



Whitepaper: Choosing the Right Cell Format

Explore the advantages and trade-offs of cylindrical, prismatic, and pouch cells for various applications.

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Introduction

Battery technology is a critical element in the design and performance of electronic products, electric vehicles (EVs), and renewable energy systems. As the demand for efficient, durable, and compact power storage solutions increases, manufacturers and engineers are faced with the decision of selecting the optimal battery cell format for their applications. The three most common formats—cylindrical, prismatic, and pouch cells—each offer distinct advantages and limitations depending on the specific requirements of the application, such as energy density, cost, thermal management, and manufacturing flexibility.

This white paper provides an in-depth analysis of the three main types of battery cells, comparing their features, advantages, trade-offs, and typical use cases. By understanding these characteristics, engineers and designers can make more informed decisions when choosing the right cell format for their power storage needs.

Cylindrical Cells: Reliability and Standardization

Cylindrical cells are one of the most widely used formats in consumer electronics, electric vehicles, and industrial applications. These cells are characterized by their round shape, typically with a metal casing that ensures structural integrity and protection from environmental factors.

Advantages:

- ¹ Mature Technology: Cylindrical cells, such as the 18650 and 21700 formats, have been in use for decades and are widely available. This maturity allows for a well-established supply chain, lower costs, and abundant technical knowledge.
- Robust Performance: The cylindrical design allows for good thermal management due to the cylindrical shape's ability to dissipate heat evenly. This is particularly important in high-power applications, such as electric vehicles (EVs), where efficient heat dissipation is critical for battery life and performance.
- ³ Durability and Safety: The metal casing of cylindrical cells provides physical protection, making them less susceptible to external mechanical stresses and ensuring greater safety in the event of thermal runaway or other failures.

Trade-offs:

- ¹ Space Efficiency: Cylindrical cells are not as space-efficient as other formats, as their round shape results in empty spaces when arranged in packs. This leads to less energy density compared to prismatic or pouch cells of the same size.
- ² Manufacturing Constraints: The standardization of cylindrical cells, while beneficial for cost and availability, limits flexibility in terms of form factors. Applications requiring non-standard sizes may need custom packaging or adaptations.

Applications:

- Electric vehicles (EVs)
- Power tools
- Laptops and portable electronics
- Large-scale energy storage systems

Prismatic Cells: Maximizing Space Efficiency

Prismatic cells are rectangular or square in shape and are designed to maximize the use of space within a battery pack. These cells typically have a rigid metal or plastic casing and are known for their higher energy density compared to cylindrical cells.

Advantages:

- ¹ Higher Energy Density: Prismatic cells make better use of space due to their rectangular shape, leading to higher energy density. This is particularly beneficial for applications where maximizing the amount of energy stored in a limited space is a priority.
- ² Flexible Configurations: The rigid casing and uniform shape of prismatic cells allow for flexible pack designs, making them ideal for integration into compact or irregularly shaped battery packs, such as those found in consumer electronics or EVs.
- ³ Simplified Assembly: Because prismatic cells are often larger and come in uniform sizes, they can simplify the assembly process by reducing the number of interconnections required between cells.

Trade-offs:

- ¹ Cost: Prismatic cells tend to be more expensive than cylindrical cells, due to their complex manufacturing process and the additional materials required for their casings.
- ² Thermal Management Challenges: While prismatic cells offer high energy density, their flat design can lead to uneven heat dissipation, which may impact performance and lifespan in high-power applications unless properly managed with additional cooling systems.

Applications:

- Electric vehicles (EVs)
- Portable power stations
- Medical devices
- Consumer electronics

Pouch Cells: Lightweight and Flexible

Pouch cells are soft, flexible cells that are encased in a heat-sealed plastic pouch rather than a rigid metal casing. This format allows for a lightweight design and offers a higher degree of flexibility in terms of form factor.

Advantages:

- ¹ High Energy Density: Pouch cells provide a higher energy density than cylindrical cells and are able to pack more energy into a given volume due to the lack of metal casings and the flexible nature of the design.
- ² Customizable Form Factor: The flexible nature of pouch cells allows for customization of the size and shape of the battery pack. This makes them ideal for products with space constraints or unique designs.
- ³ Lightweight: The absence of a heavy metal casing makes pouch cells lighter than prismatic and cylindrical cells of equivalent capacity, which can be a significant advantage in portable devices and electric vehicles.

Trade-offs:

- ¹ Physical Vulnerability: Pouch cells are more susceptible to physical damage due to their lack of a rigid casing. This makes them less durable and more vulnerable to punctures or impacts, which can lead to safety risks if not handled properly.
- ² Complex Thermal Management: The flexible pouch design does not provide the same level of heat dissipation as cylindrical or prismatic cells, requiring more advanced cooling systems to maintain performance and safety in high-demand applications.

Applications:

- Smartphones and laptops
- Electric vehicles (EVs) and e-bikes
- Drones and other small electronics
- Wearable devices

Conclusion

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The selection of the right battery cell format—cylindrical, prismatic, or pouch—depends on the specific requirements of the application, including energy density, cost, size constraints, thermal management needs, and safety considerations. Each format offers distinct advantages, with cylindrical cells providing a balance of cost, reliability, and safety; prismatic cells excelling in space efficiency and energy density; and pouch cells offering the highest energy density and flexibility but with certain durability and thermal management challenges.

Engineers and product designers must weigh these factors carefully when making their decision, considering the operational environment and expected performance requirements. By choosing the most appropriate cell format for their application, manufacturers can ensure optimal performance, longevity, and cost-effectiveness of their power storage systems.