Application Note: Solid State Batteries for Automotive Applications

Introduction

Autonomous or smart transportation has gone from a concept to a fast-evolving reality in the space of just a few years. Studies predict a very high growth rate in the deployment of technologies in automotive applications, examples being:

- "*Smart Transportation Market Solutions worth $139Bn by 2020*" (Markets and Markets, 2015).
- "*22 billion sensors used in the automotive industry per year by 2020*" (Automotive Sensors, 2017).
- "*The automotive sector is the largest consumer of micro-controller systems, with a market estimated to be worth $27Bn by 2020*" (Grand View Research, 2015).

All aspects of transportation systems will be touched by these dramatic developments, not just cars, but also buses, parking systems, planes, trains, traffic management, trucks and, of course, all important safety systems. New devices are therefore seen as key to enabling Smart Transportation.

Modern cars already have up to 100 sensors and, with increased use of wireless systems such as Bluetooth LE, Wi-Fi & Cellular, more and more devices with added functionality are being developed. But such devices will often need new power sources in order to operate autonomously for long periods of time (circa 10 years). This is all the more important as cabling is now the third heaviest component (behind chassis and engine), averaging 100 kg (Automotive Sensors, 2017).

The enabling technology for deploying increased sensor numbers is distributed energy storage using Solid State Batteries (SSB) such as Ilika's Stereax®.

Automotive devices enhanced by solid state batteries

- *Rain sensor:*
  Stereax® SSB are moisture resistant and their small size enables ultra-thin sensors with solar energy harvesting, without cabling or bulky coin cells.
- *Key fobs:*
  Ultra-thin fobs may not allow space for coin cells. Can use mechanical impulse from pressing button to charge solid state battery.
- *Battery pack temperature control:*
  Stereax® SSB can be used at temperatures up to 100°C.
- *Exhaust sensors:*
  Stereax® SSB resistant to high temperatures; no cabling.
- *Pre-collision:*
  Ultra-thin sensors outside cars would not need cabling.

Use case: tyre pressure monitoring system

- Need for small energy source for Intelligent TPMS to replace coin cells which have insufficient low and high temperature performance.
- Current devices installed in the valve; new generation powered by Stereax® could be placed inside tyre for greater accuracy.
- These intelligent products could have added functionalities, e.g. temperature, radial acceleration, tangential acceleration, tread wear and tyre traceability.

Ilika Technologies Ltd, Kenneth Dibben House, Enterprise Road, University of Southampton Science Park, Chilworth, Southampton, SO16 7NS, UK

Tel: +44 (0)23 8011 1400 | Fax: +44 (0)23 8011 1401 | Email info@ilika.com | www.ilika.com | /ilika-plc | @ilikaplc

Typical system specifications:

Transmission rate	10 Hz
Battery dimensions	14x14x1 mm
Average consumption	130 µA
Operation when car is not on	2 h
UHF transmission	250 µW
Operating temperature	-40° to 100°C
Stereax SSB capacity	250 µAh
Energy source	Vibration
Battery expected life	10 years

Autonomous Vehicles / Smart Mobility

It is predicted there will be 10 million autonomous cars on the road by 2020 (BI Intelligence 2016). This will result in dramatic increases in the number of sensors per car to ensure the car:

- Knows where it is and where it is going (GPS, gyros, accelerometers).
- Can see where it is going (LIDAR: Light Detection and Ranging, 360°).
- Arrives safely (navigation, guidance, image-capture).

Battery requirements for Smart Vehicles

- Safe, with no thermal runaway and no flame.
- Industrial temperature range, e.g. -40°C to +85°C, with +100°C very desirable
- Small footprint and thin profile for integration.
- Life of product performance never change the battery.
- Extremely low self-discharge.
- No chemical leakage.
- Impervious to vibration and magnetic fields.
- Rechargeable thousands of times.

Stereax® advantages for automotive devices

- Ultra-thin profile.
- Various footprint shapes, including custom sizes.
- High energy density.
- Low self-discharge.
- Stereax patent pending SSB stacking adds capacity.
- No battery transportation issues.
- No product end-of-life disposal issues.
- Ability to withstand high temperatures.
- May be combined with supercapacitors for very low temperatures.

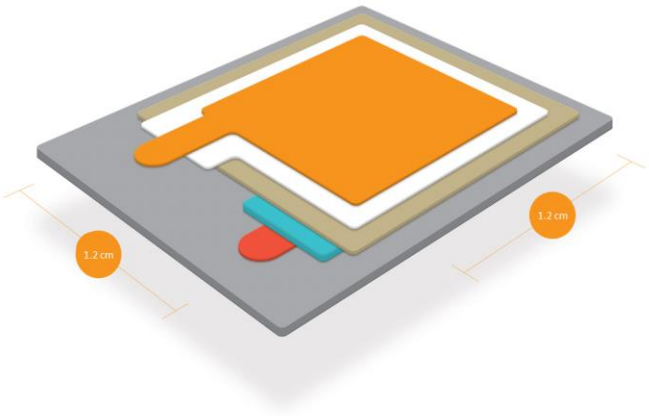

Figure 1:Graphic representation of 250 µAh Stereax® M250 solid state battery.

Figure 2: Photographic picture of 250 µAh Stereax® M250 solid state battery.