RESEARCH TO INDUSTRY CZZ Lech



## **ULTRASOUND INTERROGATION FOR BATTERY MONITORING ?(T21)**











Piezoelectric transducers for acoustic analysis placed on a smart phonebattery.

Non-destructive test (NDT) method;

• Study the propagation of acoustic waves throughout the battery's materials;

Acoustic waves interact with materials and interfaces.

# Why ?

What ?

• External setup, does not interfere with the normal operation Easy to put in place on any types of battery and battery cells

Detect materials density variations, discontinuities, defects, bubbles generation...



### **Example of results**

□ Significant evolution of the waveforms during cycling; □ High repeatability of the physical behavior, even during cycling at different C-rates.

Settimate SoC from physical variation of materials, independently of electrochemical parameters (U, I, Q)

# Time (s) ≥ 3.5 -2.5 0.5 Capacit

Example of the evolution of acoustic waves during cyclin at different rates of a 18650 battery.

### Main potential use:

- Formation process
- Optimal operation range (minimize stress)
- Detection of defects / Quality

#### **Advantages:**

- Output Description And A Construction And A Construction And A Construction And A Construction A Constructio operation (monitoring of the formation process, detection of defects or bubbles generation...).
- advanced BMS for better performance and safety
- Safety (abusive test, detect early signs)

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• External setup, does not interfere with the normal operation. • Easy to put in place on every type of battery (18650, LiPo, Pb-acid...).

### **Drawbacks**:

□ The development of the technique is underway... □ Variable sensitivity to different phenomena (to be evaluated).

#### Acoustics measurements (T13) (VITO, CEA)



Ultrasound technique is a novel and non-destructive method, based on the use of two acoustic transducers (emission and reception). The study of the waveforms transmitted through batteries is particularly interesting for the supervision and management of batteries. As an example, CEA has already shown the usability of this technique in the early detection of thermal runaway events, and also in the establishment of state-of-charge (SoC) indicator without the use of classical parameters like voltage/current. Finally, this technique is also promising to define the optimal usage range of batteries, especially in the case of new materials, or aged materials such as in the case of second life of batterie.

R&D Status: Validation of literature results





L. Gold *et al.*, "Probing lithium-ion batteries' state-of-charge using ultrasonic transmission – Concept and laboratory testing," *J. Power Sources*, vol. 343, pp. 536–544, 2017.

A. G. Hsieh *et al.*, "Electrochemical-acoustic time of flight: In operando correlation of physical dynamics with battery charge and health," *Energy Environ. Sci.*, vol. 8, no. 5, pp. 1569–1577, 2015

#### Acoustics measurements

What can we characterize : cells

Experimental time: 1 h or longer

Advantage: a way to observe cell behaviour in another way then by the cell potential. So, additional BMS technique: for SOC and safety

Drawback: Response quite dependent on cell type and certainly on cell size. Not well established currently.



