Homeland Defense & Security Information Analysis Center

HDIAC TECHNICAL INQUIRY (TI) RESPONSE REPORT

Lithium-Ion Pouch Cell Performance

Report Number:
HDIAC-BCO-2021-187
Completed September 2021

HDIAC is a Department of Defense Information Analysis Center

MAIN OFFICE
4695 Millennium Drive
Belcamp, MD 21017-1505
443-360-4600

REPORT PREPARED BY:
Daniel Fleming
Office: HDIAC

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From – To)*
10-09-2021	Technical Research Report	

4. TITLE AND SUBTITLE
Lithium-Ion Pouch Cell Performance

5a. CONTRACT NUMBER
FA8075-21-D-0001

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Daniel Fleming

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Homeland Defense & Security Information Analysis Center (HDIAC)
SURVICE Engineering Company
4695 Millennium Drive
Belcamp, MD 21017-1505

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Defense Technical Information Center (DTIC)
8725 John J. Kingman Road
Fort Belvoir, VA 22060-6218

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

DISTRIBUTION A. Approved for public release: distribution unlimited.

13. SUPPLEMENTARY NOTES
energy and power technologies: energy storage; alternative energy

The Homeland Defense and Security Information Analysis Center (HDIAC) was asked to provide state-of-the-art information on lithium-ion (Li-ion) pouch cell performance for North American manufacturers. The inquirer's primary interests were the current capabilities of various types of batteries while keeping future technologies in mind. Research was conducted on identifying domestic manufacturers and supply chains and their national and international capabilities. Three domestic companies were found—Enersys, Enovix, and QuantumScape—and information on their Li-ion pouch cells were provided to the inquirer.

15. SUBJECT TERMS
alternative energy, battery, lithium-ion, Li-ion, supply chain

16. SECURITY CLASSIFICATION OF: U			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			Ted Welsh, HDIAC Director
U	U	U	UU	11	**19b. TELEPHONE NUMBER** *(include area code)* 443-360-4600

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

ABOUT DTIC AND HDIAC

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DTIC sponsors the DoD Information Analysis Center's (IAC's) program, which provides critical, flexible, and cutting-edge research and analysis to produce relevant and reusable scientific and technical information for acquisition program managers, DoD laboratories, Program Executive Offices, and Combatant Commands. The IACs are staffed by, or have access to, hundreds of scientists, engineers, and information specialists who provide research and analysis to customers with diverse, complex, and challenging requirements.

The Homeland Defense & Security Information Analysis Center (HDIAC) is a DoD IAC sponsored by DTIC to provide expertise in eight technical focus areas: alternative energy; biometrics; chemical, biological, radiological, and nuclear (CBRN) defense; critical infrastructure protection; cultural studies; homeland defense & security; medical; and weapons of mass destruction. HDIAC is operated by SURVICE Engineering Company under contract FA8075-21-D-0001.

A chief service of the DoD IACs is free technical inquiry (TI) research, limited to 4 research hours per inquiry. This TI response report summarizes the research findings of one such inquiry jointly conducted by HDIAC.

ABSTRACT

The Homeland Defense and Security Information Analysis Center (HDIAC) was asked to provide state-of-the-art information on lithium-ion (Li-ion) pouch cell performance for North American manufacturers. The inquirer's primary interests were the current capabilities of various types of batteries while keeping future technologies in mind. Research was conducted on identifying domestic manufacturers and supply chains and their national and international capabilities. Three domestic companies were found—Enersys, Enovix, and QuantumScape—and information on their Li-ion pouch cells were provided to the inquirer.

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1.0 TI Request

1.1 INQUIRY

What is the state of the art in lithium-ion (Li-ion) battery pouch cell capabilities, trends for future batteries, and domestic (North American-based) manufacturing capabilities?

1.2 DESCRIPTION

The inquirer requested a review of current specifications and chemistry on Li-ion batteries and which manufacturers, including their supply chain, are solely domestic.

2.0 TI Response

Homeland Defense and Security Information Analysis Center (HDIAC) staff searched open sources and the Defense Technical Information Center (DTIC) Research and Engineering Gateway for information relevant to a state-of-the-art Li-ion battery's capabilities and its manufacturers. HDIAC found that most manufacturers and patents would indicate a foreign presence in the research, manufacturing, or supply chain processes.

Li-ion batteries can be categorized as having a "pouch" format or the commonly recognized "can" format. The "pouch" format is a rectangular shape and can be found in most modern phones, whereas "can" formats are cylindrical. HDIAC research determined that the capabilities of different manufacturers and their specific designs allow pouch cells to have competitive specs to the can format; however, cost can be much more costly in some cases.

2.1 INTRODUCTION

Foreign supply chains and manufacturers of these Li-ion batteries dominated the population in this field. Figures 1 and 2 show the organizations with the highest number of patents for Li-ion batteries as well as the time scale for how many developing patents were directly related to Li-ion batteries each year. Although domestic manufacturers are listed, there is a possible foreign supply chain associated with them. As one of the parameters of this technical inquiry was to exclusively focus on domestic manufacturers with a domestic supply chain, batteries from those companies and foreign countries are not included. As a result, only three North American companies with Li-ion manufacturing capabilities are reviewed in this report—Enersys, Enovix, and QuantumScape. The information provided next is not all inclusive but a summary of their Li-ion pouch battery capabilities.

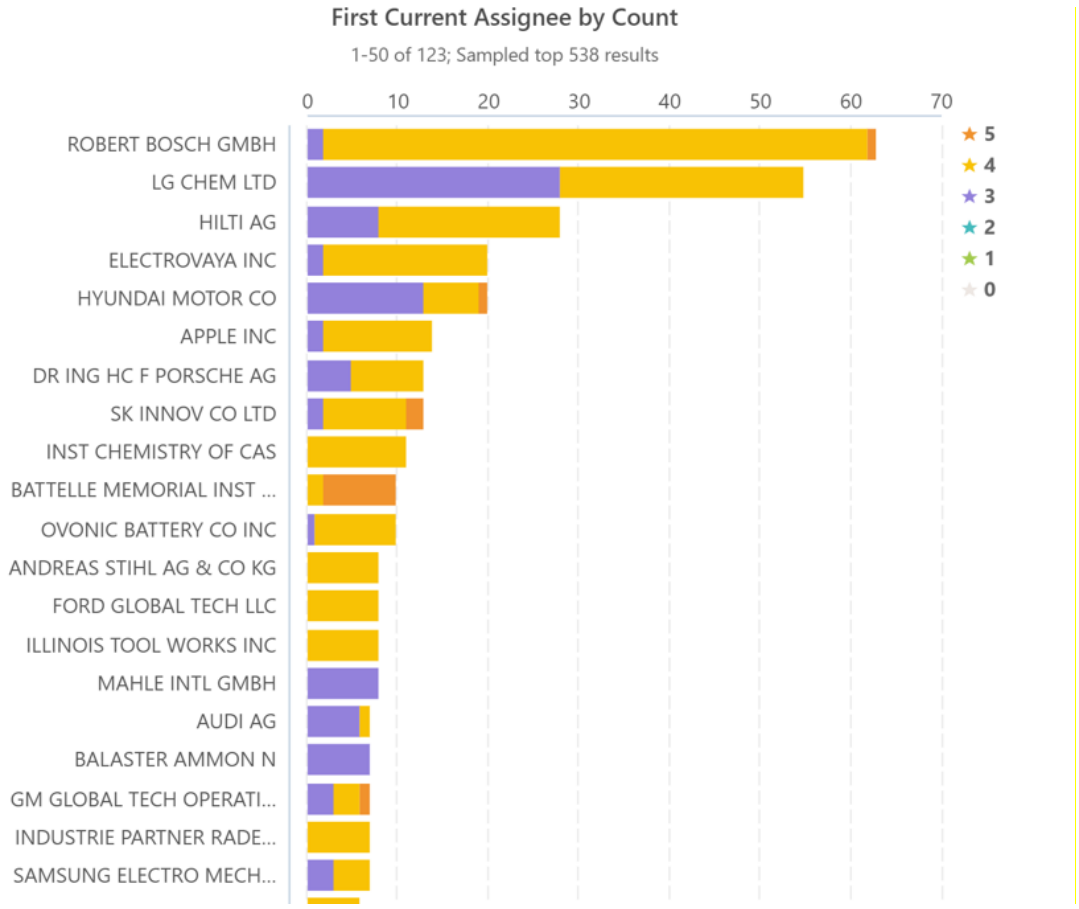

Figure 1: Number of Patents Related to Li-Ion Batteries per Company *(Source: Armistead [1] via InnovationQ+ Visual Tool).*

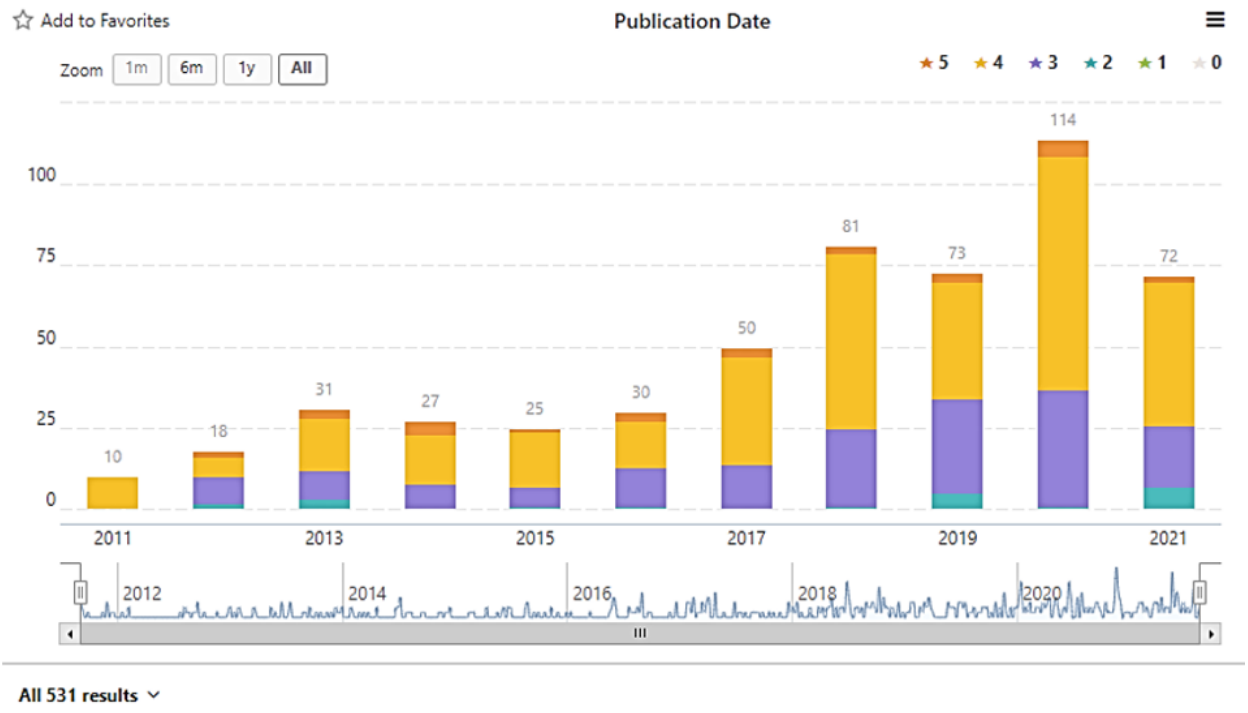

Figure 2: Number of Patents Approved for Li-Ion Batteries by Year *(Source: Armistead [1] via InnovationQ+ Visual Tool).*

2.2 ENERSYS

Enersys is a domestic, stored energy systems and technology provider for industrial applications. On October 28, 2013, they acquired Quallion LLC, a company that designed, fabricated, and manufactured state-of-the-art Li-ion cells, battery packs, and pouch cells. Quallion has had contracts developing new battery chemistries for the U.S. military, aerospace, medical, and automotive industries. Enersys has a pouch cell format that is competitive in performance with the typical can format but comes at an increased cost [2].

2.3 ENOVIX

Enovix is a leader in advanced silicon-anode, Li-ion battery development and production. Domestically owned and operated, Enovix is in the preproduction stages for leading mobile device batteries and electronic vehicle batteries. The company expects to produce 8 million cells annually by the end of the fiscal quarter of 2022 and plans to ramp up to a maximum manufacturing capability of 45 million cells per year. An extensive amount of research went into mitigating heat loss in their Li-ion batteries, as well as preventing their silicon from expanding, as that is a common issue with silicon-based anodes. Their batteries are intended for various products like batteries for smart watches, augmented reality glasses, radios, cell phones, laptops, and future electronic vehicles [3].

2.4 QUANTUMSCAPE

QuantumScape, a domestic company based out of California, changed the fundamental chemistry of their batteries. Instead of Li-ion batteries, they developed lithium metal batteries and a battery whose supply chain consists of domestically abundant materials. The company deals in electronic vehicle batteries capable of operating efficiently between –30 °C and 60 °C and has a large amount of open-sourced literature on their products. QuantumScape is in a preproduction stage, with the goal of having their products commercially available in 2024–2025. They developed batteries capable of a 1000 Watt*hour/L energy density without any considerable degradation on cycle lives per depth of discharge. Over 800 discharges were performed on several batteries across several different lots that all had an individual maximum energy retention rate between 95% and 99% [4].

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