

Underwriters Laboratories®



Counterfeit
Lithium-ion
Cells and Batteries



Counterfeit Lithium-ion Cells and Batteries



Lithium-ion cells power a variety of applications from small electronic devices to electric vehicles and grid energy storage. The invention of lithium-ion cells has made rapid progress in consumer electronics, cellphones, electric vehicles, and grid energy storage possible. Many favorable properties including high energy and power density, lack of memory effect, long cycle and calendar life and lowering costs make this battery chemistry increasingly appealing.

Widespread demand of lithium-ion cells and batteries (hereon referred to as 'products') has attracted illicit copying to profit through counterfeiting. Counterfeit cells are manufactured by copying high-quality products and deceive unsuspecting customers. These counterfeit products often contain an unauthorized trademark or logo that is the same as the trademark of another product and may make it impossible to differentiate. These products have low quality components and are not certified to any standards.

Counterfeit products pose many safety risks as they may be prone to failure and cause fires and explosions. These are illegal enterprises and the manufacturers typically lack the technical knowledge and understanding that are required for quality control, safety and shipping. Certifications are falsified along with misleading performance claims on the label. This directly results in compromised safety of the lithium-ion products and eventually the devices that use them. Occasional bargains in counterfeit products may not be cost efficient considering the lack of performance, quality and safety compared to an original product. This can result in frequent purchases when compared of the original products.



*Please note that the numbers indicate all counterfeit products combined and not just for batteries.

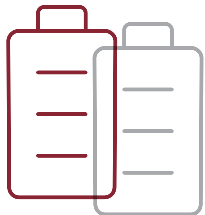


False certifications and standards

Counterfeit products make false claims of certifications and test results that are exhibited by authentic cells. Certifications to standards and regulations confirm that the minimum requirements for performance, quality and safety have been met. Products receiving the certification establish confidence in customers that they are genuine products.

Safety and performance of counterfeit products cannot be verified, and hence, may pose serious risks. In many cases, it is challenging to distinguish an authentic certification or certification mark on a counterfeit product. Hence, caution is warranted when purchasing cells when verifiable performance, safety and quality are of utmost importance. Purchases from third-party sellers on online marketplaces and unauthorized resellers may involve the risks of counterfeits and must be proceeded with caution.





Examples of counterfeit products

Counterfeit products are not always visually identifiable as such. Figure 1 has the photos of two products that look very similar but differ in spelling.

Figure 2 shows the photos of products that have an incorrect UL Mark indicating that they are not knowledgeable about UL certifications and marks assigned for UL certified products.

Some counterfeit products make false claims of high performance or safety. False claims for performance may be detected from the information on the label but product safety cannot be determined visually.

Lastly, one cannot tell the difference visually between a counterfeit and original cell as both look identical visually in all aspects. These points are discussed later on.



Figure 1. Comparison of a cell from an authentic U.S. brand to a counterfeit. The counterfeit product shows a misspelling of California (“Colifornia”) and a missing date stamp¹.



Figure 2. Products sold online with counterfeit UL certification Marks^{2,3}.



Transportation

Lithium-ion products are dangerous goods and must be labeled as such when transported. Strict guidelines and restrictions must be followed and must meet UN 38.3 test standards when transporting these products via air. However, counterfeit products can be mislabeled and not declared as dangerous goods in order to avoid the restrictions. Lithium-ion products copied to look like genuine products are inferior in quality and safety. Events such as drops during transportation

may cause cells to undergo venting, thermal runaway, and fire if they have not been tested and proven against such incidents as part of the testing and certification process. Shipping counterfeit lithium-ion products is a serious risk and it causes accidents⁴. Incidents of fatal crashes and fires in airplanes have been reported to be caused by fire resulting from undeclared lithium-ion products during transport⁵.



Safety

High-quality components and safety mechanisms are needed in lithium-ion products for protection against off-nominal conditions. Overcharging, overdischarging, extreme temperatures, and external or internal shorts are some of the off-nominal conditions that products may experience in use which may result in thermal runaway and fire.

Counterfeit products may be indistinguishable by visual inspection when compared to the high-quality and authentic original equipment manufacturer (OEM) products. Careful examinations using performance characterization, destructive physical analysis (DPA), and safety tests may be needed to verify counterfeit products. Figure 3 shows a comparison of two similar looking cells that differ in performance, safety, and quality. Although they look similar, a teardown or DPA on the cells can elucidate contrasting quality and safety features.

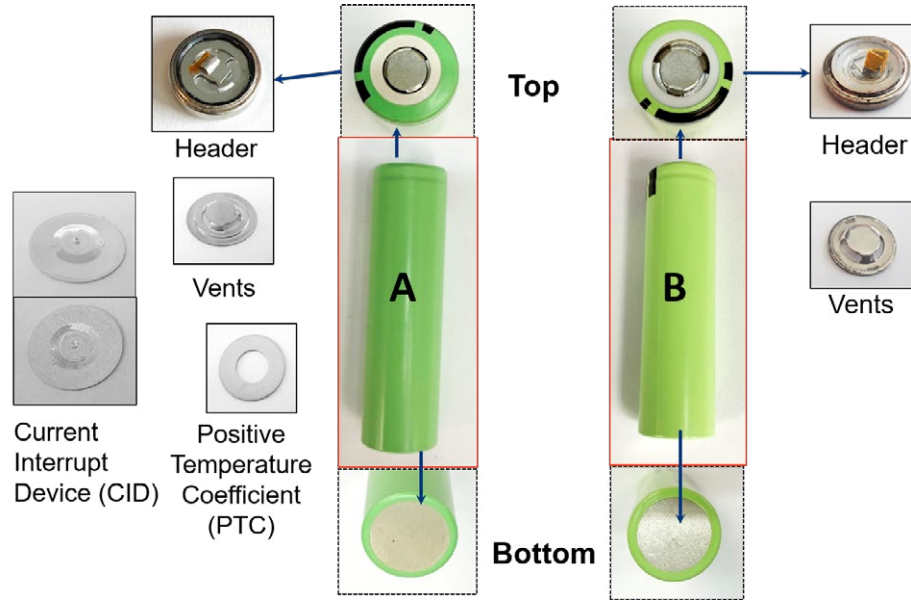
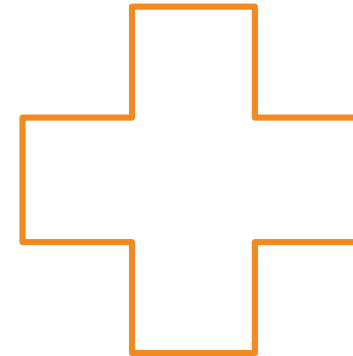


Figure 3. Photos showing the parts in the header of the cells from manufacturer A (OEM) and B (counterfeit). Destructive physical analysis (DPA) confirmed the presence of the safety devices PTC and CID in the high quality cells that were missing in the counterfeit cells.

Cells from the Original Equipment Manufacturer (OEM), manufacturer A of the cylindrical 18650 model contain a positive temperature coefficient (PTC) device to protect the cell in case of external shorts. Another safety device included in the cell, the current interrupt device (CID) offers protection in case of overcharge conditions. Teardown inspection of the cells from manufacturer B show severe quality issues like rust in the cell can and header area. More importantly, there are no PTC and CID included in the cells that are important for safety of the cells.



BACK TO OVERVIEW



Overcharge tests can provide insights on safety features of cells in order to protect against overvoltage. Tests conducted on cells from manufacturers A and B highlight significant differences in the safety of the cells. In case of the authentic cells from manufacturer A, when the cells experience overvoltage, the CID activates. Activation of the CID involves the loss of physical and electrical contact between the two discs of the CID which is brought about by

an increase in internal pressure of the cell. Hazards such as extreme heating, electrolyte leaks, smoke, fire, and thermal runaway are prevented. Figure 4 highlights the differences in safety of cells from manufacturers A and B during an overcharge test. Whereas cell from manufacturer A does not show any noticeable hazard, the low-quality cell from manufacturer B displayed electrolyte leakage, smoke and fire.

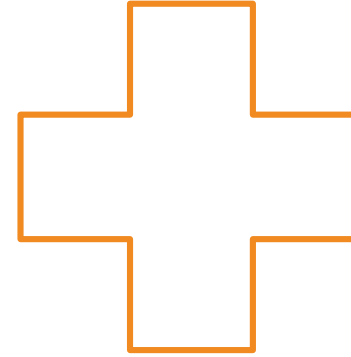


Figure 4. Comparison of overcharge test on authentic (A) and low-quality (B) cell showing difference in safety of these cells. Electrolyte leak, high heat and fire is observed in case of low-quality cell.



Figure 5. Manufacturer's label displaying cell capacity of 5000 mAh on the cell. Upon lab testing, measured cell capacity was only 1200 mAh.

Performance

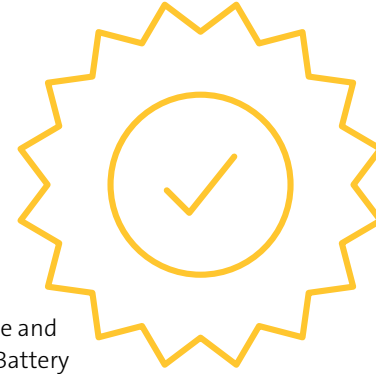
Lithium-ion cells are highly variable in terms of geometries and chemistry-types. Application-specific designs of cells mean performances may vary among cells that appear similar. Factors such as energy, power, current capability and voltage limits vary for different lithium-ion cells. Verification of claims made by manufacturers on cell performance may not be easy to perform because they often require specific instrumentation not readily available to everyone. Some manufacturers of low-quality cells advertise performances that are not achievable by that model of cell. Customers unknowingly purchase these items because they appear superior compared to other similar cells based on advertised performance which is not easily verifiable.

Large discrepancies in advertised performance and actual achievable performance may occur in low-quality cells. Experimentally testing performance features such as cell capacity and power can highlight these discrepancies. Cell capacity lower than one quarter of the advertised value listed on the label from manufacturer was experimentally measured for cells purchased online, as shown in Figure 5.



Quality

Devices powered by lithium-ion products rely on proven performances, safety and reliability. Stringent quality control in the production of cells and batteries that power these devices is of utmost importance to ensure optimal and safe operation. Counterfeit products may forego some of the strict quality control measures needed for high-quality and safe lithium-ion cells in order to keep costs low. Furthermore, lack of manufacturing know-how and resources needed for high-quality manufacturing may also affect the final product. Additional cost-cutting measures such as the use of cheap materials and lack of scientific and engineering expertise also yield low-quality cells.



Counterfeit products affect the overall performance and safety of battery powered devices and appliances. Battery management systems (BMS) embedded within the batteries are expected to ensure normal operation and safety. Compromises in cell quality may affect the uniformity of the cells inside a battery pack making the BMS functions complex or inoperable or in some cases the components that are used in the BMS may not be compatible with the charger or the application.



Detecting counterfeit products

Counterfeit products may be difficult to distinguish from authentic and high-quality products. However, the following guidelines may be useful in detecting counterfeit products:

1

First-hand inspection to look for signs of poor quality such as: inaccurate printing, misspelled wording, crooked label placement and signs of defective workmanship.

2

Hologram stickers placed by some manufacturers on the batteries may be fake and not what is typically provided by the certification organization.

3

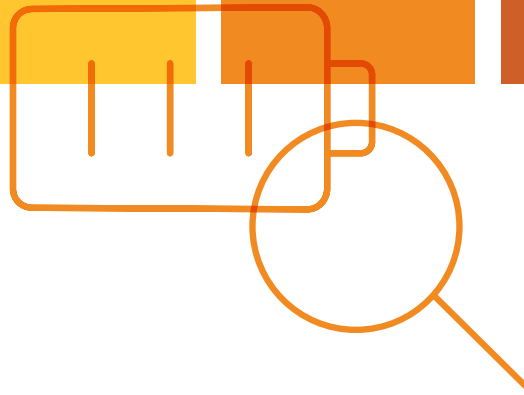
If the cells have been purchased, measuring the cell voltage, weight, dimensions and quality of the materials and comparing with data sheets available through original manufacturers may be useful.

4

Inappropriate or fake certification labels on the cells and batteries.

5

Significantly reduced price in comparison with similar authentic products.



BACK TO
OVERVIEW



Considerations for avoiding counterfeit products



1

Purchase only from the OEM or from reputable retailers and suppliers recommended by the OEM.

2

Check every detail of the product as described in previous section to detect and avoid counterfeit products.

3

Whenever possible, ask the vendor for pictures of the actual products. Compare the trademark and the logo with the authentic one.

4

Verify that the certification label is authentic.

Precautions must be taken during purchase to avoid counterfeit products. Some easy-to-follow considerations may be helpful in avoiding these:

BACK TO OVERVIEW



References

1. <https://publicintelligence.net/fbi-counterfeit-lithium-batteries/>
2. <https://www.ul.com/news/ul-warns-li-ion-batteries-counterfeit-ul-mark-release-12pn-67>
3. <https://nissindigital.us/products/klarus-26650-5000mah-3-7v-li-ion-battery>
4. https://www.engineeringnews.co.za/article/counterfeit-lithium-batteries-pose-increased-risk-to-aviation-sector-2019-10-23/rep_id:4136
5. https://www.iata.org/contentassets/05e6d8742b0047259bf3a700bc9d42b9/lithium_battery_risk_assessment_guidance_for_operators.pdf



Underwriters Laboratories Inc. All rights reserved. UL and the UL logo are trademarks of UL LLC. All rights reserved. This white paper may not be copied or distributed without permission. It is provided for general information purposes only and is not intended to convey legal or other professional advice.

BACK TO
OVERVIEW

