Faculty of Exact Sciences
Department of Chemistry
Prof. Doron Aurbach
Head of Israel National Institute for Energy Storage

הפקולטה למדעים מדויקים
המחלקה לכימיה
פרופ' דורון אורבך
ראש המרכז הישראלי לאגירת אנרגיה

4/30/2025

For:

Pulse Charge Co.

Re: A technical report on the technology of Pulse Charge company, proposing fast charging options for practical rechargeable Li ion batteries, based on experimental work that was carried out in the laboratories of the electrochemistry group at Bar-Ilan university, under my supervision.

To whom that may concern and be interested.

Pulse-Charge people approached me and asked me to examine their technology, which offers options of fast charging for commercial (fully practical) rechargeable Li ion batteries. On 26 and 27 March, a month ago, Pulse-Charge people Pavel Maslyakov, Makish Danielyan and Igor Peer worked together with my people Prof. Boris Markovsky (senior researcher) and Oded Ovitz (PhD student) and tested their technology under my supervision. We run several cells in parallel. Pulse-Charge people brought their equipment, and we applied it for fast charging of commercial 1.5Ah cylindrical 18650 Li ion batteries. These batteries underwent 10 cycles that included each, fast charging by using Pulse-Charge equipment and then discharging at 1C rate by using one of our standard computerized multichannel cyclers made by Arbin Co. USA. Then the cells were moved to long cycling experiments (by the same Arbin made, computerized multichannel cycler). In these experiments the cells were fully charged at constant current up to 4.2V and at 0.5C rate and discharged to 2.5V at 1C rate. 1C rate means the use of a total constant current adjusted to either extract (discharging) or recharge all the cell's capacity (1.5Ah) within one hour. 0.5C rate means the use of a total constant current adjusted to either extract (discharging) or recharge all the cell's capacity (1.5Ah) within two hours. In parallel to these fast charging (10 times) cycling experiments followed by 0.5C/1C constant current charge/discharge cycling, in reference experiments - similar batteries underwent continuous 0.5C/1C constant current charge/discharge cycling in the voltage range 4.2 – 2.5 V.

The results of these experiments can be summarized as follows:

1. All fast-charging processes using Pulse-Charge equipment took exactly 15 minutes.
2. The consequent constant current discharge processes at 1C rate after the fast-charging steps, provided the expected capacity of 1.5 Ah. The voltage profiles of these processes were recorded.
3. For each of the cells measured, the 10 voltage profiles related to the 1C rate discharge processes after the fast-charging steps were the same, overlapping, reflecting a total capacity of 1.5Ah, which is exactly the nominal expected capacity of these batteries.
4. The following-up cycling processes of the cells that underwent 10 fast charging cycles did not indicate any damage or mal-functioning for these cells, due to the fast-

charging steps. The impression so far is that the fast-charging processes by Pulse-Charge equipment do not cause any damage to the cells.

It is important to note that this report reflects a limited number of experiments. We continue further with prolonged comparative cycling tests of both cells that underwent 10 fast charging cycles and reference cells that are being cycled at constant current in 0.5C/1C rate periodic charge discharge processes. We intend to accumulate a large database that will reflects many experiments in parallel and will back Pulse-Charge with sufficient volume of data.

Despite the relatively limited number of experiments on which this report is established, the results thus obtained are significant and should promote further development. The Pulse-Charge initiative and people deserve encouragement to continue with their development efforts. The positive aspects of Pulse-Charge and the experiments we carried out are summarized below:

1. Pulse-Charge technology, which is based on applying high voltages in short pulses at certain time domains is logical as I explain: In general, conventional fast charging of batteries requires application of high voltages that enable a flow of high currents. However, applying the high voltages required for fast charging causes dangerous and detrimental electrolysis of battery components, especially the electrolyte solutions. The way to overcome this serious limitation is to charge the battery with a series of sharp pulses. If the pulses are sharp enough, it is possible to apply high voltages. By high voltage sharp enough pulses, it is possible to charge within the battery only capacitive elements, without causing detrimental electrolysis phenomena. Hence, by choosing appropriate regimes of high voltage/sharp pulses, it is possible indeed to charge batteries to their maximal capacity at shorter periods than by any other conventional charging processes.

2. Consequently, the technology of Pulse-Charge has a solid basis. The necessary electronic instrumentation is not complex either. It seems that the instrument that pulse-Charge has elaborated marks an appropriate starting point.

3. Although the current project and its scope did not enable us to collect a large scope of data, the information we have gathered provides a very positive perspective about the technology of Pulse-Charge. The batteries that underwent fast charging via Pulse-Charge apparatus for no more than 15 minutes, could be fully discharged at 1C rate (relatively fast!) and provided the formal certificated capacity of 1.5Ah. Repeating these fast charging/1C rate discharge 10 times provided fully overlapping voltage profiles. Further cycling the cells at constant currents: 0.5C charge/1C discharge, confirmed that the cells were not damaged by the fast-charging processes.

4. I mention again that we continue to cycle several cells in prolonged cycling experiments, to acquire a large scope of data as a background for a deeper evaluation, if it is required further.

Conclusions:

1. Pulse-Charge deserves to receive from me a green light for continuing their R&D efforts.
2. It is recommended to upgrade the apparatus they have right now to a prototype instrument that can be fully computerized, part of a standard battery cycling system. It is recommended to have several prototypes that will enable carrying out many experiments in parallel.
3. It is recommended to complete many more measurements with several types of rechargeable Li batteries and to prepare a large database from many types of measurements, what will provide Pulse-Charge convincing arguments.
4. Even at this stage, Pulse-Charge deserves aid from investors both from private and public sectors.
5. Consequently, Pulse-Charge deserves to become a formal, well-funded start-up company.
6. The goals should include the possibility to charge fast also complex batteries for electric vehicles and other batteries packs for transportation, in which many cells are connected in parallel and in series.
7. It is important to put forward the dream of industrial development, to establish Israeli industry related to energy storage and conversion, that will include options of fast energy exchange.

I will be pleased to assist Pulse-Curve

Feel free to contact me if you require any further help.

Sincerely,

Doron Aurbach

Prof. Doron Aurbach

Head of the Electrochemistry Group, Department of Chemistry,

Founder of the center of energy and sustainability of Bar-Ilan university (70 research groups from 8 Faculties).

Bar-Ilan University, Ramat-Gan, Israel, 5290002

MRS, ECS, ISE Fellow, Senior Editor: Journal of the Electrochemical Society.

Founder and Head of Israel National Institute of Energy Storage (INIES).

Tel: 972-3-5318317; Fax: 972-3-7384053; aurbach@mail.biu.ac.il

Prof. Doron Aurbach: A Short Biography

Prof. D. Aurbach is formally a Professor Emeritus in the Department of Chemistry, Bar-Ilan University. However, since he became a Professor Emeritus, he continues to function as a full professor, leading a research group, employed by the university. In parallel he also serves as a consultant in the fields: energy, chemical engineering, electrochemistry, and safety issues. He was the founder of the electrochemistry group at BIU in 1985, educated several hundreds of young scientists (e.g. 90 graduate students received their PhD degree under his direct supervision; he guided more than 60 post-doctoral fellows, many of which hold academic positions in Israel, S. Korea, China, India, USA and Argentina). The scope of his research includes all aspects of non-aqueous electrochemistry, all types of batteries, supercapacitors and electrochemical water desalination. He pioneered the field of rechargeable magnesium batteries, demonstrating working prototypes. He published > 820 peer reviewed papers, cited > 116000 times, with H – index of 161 (Google Scholar, April 2025). He belongs to the most highly cited researchers today, (last 7 years including 2024), the second most highly cited scientist in Israel, as recognized by ISI Web of Science and Clarivate. Prof. Aurbach obtained his academic degrees (summa cum laude) from the Department of Chemistry, Bar-Ilan University (BIU), also obtained a degree in Chemical Engineering (1981) from the Technion - Israel Institute of Technology while undertaking his PhD at BIU. He served as the Chair of the BIU Department of Chemistry (2001-2005) and as the Chair of the Israel Labs Accreditation Authority (2010- 2016). He founded the center of Energy and Sustainability of Bar-Ilan university (70 research groups from 8 Faculties). He is also the founder and leader of INIES - Israel National Institute of Energy Storage (supported and financed by Israel Ministry of Energy & infrastructures).

He won several prestigious Israeli national and international prizes and awards, including the ECS J. Goodenough Prize (2025) , the Israel Chemical Society's Gold Medal (2020), Eric and Sheila Samson Prime Minister's Prize for Innovation in Alternative Fuels for Transportation (2018), the International Society of Electrochemistry's Alexander Frumkin Medal (2018), the Electrochemical Society's Allen J. Bard Medal (2017), the International Battery Association's Ernest B. Yeager Award for outstanding contributions to electrochemical energy conversion and storage science (2014), the prize of excellence in research of the Electrochemical Society / Batteries Division (2013), the prize of excellence in research of the Israel Chemical Society (2012).