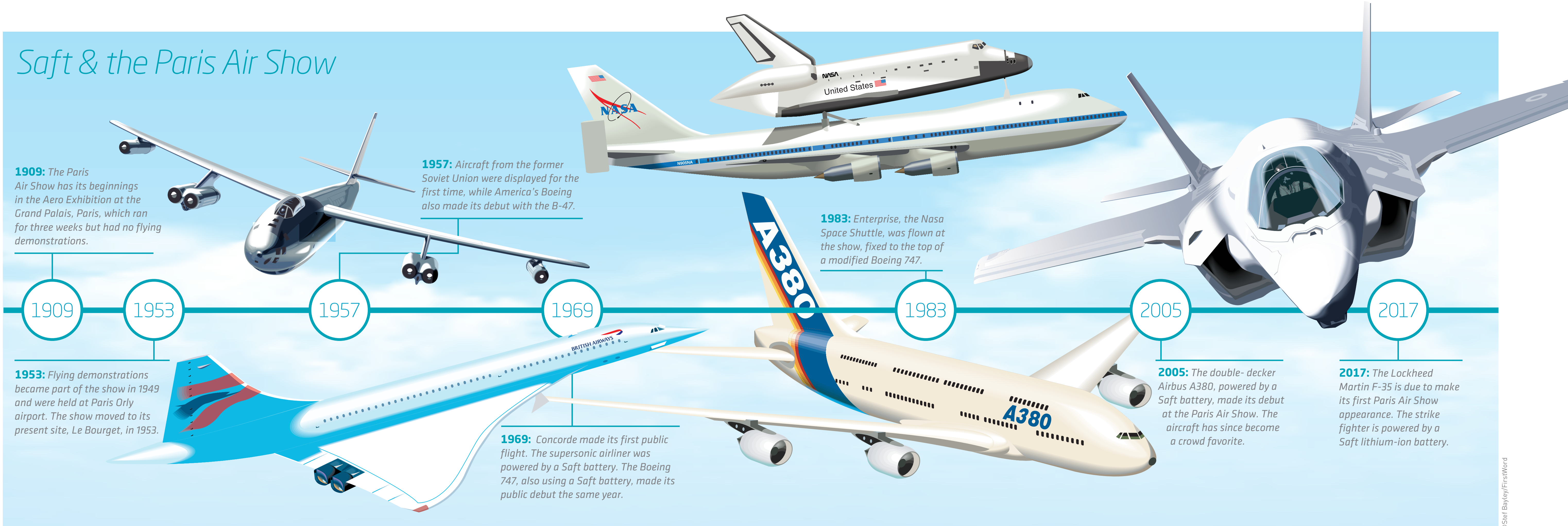
Posters of 1951 - 1953 - 1955

Mr Weber, now retired, first went to the Paris Air Show in 1973, when Saft had a small booth of around 10m². This year, Saft's stand will fill 60m² and feature the battery for the ExoMars Rover, due to be launched in 2020.

A fighter's first appearance

This year is expected to see the first appearance by the Lockheed Martin F-35, the multi-role fighter plane and one of the first aircraft to be powered by a lithium-ion battery.

Antoine Brenier, who took over in 2014 from Mr Weber as Saft's aviation director, says: *"Today, Saft is working with all the major aviation manufacturers in the world. We are excited by the innovations in lithium-ion batteries, which are making it possible for more functions on the aircraft to be handled electrically."*
A lot has changed since Concorde first wowed the Paris crowds, but Le Bourget remains the unmissable center of the air-show calendar.



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ATR regional airliners upgrade to ULM® batteries

Saft's ULM (Ultra Low Maintenance) nickel-based batteries are now the technology of choice for commercial aircraft where they support a range of functions, including providing safe and reliable power to start the APU (Auxiliary Power Unit) as well as emergency backup for critical systems. For OEMs, they offer the ideal combination of high performance and low weight. While for operators the ULM design ensures extended maintenance intervals that enable significant reductions in the total cost of ownership (TCO).

Saft has been the onboard battery partner for ATR's regional turboprop airliners since they entered service in the 1980s.

Saft has been the onboard battery partner for ATR's regional turboprop airliners since they entered service in the 1980s. Our batteries are installed on some 1,300 aircraft and have clocked up over 30 million flight hours. ATR will further extend this relationship by upgrading to Saft's new generation ULM batteries for all its ATR 42 and 72 aircraft - between 80 to 100 aircraft a year.

Each aircraft will be equipped with two 24 volt batteries – a 44 Ah main battery and a 17 Ah emergency battery. The Saft batteries fitted since the aircraft first entered service have delivered exceptional performance and a long service life of around eight years. With the upgrade to ULM, ATR 42 and 72 fleet operators will be able to reduce their maintenance costs by at least a dollar for each flight hour while saving more than one kilogram of weight compared with the existing batteries.

ATR is a French-Italian aircraft manufacturer founded in 1981 as an equal partnership between Airbus and Leonardo. It is the world leader for regional aircraft in the below 90 seats category and the company has equipped the fleets of around 200 airlines in 100 countries.

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What happens when an airliner loses engine power?

Miracle on the Hudson: a great pilot and ground support

In 2009, Chesley Sullenberger was able to land his Airbus A320 on the Hudson river on the east side of Manhattan after birdstrike caused both engines to fail shortly after takeoff from LaGuardia airport, New York.

Batteries step in when jets fail

Many of the systems required to safely land an airplane, including in an emergency condition, rely on electrical power. This was exactly the case experienced by Flight 1549's Captain Sullenberger, after the dual engine loss. Saft batteries started the auxiliary power unit that day and help the aircraft to land safely.

FEATURE STORY

What happens when an airliner loses engine power?

Every nervous flyer has probably gazed out of the window and wondered what would happen if those enormous engines stopped working. The reality is less worrying than you might think.

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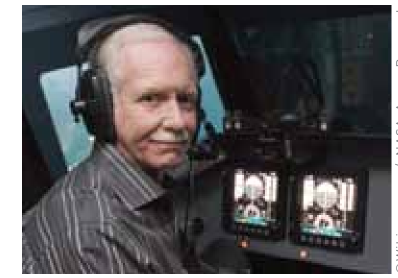

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Captain Sullenberger

Flying in a modern commercial jet has become an unremarkable experience. Routine. Extremely rarely, though, circumstances might just conspire to make all that training and safety backup equipment worthwhile.

The overwhelming majority of pilots go through their entire careers without experiencing a dual flameout: both engines cutting out at the same time and leaving the aircraft gliding – still flying forward at great speed but no longer propelled by jet power. John Denker's comprehensive flying manual *See How It Flies* is clear on what the cockpit crew should do: *"The first step in dealing with any in-flight emergency is always the same: fly the airplane."*[1]

No matter what, the pilot must stay calm and in control. A flameout like this might be rare but it has been anticipated and planned for and a skilled pilot can take an aeroplane without engines and land it safely with minimal injury to the passengers.

Miracle on the Hudson: a great pilot and ground support

In 2009, Chesley Sullenberger was able to land his Airbus A320 on the Hudson river on the east side of Manhattan after birdstrike caused both engines to fail shortly after takeoff from LaGuardia airport, New York.[2]

Having lost all engine power and losing what little altitude he had, Captain Sullenberger stayed in constant contact with air traffic controllers in an attempt to find somewhere safe to land. He knew he wouldn't get back to LaGuardia and considered using the smaller runway at Teterboro in New Jersey before ruling that out and opting to ditch in the river.[3]

US Airways Flight 1549 had not reached sufficient airspeed to attempt a restart of the engines and one of them was on fire, so ditching was the only option. Roughly four minutes elapsed between the engine failure and the plane landing in the river. All 155 passengers and crew were saved by a combination of Captain Sullenberger's skill and composure and the prompt action of the emergency services, who rescued them from the wings of the floating plane.

"The first step in dealing with any in-flight emergency is always the same: fly the airplane."

Captain Sullenberger, interviewed shortly afterwards, said that realizing he had lost power from both engines was *"... the worst, sickening, pit-of-your-stomach, falling-through-the-floor feeling I've ever felt in my life. I knew immediately it was very bad. My initial reaction was one of disbelief: 'I can't believe this is happening. This doesn't happen to me'."*[4]

He knew he had to overcome that feeling to stay in control: *"The physiological reaction I had to this was strong, and I had to force myself to use my training and force calm on the situation."*

Batteries step in when jets fail

Many of the systems required to safely land an airplane, including in an emergency condition, rely on electrical power. This was exactly the case experienced by Flight 1549's Captain Sullenberger, after the dual engine loss.

All large aircraft use 28-volt batteries, either nickel-based or lithium-ion batteries, to accomplish tasks from starting the airplane engines to powering backup functions. In normal flight, the battery is recharged by the aircraft engines. In an emergency, the battery is the primary power source for radio communication with air traffic control, the instruments that give guidance and orientation information and the systems that control the airplane.

However, the battery does not fill this emergency role alone. The airplane may eventually rely on the auxiliary power unit (APU), which has to be started by the batteries and then ensures power generation, engine re-starting and cabin pressurization.

In its report on Flight 1549, the US National Transportation Safety Board said that Captain Sullenberger's decision to start the APU was *"critical because it improved the outcome of the ditching by ensuring that electrical power was available to the plane."*[5]

Without a powerful and reliable battery to start the APU, the risk to the plane would be much greater - and this is where Saft plays a vital role. In fact, eighty percent of commercial airliners rely on Saft batteries.

Without a powerful and reliable battery to start the APU, the risk to the plane would be much greater - and this is where Saft plays a vital role.

Thanks to a plane's electrical systems, losing engine power doesn't mean losing control, and a calm presence behind the controls can result in a safe glide to the ground. Whether jet powered or while gliding and powered by emergency batteries, as pilot Karlene Petitt said after another dual flameout that landed safely, this time over Singapore:
"Pilots never stop flying the plane, no matter what."[6]

[1] Dealing with emergencies – See How It Flies: www.av8n.com/how/htm/emerge.html

[2] US Airways pilot rejected emergency landings at two airports, The Guardian, 16 January 2009: www.theguardian.com/world/2009/jan/16/new-york-plane-crash-hudson-river-sullenberger-pilot

[3] FAA transcript of Hudson river plane landing, The Guardian, 5 February 2009: www.theguardian.com/world/2009/feb/05/us-airways-crash-transcript

[4] Miracle on the Hudson, CBS 60 Minutes: www.cbsnews.com/news/sully-miracle-on-the-hudson-60-minutes/

[5] US Airways Flight 1549 Accident Report, National Transportation Safety Board: www.ntsb.gov/investigations/AccidentReports/Reports/AAR1003.pdf

[6] We asked pilots what happens when a jet loses both its engines, Business Insider, 27 May 2015: http://uk.businessinsider.com/a-singapore-airlines-flight-836-lost-engine-mid-flight-2015-5

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A high flyer in Li-ion

Jean-Yves Clotes is the technical leader for the Airbus 350 lithium-ion (Li-ion) battery project within Saft. We had the opportunity to talk to him about all things in passenger aircraft.

How did you become an expert in Li-ion specifically for Aerospace?

I joined Saft just over a decade ago, originally working with the integration of Li-ion batteries in Bordeaux. At that time, I was working on batteries aimed at hybrid vehicles in the automotive market. I also spent a lot of time on site with customers, facilitating their tests of Li-ion batteries. In 2008, I joined a Saft R&D project focused on the development of 28 volt Li-ion batteries for the aerospace market. It was during this project that we came up with the proposal for the Airbus 350 battery, and I've been involved with the project ever since.

Today I am still based in Bordeaux where we have about 150 people working on aviation batteries. There was some serious competition to supply Airbus with its Li-ion batteries. The review process lasted about six months and we were very excited to be selected.

"Our Li-ion batteries are currently being used by 13 commercial airlines including Qatar Airways, Finnair and Asiana."

Tell us a little bit more about what your role entails.

I am responsible for running the team and all the engineering co-ordination in relation to the Li-ion battery project for the A350 aircraft.

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©Airbus S.A.S. 2011 - computer rendering by Fixion -GWLNSD

On a practical level that means creating and sticking to the timeline in order to reach specific milestones. Within this project we are working on the development of the battery itself (the Li-ion cells and mechanical elements), all related electronics, the casings for the batteries, along with maintenance plans and documentation.

Naturally, part of my role is to contribute to Saft's aircraft business as a whole. This means ensuring we are up to date with standards and regulation, that our technical skills are top rate and that we are always keeping an eye out for new configurations that might work for other customers.

What's so special about what Saft has to offer aircraft manufacturers?

A few of our firsts in Li-ion aircraft batteries include: integrating a silicon battery contactor, embedding a charger within the battery, and making this battery act as a No Break Power Transfer meaning that the power to the aircraft electrical loads is never interrupted.

Today, we hold the highest Design Assurance Level – DAL A to answer the tight aircraft industry safety requirements.

Why are aircraft manufacturers interested in Li-ion?

Li-ion batteries are lighter than traditional nickel-cadmium (Ni-Cd) batteries. They also have better energy and power-density. For the same, or even better performance, you can save 80 kg on the weight of an aircraft by adopting Li-ion technology. In this business, saving weight means cost savings for the airlines and lower CO_2 emissions.

"Today, we hold the highest Design Assurance Level – DAL A to answer the tight aircraft industry safety requirements."

In addition, there is less maintenance required for Li-ion batteries – service intervals can be extended to two years versus the six-monthly servicing required by Ni-Cd batteries. That presents a powerful case for optimized total cost of ownership (TCO).

And finally, Li-ion batteries enable the embedding of other electronics to facilitate additional services like remote condition monitoring.

Are there any aircraft using Li-ion batteries in the air?

Absolutely! We've produced close to 700 Li-ion batteries in our factories and they are currently being used by 13 commercial airlines including Qatar Airways, Finnair and Asiana. Li-ion batteries are also in use on close to 200 military aircraft.

Speaking of the future, what role will batteries play in electric aircraft?

There's no doubt that the evolution of aircraft will require more complex batteries with even higher performance. We are already seeing the trend to more electric aircraft as electrics replace hydraulics. And in the long term we will see electric-driven aircraft. That will require a step change in battery technology at the cell level to offer the required levels of energy density, combined with reliability and safety of course.

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MAKING THE DIFFERENCE | LOCKHEED MARTIN

Lockheed Martin sharpens weather predictions

Jeff Shook is the GOES Spacecraft Director at Lockheed Martin. His team, along with their industry partners, is responsible for the design, build, test and delivery - everything it takes to build the spacecraft bus, including the software, rocket engines, structure, battery and power systems.

The Geostationary Operational Environmental Satellites, or GOES spacecraft, have provided us with dependable weather forecasts for decades. Jeff Shook, the GOES Spacecraft Director at Lockheed Martin answers our questions about the newest generation, the GOES-R Series:

Q – What is the GOES-R program?

A – Powered with Saft's lithium-ion (Li-ion) VL48E cells, four new weather satellites in the GOES series are designed and built by Lockheed Martin, enabling more precise weather predictions.

Q – What have been some of the neatest technological advancements in the space industry you've seen?

A – After 33 years in the business, I've slowly watched spacecraft and weather satellite technologies evolve, enabling enhancements along the way. For the GOES-R program, advancements boil down to the ability to see clearly and "stare" at the earth at all times, day or night.

Nobody wants to be offline, so bandwidth is important to allow us to bring down the very high resolution data and information.

Also, power density and efficiency are more important than ever, and Saft's compact, high-power Li-ion batteries help free up weight and space, allowing my team to put supplementary features and bandwidth capabilities on-board.

Q – How will the on-board scientific equipment help us on earth?

A – We have three main types of equipment on board the GOES-R satellites to detect weather changes or interferences:

The Geostationary Lightning Mapper will help map or detect lightning over land and oceans, helping increase lead time with storms and the ability to get out of harm's way more quickly. Additionally, it will increase prediction accuracy.

The Solar Ultraviolet Imager will stare at the sun and look at it in ultraviolet spectrums, or different wavelengths of energy or light. It will scan for active regions on the sun to predict if high energy particles thrown from the sun are on track to come close enough to affect systems used on earth.

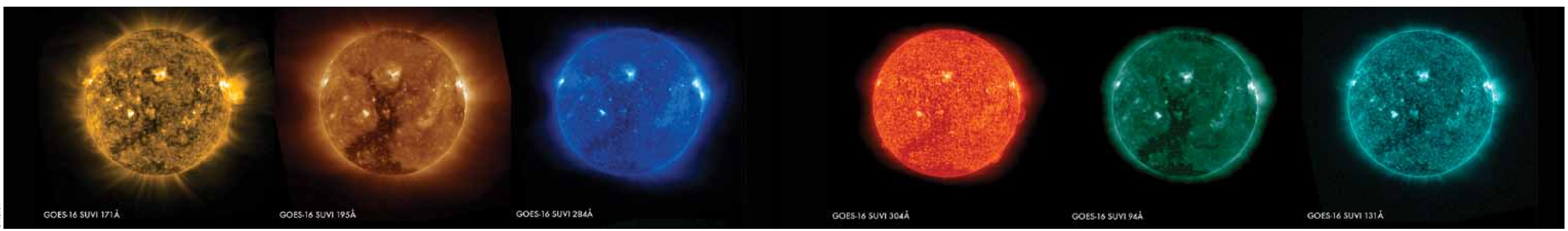
Subsequently, the Magnetometer will, for example, sense magnetic storms that could interfere with radio traffic frequency. This instrument confirms what the Solar Ultraviolet Imager predicts.

> GOES-R will transmit more data in its first six months of operation than all previous GOES weather satellites combined.

Q – What do you see coming in the future for satellite technology?

A – Personally, I think the scientific community will likely be continuing to examine ways to more closely watch the coastline, peer more into the oceans and watch changes in temperature currents, biology and ice packs to better inform our climate studies and models.

GOES-R Satellite Processing



These images of the sun were captured at the same time on January 29, 2017 by the six channels on the Solar Ultraviolet Imager or SUVI instrument aboard NOAA's GOES-16 satellite. Data from SUVI will provide an estimation of coronal plasma temperatures and emission measurements which are important to space weather forecasting.

INTO THE FUTURE | SPACE EXPLORATION

The new age of space exploration

From Mars rovers to moon hotels, the space programs being developed today will change our lives and reshape our understanding of the universe.

"I'd be very disappointed if we're not into space with a test flight by the end of the year," said Richard Branson in April 2017, when asked about the goals of his company, Virgin Galactic[1].

The serial entrepreneur is not alone in viewing space as the final frontier for business: Silicon Valley billionaires are pursuing everything from sub-orbital passenger jaunts to Mars colonization. In Asia, Japan's PD Aerospace and China's Kuang-Chi Science are exploring similar possibilities. Shuji Ogawa, CEO of PD Aerospace, said: *"Space tourism is a universal dream, not only for the Japanese but for all people."* [2]

Meanwhile, the world's space agencies are continuing their exploration missions. The International Space Station is a permanent orbital science lab and recent probes have landed on comets, navigated the surface of Mars and investigated Saturn's rings. This is perhaps the most exciting period for humankind's study of space for 40 years.

©ESA

The ExoMars Rover

To make these missions possible, spacecraft need robust, high performance, long life and reliable batteries that provide power in the most inhospitable conditions. Saft first made a battery for a satellite in 1966 and will be working on some of the biggest space programs of the coming years.

Uncovering the secrets of the universe

In 2020, the European Space Agency (ESA) will launch Euclid, on a six-year mission to learn more about dark energy and dark matter, which the ESA says, *"pose some of the most important questions in fundamental physics today"*.[3]

Euclid, which will conduct measurements that allow it, effectively, to see what the universe looked like 10 billion years ago, should help scientists to understand more about what dark energy and dark matter are and how they work.

> The first Saft battery to be used in a satellite was in 1966 and Saft batteries will power Euclid, the ExoMars Rover and CHEOPS, among other missions.

Also launching in 2020 is the ExoMars Rover, which will reach the Red Planet in 2021 and hunt for signs of life[4]. Next year, the ESA expects to launch CHEOPS (Characterizing Exoplanet Satellite), which will gather more information about the planets that we already know are orbiting distant stars.[5]

Space: the trendiest tourist destination

Amazon, the internet retailer, has plenty of experience in sending packages around the world, but its founder, Jeff Bezos, has set his sights on space. A rocket from his company, Blue Origin, will launch a satellite into geostationary orbit by 2022. Eventually, Blue Origin will take passengers.

"The long-term vision is millions of people living and working in space," Mr Bezos told a conference in March 2017. *The target, he said, is to "get to a place ultimately where it is much more like commercial airlines"*.[6]

As mentioned above, Blue Origin will face competition from the likes of Virgin Galactic, PD Aerospace and SpaceX. The biggest challenge remains safety: some early pioneers might be willing to accept a high level of risk, but a passenger service will not be in business for long without an impeccable safety record.

Powering the space race

Besides safety, consistency and reliability are vital for space missions – and that, of course, applies to the batteries that power them. *"Space batteries have to cope with extreme temperatures – anything from -20°C to +50°C,"* says Annie Sennet, executive vice president, Saft Space & Defense.

"They need to be able to withstand the vibrations at launch and, in some cases, the impact of landing. They must handle huge amounts of radiation and, of course, they cannot fail. Space batteries undergo three-to four-times as much testing as normal batteries."

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Satellites have batteries that are charged when sunlight is available and provide power when it isn't. Landers and probes require batteries that can stay dormant for a long time while the vehicle travels to its destination and then reliably provide power when it is needed.

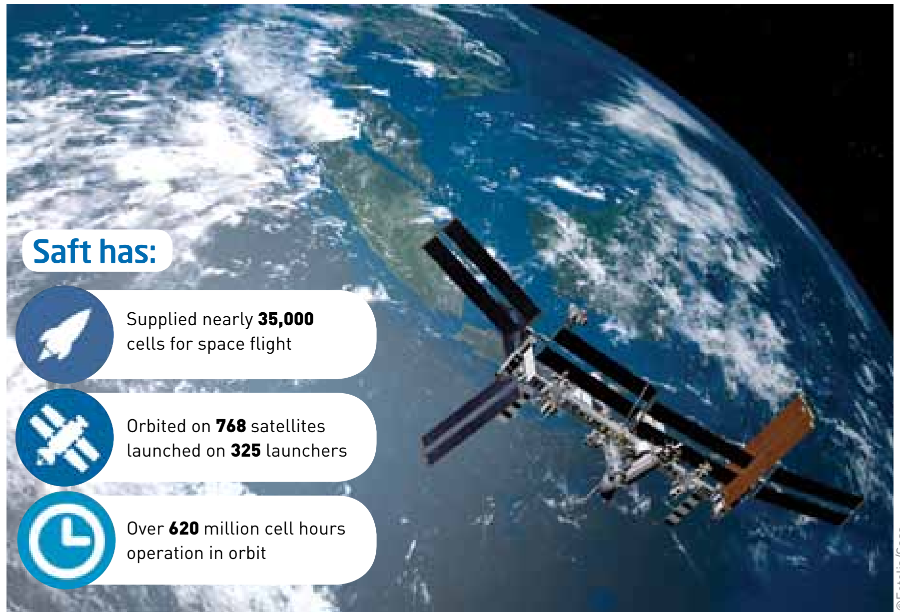
"The ExoMars Rover is a particular challenge," says Ms Sennet. *"The battery has to be completely sterile because we absolutely cannot introduce new bacteria to Mars. We always use a clean room for final battery assembly, but this battery is being put together in what is effectively a clean room within a clean room."*

The peak of the Space Age was in the 1960s, when humans first orbited the earth and landed on the Moon. By the 1990s, with less investment in space exploration, public excitement had waned. The retirement of Nasa's space shuttle in 2011 marked the end of an era.

However, human beings are not content to stay earthbound and the flurry of activity in recent years suggests the dawn of a new Space Age, one that aims to answer the deepest questions about our existence and allow many of us to become space travelers.

[1] www.telegraph.co.uk/business/ 2017/04/02/sir-richard-branson-vows-have-virgin-galactic-passengers-space/
[2] www.cnbc.com/2017/04/12/asias-space-tourism-players-arent-scared-of-spacex.html
[3] http://sci.esa.int/euclid/42267-science/
[4] http://exploration.esa.int/mars/
[5] http://cheops.unibe.ch/cheops-mission/executive-summary/
[6] http://news.eutelsat.com/pressreleases/eutelsat-signs-up-for-blue-origins-new-glenn-launcher-1845131

Taking space power to the next generation



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Yannick Borthomieu, Saft's Space and Defense Product Manager, sat down with Saft International Magazine editors to talk about the next generation of lithium-ion batteries for space.

Saft's trailblazing battery technologies have accelerated space exploration since 1966, first helping power the Diapason 1A satellite launch. More than 50 years later, our legacy of reliability in orbit continues at full force. In fact, Saft is the only battery manufacturer to supply all three battery technologies used in space, including nickel-based, primary lithium and lithium-ion (Li-ion).

To address the ever-evolving power demands of space missions, we developed our latest generation space battery cell, the VL 51ES, that delivers exceptional energy density. Containing specifically selected positive and negative electrode materials, this sixth-generation space cell can sustain 18-year life time missions. It is designed to power GEO[1] and MEO[2] space applications, LEO[3] satellites such as radars, and other high energy space applications.

The VL 51ES manufacturing process will be simpler, thus delivering cost savings and reducing the production time. The cell is the building block for the rest of the battery pack already qualified and flight proven with the previous cell generations. Uniquely, the VL 51ES is being developed and manufactured in both France and the United States, bringing together a global team of experts from various divisions.

> The new VL 51ES space cell can sustain 18-year life time missions.

We collaborate with customers throughout the entire process – from the cell chemistry development, electrode coating and manufacturing, to battery assembly, integration, testing and in-orbit support. To ensure the battery will provide energy for the full mission without failure we performed rigorous testing that simulates the harsh environment of outer space. The qualification process includes various environment testing conditions such as electrical, thermal vacuum, vibrations, accelerations, shocks and radiation. We provide customers with a thorough data package of all the qualification tests. The VL 51ES will be fully qualified in 2018.

As new space exploration endeavors take flight and satellite technologies continue to evolve, we look forward to working with customers to develop customized, state-of-the-art battery systems that provide unparalleled energy in orbit.

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[1] GEO: Geosynchronous Orbit
[2] MEO: Medium Elliptical Orbit
[3] LEO: Low Earth Orbit

A new incubator to energize the future of battery technology

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Just a short drive from Washington, DC,the United States' national defense epicenter, Saft has established a new incubator at its Cockeysville, Maryland facility. Its main mission is to bridge the gap between fundamental research and close-to-production prototyping.

> The incubator fosters collaboration across Saft's scientific community to ensure that our engineers are developing products that offer solutions to real world problems, more effectively and more quickly.

Staffed by a rotating team from Cockeysville's R&D, mechanical, electrical, and software engineering departments, the incubator touches on all industry segments and applications that Saft serves.

Work in progress includes advancing cell development by utilizing lithium manganese iron phosphate (LMFP). Compared to lithium-iron phosphate, this low-cost material promises increased energy density (operating time) without compromising on safety. Currently the team is working to improve the LMFP cycling life and power capability by optimizing electrode structure and electrolyte composition. With successful development Saft will be able to produce extremely safe cells (similar to iron phosphate today) without sacrificing energy density in comparison to traditional lithium-ion (Li-ion) chemistry based cells. Thus, answering the need for next-generation technology that brings higher performance, enhanced safety and advanced functionality.

The incubator fosters collaboration across Saft's scientific community to ensure that our engineers are developing products that offer solutions to real world problems, more effectively and more quickly. For instance, the electrical engineering team members designed and demonstrated a new module-monitoring circuit board that reduces size and cost by half, when compared to Saft's legacy electronics. The demonstration effort provided the confidence needed to propose the new electronics in a large defense project with critical space constraints.

Saft not only takes great pride in improving the future of battery technology, but also in the community's. In partnership with the University of Maryland, the Cockeysville incubator works with graduate students to learn about industry advancements and innovative technologies in tandem, collaborating on real-time projects, as well as cases from the students' coursework. These mutually beneficial partnerships allow our experts to explore new ideas and the students to gain real world experience.

Technological innovation is at Saft's core, and the Cockeysville incubator is an exceptional example of our pioneering efforts to further technology and commercial applications through new chemistries, and mechanical and electrical designs. With great pride in improving the industry, Saft is investing in research and innovation and will continue to develop next-generation battery systems for future applications.

"If you'd like to see what we're currently working on, or share insight into upcoming technology challenges you've identified within your own business, we'd love to hear from you," highlights Carine Margez the Cockeysville incubator leader.

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INNOVATION | RESEARCH

Three battery technologies that could power our future

The world needs more power, preferably in a form that's clean and renewable. Our energy-storage strategies are currently shaped by lithium-ion batteries - at the cutting edge of such technology - but what can we look forward to in years to come?

Let's begin with some battery basics. A battery is a pack of one or more cells, each of which has a positive electrode (the cathode), a negative electrode (the anode), a separator and an electrolyte. Using different chemicals and materials for these affects the properties of the battery – how much energy it can store and output, how much power it can provide or the number of times it can be discharged and recharged (also called cycling capacity).

Battery companies are constantly experimenting to find chemistries that are cheaper, denser, lighter and more powerful.

We spoke to Saft Research Director Patrick Bernard, who explained three new battery technologies with transformative potential.

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Saft Research Director, Patrick Bernard

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SODIUM-ION

What is it?

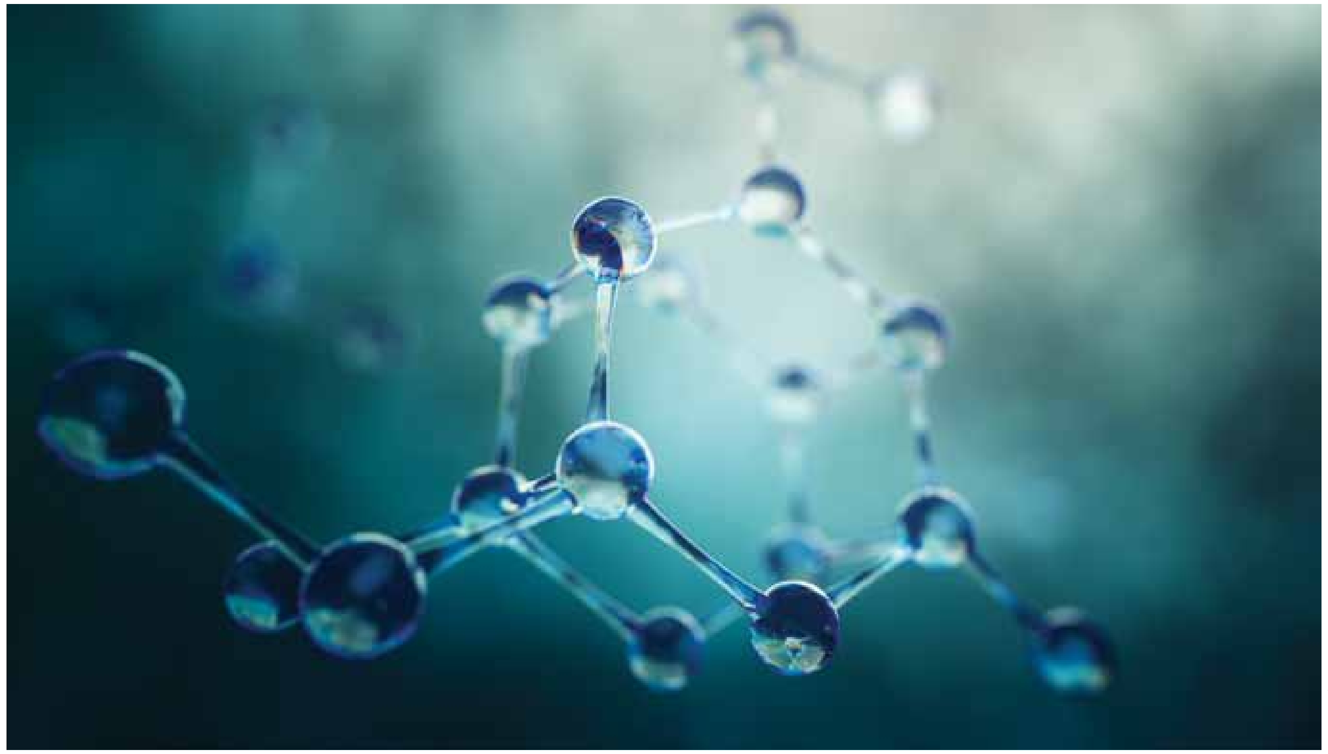
The way that sodium-ion (Na-ion) batteries work is similar to lithium-ion (Li-ion) batteries; as the name suggests, the main difference is the replacement of lithium by sodium. A variety of sodium-based materials can be used as the battery's positive electrode, which is decisive when it comes to performance - longer life or cycling capacity for example.

What are its advantages?

Na-ion batteries offer numerous advantages. The main one is that they are cheaper than Li-ion batteries (by up to 30 per cent per cell). However, this technology will not be able to compete with Li-ion in terms of energy density – neither by weight nor volume – and could only be used for stationary applications where this is not a major requirement. These might include storing excess electricity generated by renewable energy sources such as solar or wind power.

When can we expect it?

Many of the cell components and manufacturing processes are the same as for current Li-ion batteries. The main development is focused on electrode materials. Na-ion batteries might be ready to enter production in three to four years' time.



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LITHIUM-SULFUR

What is it?

In Li-ion batteries, the active materials are layered between the lithium ions in stable host structures during charge and discharge. In lithium-sulfur (Li-S) batteries, there are no host structures. While discharging, the lithium anode is consumed and sulfur transformed into a variety of chemical compounds; during charging, the reverse process takes place.

What are its advantages?

A Li-S battery uses very light active materials: sulfur in the positive electrode and metallic lithium as the negative electrode. This is why its theoretical energy density is extraordinarily high: four times greater than that of Li-ion. That makes it a good fit for the aviation and space industries.

When can we expect it?

Li-S technology needs further research and development work to improve its life expectancy and to continue to increase specific energy density. It is not expected to be ready for applications requiring long battery life for at least five years.

SOLID-STATE

What is it?

Solid-state batteries represent a paradigm shift in terms of technology. In modern Li-ion batteries, ions move from one electrode to another across the liquid electrolyte (also called ionic conductivity). In all-solid-state batteries, the liquid electrolyte is replaced by a solid compound which nevertheless allows lithium ions to migrate within it. This concept is far from new, but over the past 10 years – thanks to intensive worldwide research – new families of solid electrolytes have been discovered with very high ionic conductivity, similar to liquid electrolyte, allowing this particular technological barrier to be overcome.

What are its advantages?

The first huge advantage is a marked improvement in safety at cell and battery levels: inorganic solid electrolytes are non-flammable when heated, unlike their liquid counterparts. Second, it permits the use of innovative, high-voltage high-capacity materials, enabling denser, lighter batteries with improved safety performance and better shelf-life as a result of reduced self-discharge. As the batteries can exhibit a high power-to-weight ratio, they may be ideal for use in electric vehicles.

When can we expect it?

Several kinds of all-solid-state batteries are likely to come to market as technological progress continues. The first could be solid-state batteries with graphite-based anodes, bringing improved energy performance and safety. In time, lighter solid-state battery technologies using a metallic lithium anode should become commercially available.

We've got it covered

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