

realme



The Future of Battery Tech

Smartphone Battery Life Whitepaper

realme × TÜV Rheinland 2025.05

In an era characterized by the relentless advancement of technology, smartphones have seamlessly integrated into the fabric of daily life for the vast majority of individuals across the globe. As of 2021, the global mobile device user population approximated 8.6 billion. In the fourth quarter of 2024, global smartphone shipments registered a 1.4% year-on-year increase, reaching 328.5 million units. Concurrently, as smartphones assume an increasingly crucial role, the demand for extended battery life has become a focal point for users.

The battery life of a smartphone is a complex function determined by the interplay of both hardware and software, such as the performance and energy efficiency of the System-on-Chip (SoC), screen brightness and refresh rate, mobile network and Bluetooth connectivity, charging speed, playing games or using other high-performance apps, and background processes all contribute to the overall battery consumption. However, the battery's inherent technological characteristics remain the preeminent determinant. To comprehensively explore the future development trajectories of battery life technology, realme, in collaboration with TÜV Rheinland, jointly released the "Battery Life Tech" white paper. This white paper provides an in-depth analysis of the current state of battery life technology within the mobile phone industry, elucidate how realme enhances battery life performance through technological innovation, and anticipate the impact of emerging technologies on elevating battery life and improving the user experience for smartphone end-users.

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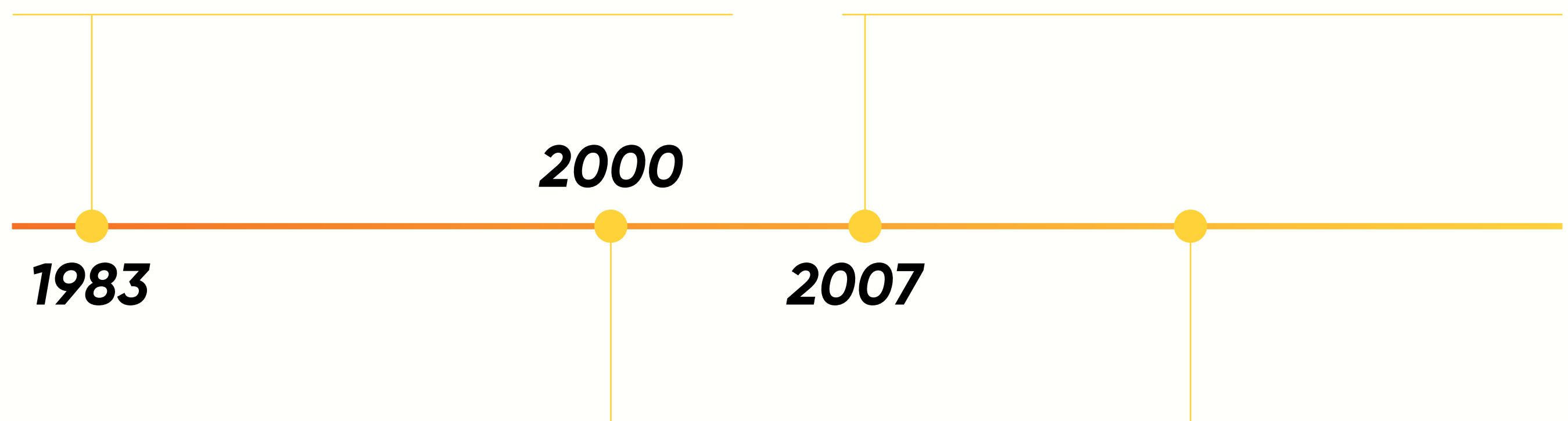
Chapter 1

Current Situation of the Mobile Phone Battery Industry

1.1 Evolution of Mobile Phone Battery Life Technology

In 1983, Motorola introduced the DynaTAC 8000X, the world's first mobile device, into the commercial market. This pioneering device had a rather limited operational time, necessitating **recharging after merely 30 minutes of use**.

In 2007, Apple unveiled the first-generation iPhone, which was equipped with a 1400mAh battery. Apple claimed that this device could support a maximum **standby time of 250 hours and offer up to 5 hours of talk time, video viewing, or web browsing**.



Circa 2000, feature phones dominated the mobile phone market. These devices were equipped with batteries having capacities ranging from 200 to 800mAh. They typically boasted **standby times spanning several days or even weeks and continuous talk times of a few hours**. Given the relatively infrequent usage patterns at that time, standby time emerged as a more significant metric for evaluating battery performance.

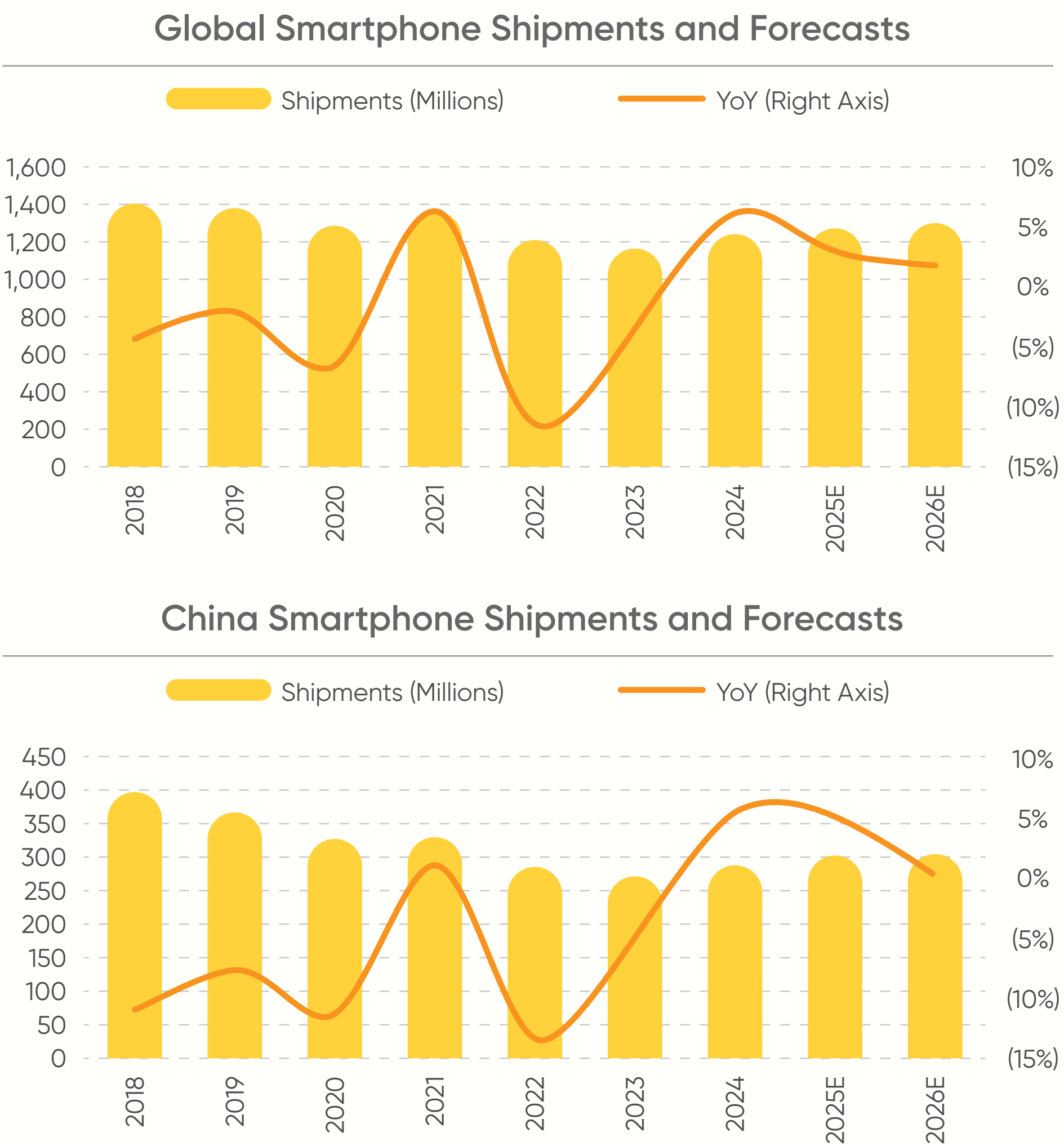
Since then, the **functionality and content of mobile phones**, driven by the proliferation of applications, have become increasingly diverse. Simultaneously, the frequency and duration of daily usage have witnessed exponential growth. Moreover, the adoption of a non-removable battery design in smartphones has exponentially **increased the significance of battery life**.

1.2 Mobile Phone Market Demand

In 2024, the global smartphone market witnessed shipments reaching 1.23 billion units, marking a 6.1% year-on-year increase and reversing two consecutive years of decline. In the Chinese market, smartphone shipments amounted to 280 million units, reflecting a 5% annual growth.

User scenario analysis reveals that the combined power consumption of gaming, video-related activities, and communication functions accounts for 78% of the total.

- Gaming scenario: Gaming applications impose substantial demands on both the GPU and computational power. For instance, in the 90-frame mode of "Honor of Kings", the GPU power consumption reaches 23W.
- Video shooting: The power consumption for 4K video recording is approximately 3.7W. Additionally, the live-streaming scenario further intensifies the load on the radio-frequency module.
- Communication and standby: In a 5G network environment, the power consumption for web-page loading is 1.6W, and that for navigation and positioning is around 1.9W.



Note: E=SPDB International Holdings Limited Forecasts; **Sources:** IDC, Bloomberg, SPDB International Holdings Limited

1.3 Technical Turning Point and Industry Value of Mobile Phone Batteries

Technical Turning: Lithium battery system approaching its limit

Anode materials bottleneck:

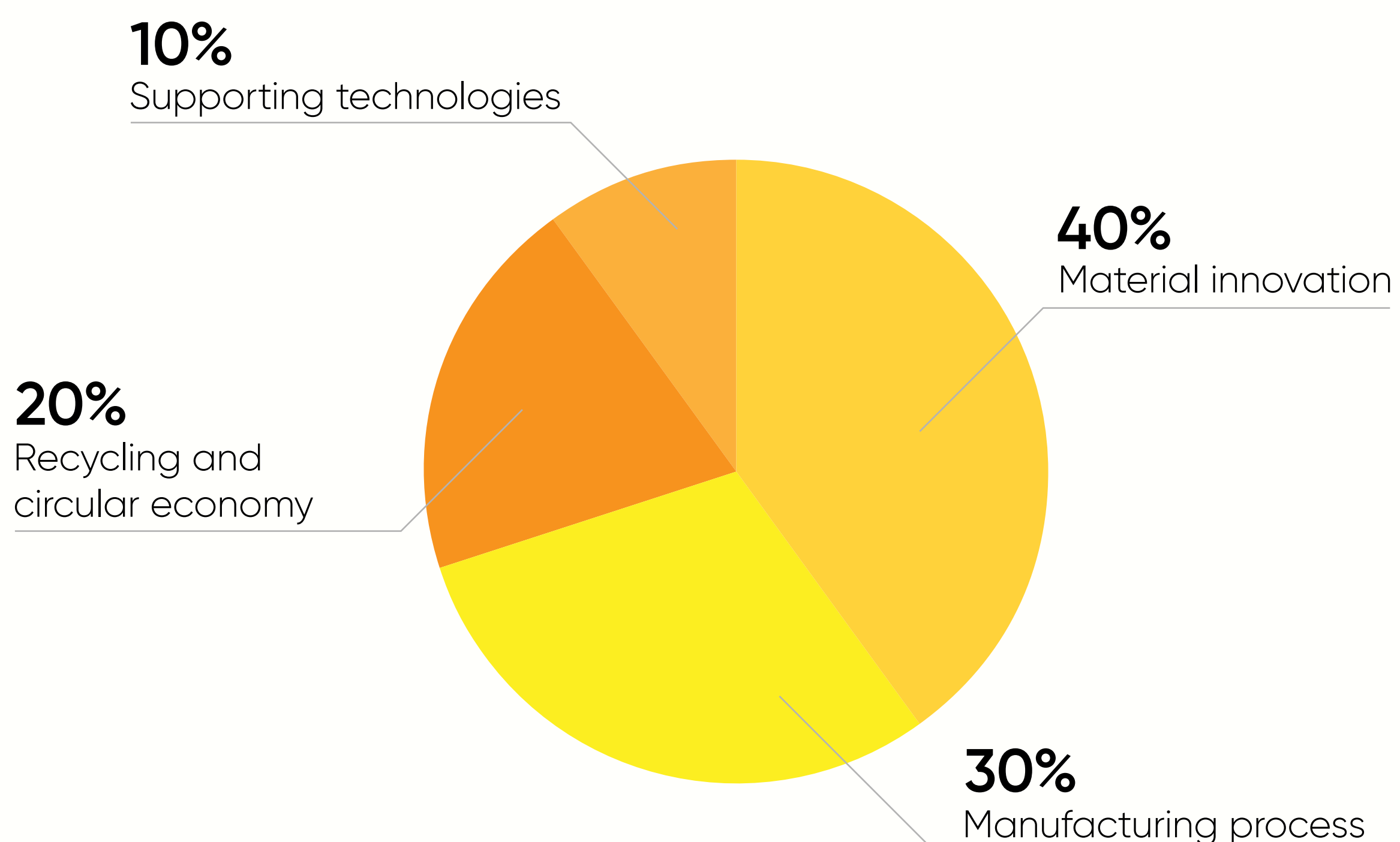
- Graphite anodes: The theoretical specific capacity of graphite anodes is 372mAh/g. In practical applications, the specific capacity of products has reached 360mAh/g, approaching its theoretical limit.
- Silicon-based anodes: Silicon-based anodes exhibit a theoretical specific capacity of 4200mAh/g. However, they suffer from a significant drawback of a 380% volume expansion rate, and their cycle life is limited to only 300 to 500 cycles.

Cathode materials bottleneck:

- Lithium cobalt oxide (LiCoO₂): The theoretical specific capacity of lithium cobalt oxide is 274mAh/g. Under the high-voltage condition, its practical development has reached approximately 180mAh/g. Nevertheless, its structural instability leads to capacity attenuation during cycling.

Industry value: Technical upgrading drives innovation in the industrial chain

The advancement of battery technology is expected to generate an annual industrial-chain opportunity exceeding \$20 billion. The distribution of this opportunity across different sectors is as follows:



Chapter 2

Battery Life Optimization Strategies

2.1 Main Factors Affecting Mobile Phone Battery Life

- **Battery capacity:**

Battery capacity forms the cornerstone of a smartphone's battery life. However, its actual performance is contingent upon the optimization of other hardware components and software algorithms.

- **User usage scenarios and habits:**

Mobile gaming, video consumption, and the use of instant-messaging applications have emerged as the three most prevalent usage scenarios.

- **Hardware and software optimization:**

The power-consumption optimization of chips, screens, and operating systems directly influences the battery life performance. For example, 5G chips and high-refresh-rate screens pose more stringent requirements for battery endurance.

- **Charging technology:**

Fast-charging technology reduces the charging time by increasing the charging current and/or voltage, thereby minimizing the impact of low battery levels on smartphone usage. Nevertheless, it often generates heat, which can have an adverse effect on battery life.

As a critical energy-storage component in mobile-phone products, the battery not only determines the battery life of a smartphone but also plays a pivotal role in ensuring its safety.

2.2 Introduction to Lithium - Ion Batteries

Most lithium-ion batteries are composed of battery cells, a protection board, and, in some cases, a rigid outer enclosure. The battery cell, in turn, consists of five key components: cathode, anode, separator, electrolyte, and casing.

Casing

The outer casing encloses the aforementioned components, isolates them from the external environment, and maintains the structural integrity of the battery cell. It may also offer mechanical protection.

Cathode

Coated on an aluminum-foil-based current collector, the cathode material serves as the source of lithium ions and is a key determinant in battery energy storage and release. Currently, commonly used cathode materials include lithium cobalt oxide (LiCoO_2), lithium iron phosphate (LiFePO_4), nickel-cobalt-manganese oxide (NCM), and nickel-cobalt-aluminum oxide (NCA).

Anode

Deposited on a copper-foil-based current collector, the anode material is responsible for accommodating the lithium ions released from the cathode. Graphite is widely employed as the primary material for anodes.

Electrolyte

Serving as the medium for lithium-ion migration, the electrolyte is typically an organic solution of lithium salts (such as LiPF_6) supplemented with conductive agents and other additives. Its ionic conductivity and thermal stability are essential for maintaining optimal battery performance.

Separator

Acting as a physical barrier between the cathode and anodes, the separator permits the passage of lithium ions. Polyethylene (PE) or polypropylene (PP) microporous membranes are commonly used as separator materials. Their thermal stability and mechanical strength are crucial for ensuring battery safety.

The performance and reliability of lithium-ion batteries are intricately determined by the synergistic interaction of the cathode, anode, separator, and electrolyte.

2.3 Limitations of Current Lithium-Ion Battery Technology



1. Limited energy density:

Although lithium-ion batteries have demonstrated remarkable comprehensive advantages over earlier battery technologies, such as lead-acid and nickel-metal-hydride batteries, in terms of energy density, self-discharge characteristics, memory effect, platform voltage, operating temperature range, and cycle life, the evolution of the mobile phone industry has given rise to more exacting requirements for high-performance, lightweight, and long-battery-life devices. These requirements have placed greater pressure on the performance of lithium-ion batteries.



2. Safety concerns:

The organic-solvent-based electrolyte in lithium-ion batteries is flammable and may decompose to produce combustible gases. Given a fixed material system and battery volume, the pursuit of high capacity often necessitates a thinner separator, which increases the risk of perforation and subsequent internal short circuits.



3. Cycle life and aging:

During the cyclic operation of cathode and anode materials, capacity attenuation and structural degradation frequently occur. The graphite anode experiences expansion, and the SEI film on its surface thickens, leading to battery swelling. When used in low-temperature environments, the formation of lithium dendrites is possible. These dendrites can penetrate the separator, posing a significant threat to battery safety. Additionally, the cathode materials may undergo structural changes under high-rate or high-temperature conditions. Prolonged use of the battery results in the growth of the SEI film and the generation of by-products, which consume lithium ions and accelerate the decline of battery capacity and performance.



4. Limited operating-temperature range:

The performance of lithium-ion batteries is highly sensitive to temperature variations. In low-temperature environments, the ionic conductivity of the electrolyte decreases significantly, leading to an increase in internal resistance and a reduction in discharge capacity. Moreover, the phenomenon of lithium plating may occur, which not only elevates safety risks but also causes irreversible capacity loss. In high-temperature environments, the side reactions between the cathodes and the electrolyte intensify, resulting in the loss of lithium ions and potentially causing the battery to expand or bulge.



5. Challenges in environmental protection and recycling technology

The disposal of lithium-ion batteries has the potential to cause environmental pollution and resource waste. Currently, large-scale, efficient, and cost-effective battery-recycling technologies have not been widely implemented. In particular, the recovery of valuable elements such as lithium, nickel, and cobalt faces significant technological and environmental-protection challenges.



6. Resource dependence and cost issues

The key materials required for lithium-ion battery manufacturing, such as lithium, cobalt, and nickel, are unevenly distributed globally and have finite reserves. Coupled with the ongoing development of the battery-recycling mechanism, the cost and sustainability of battery production are directly affected.



7. Problems with fast charging

High-current charging of lithium-ion batteries induces internal stress in electrode materials, leading to rapid material aging. The heat generated during high-current charging further exacerbates this process. Additionally, high-current charging at low temperatures accelerates the formation of lithium dendrites, increasing the risk of internal short-circuits.

Despite the relative maturity and excellent performance of lithium-ion battery technology, its limitations in energy density, safety, cycle life, and cost still pose significant barriers to further development. In the future, it is anticipated that these limitations can be substantially mitigated through the development of novel materials and optimized designs.

2.4 Battery Design Optimization

Overview of new-type batteries:

Advantages

The solid-state electrolyte, a core component of all-solid-state batteries, exhibits non-flammable and non-leaking properties, offering enhanced stability and safety compared to organic-solution electrolytes. Solid-state electrolytes are typically paired with lithium-metal anodes, which possess a theoretical specific capacity of 3861mAh/g, more than ten times that of traditional graphite anodes (372mAh/g). This significantly enhances the energy density of the battery. Solid-state batteries hold the promise of achieving high safety and long cycle life under high-energy-density conditions.

Solid-State Batteries

Disadvantages

The technology for solid-state batteries is still in the developmental stage. Although reports on solid-state electrolytes with high ionic conductivity date back to the 1970s, current research on lithium-ion transport and electrochemical reaction processes at the interfaces of solid-state battery electrodes and electrolytes remains limited. All-solid-state electrolytes have yet to effectively suppress the formation and growth of lithium dendrites. There are still disparities in comprehensive performance and cost when compared to liquid electrolytes. They are currently unable to support fast charging and discharging, and issues such as rapid capacity decay and potential safety hazards persist. As such, there is still a considerable distance to commercial application.

Advantages

Sodium-ion batteries benefit from abundant resources and low costs. Sodium is abundant in the earth's crust and seawater, with a price significantly lower than that of scarce resources such as lithium and cobalt, which helps alleviate resource and cost pressures. They exhibit strong adaptability, performing well in low-temperature and high-rate environments, making them suitable for cold regions or large-scale energy storage applications. Additionally, sodium-ion batteries often utilize cobalt-free materials, resulting in high thermal stability and better safety performance compared to some lithium-ion batteries.

Sodium-Ion Batteries

Disadvantages

Sodium-ion batteries suffer from lower energy density. Due to the relatively larger volume and mass of sodium ions compared to lithium ions, the capacity and energy density of the materials they intercalate are lower than those of lithium-ion batteries, failing to meet the energy-density requirements of smartphones. Some sodium-ion cathode and anode materials are prone to performance degradation during long-term cycling, leading to a limited cycle life. At present, the commercial application of sodium-ion batteries is still in its infancy.

Advantages

Compared to the theoretical specific capacity of 372mAh/g for traditional graphite anodes, silicon-based materials, due to their unique crystal structure, can accommodate more lithium ions, offering a theoretical specific capacity as high as 4200mAh/g and better thermal stability. However, during the lithium-ion insertion process, silicon anodes experience substantial volume expansion. The repeated volume changes during cycling can cause the anode material to crack and disintegrate, ultimately leading to battery failure. By rationally designing silicon-carbon composites, it is possible to mitigate volume expansion, enhance the mechanical integrity of the electrode material, and buffer the mechanical stress during volume changes, thereby enabling the production of batteries with high energy density and fast-charging capabilities.

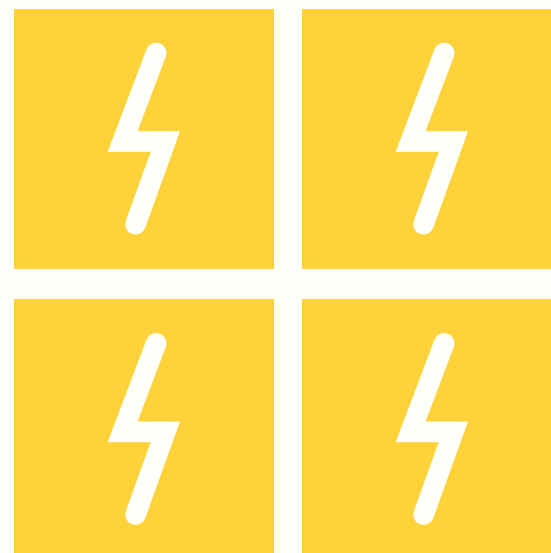
Silicon-Carbon Composites

Disadvantages

Although the expansion rate of silicon-carbon anodes is more controlled compared to silicon anodes during charging, it is still more pronounced than that of traditional graphite. After multiple cycles, silicon-carbon composites are more likely to experience material-structure changes, resulting in battery-performance degradation. The preparation process of silicon-carbon composites is intricate, involving precise control of nanostructured silicon and the composite morphology of silicon/carbon. This complexity leads to higher material-design and production-process costs.

2.5 More Systematic Battery Life Optimization Strategies

< Multi-Cell Solution >



Advantages

- Superior fast-charging performance: Multi-cell batteries can achieve higher charging power through multi-path current-sharing techniques (sharing charging current and/or voltage), which not only improves fast-charging efficiency but also reduces heat generation.
- Flexible design: The multi-cell design offers greater flexibility in adapting to complex mobile-phone structure layouts. It is particularly advantageous for ultra-thin and lightweight designs, facilitating efficient utilization of the limited internal space of mobile phones.
- Higher efficiency: When batteries are connected in series, the operating voltage can be directly increased. This reduces the transmission current and associated power losses, thereby enhancing the overall power-conversion efficiency.

Disadvantages

- Complex battery management: The multi-cell design necessitates more sophisticated circuit functions and precise control algorithms to monitor the operating status of each cell and ensure their balanced operation. Otherwise, cell-to-cell inconsistencies may arise, leading to a reduction in battery capacity and lifespan.
- Higher manufacturing costs: The processes of screening, matching, and assembling multiple cells, along with the requirement for a more elaborate battery management system (BMS), contribute to increased design and manufacturing costs.

< Fast-Charging Technology >



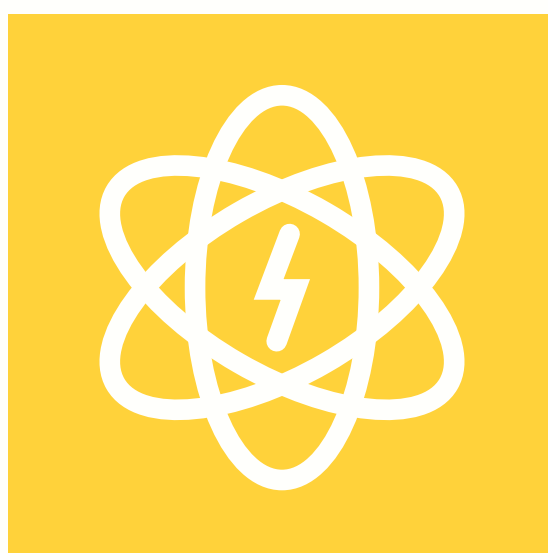
Advantages

The most notable advantage of fast-charging technology lies in its ability to markedly reduce charging time. This not only alleviates the so-called “low-battery anxiety” to a certain extent but also significantly enhances the user experience. By enabling rapid replenishment of battery power, it allows users to resume using their devices promptly, catering to the demands of a fast-paced lifestyle.

Disadvantages

- **Battery stress and degradation:** Fast charging subjects the battery to elevated stress levels. High-power charging can accelerate the battery’s degradation process, leading to more rapid capacity attenuation. This implies that the battery may reach the end of its useful life sooner than expected, necessitating earlier replacement.
- **Heat-generation issue:** During high-power fast charging, devices are prone to overheating. The generated heat not only affects the user experience but also exacerbates the negative impact of fast charging on the battery’s degradation. In extreme cases, overheating can even pose potential safety hazards, such as the risk of battery fires or explosions.
- **Lack of standardized technical norms:** Currently, the fast-charging technology landscape lacks unified norms. Many fast – charging technologies require mobile phone brands to provide dedicated charging heads and data cables. This lack of standardization makes it difficult to achieve compatibility between mobile phones and accessories from different brands, causing inconvenience for users who need to use different chargers in various scenarios.

< Intelligent Battery Management System (BMS) >



Through meticulous design and optimization, the BMS plays a crucial role in battery management. It can precisely control the charging process, striking a balance between charging speed and battery cycle life. When integrated with the mobile phone's power management system, the BMS can further optimize the device's heat dissipation and battery performance. Additionally, it offers more intelligent battery health management functions, such as real-time monitoring of battery status, prediction of battery degradation, and adjustment of charging strategies to extend the battery's lifespan and ensure its stable operation.

Chapter 3

Introduction of realme Solution

3.1 Charging Technology

320W

CHARGING TECHNOLOGY

⚡ $\frac{4420\text{mAh}}{4'30''}$ ⚡

240W

CHARGING TECHNOLOGY

⚡ $\frac{4500\text{mAh}}{9'00''}$ ⚡

150W/120W

DIRECT-CHARGING TECHNOLOGY

⚡ $\frac{\text{CHARGING EFFICIENCY}}{99.5\%}$ ⚡

100W

CHARGING TECHNOLOGY

⚡ $\frac{7200\text{mAh} \times 50\%}{20'00''}$ ⚡

FULL-PROTOCOL

BYPASS CHARGING TECHNOLOGY

⚡ Reduces the heat generated during gaming and decreases the number of battery charge cycles. ⚡

▪ **320W Charging Technology**

The 320W charging technology incorporates magnetic-coupling DCX step-down technology to convert 40V high-voltage input into 20V high-voltage output. This technology's unique physical properties enable it to instantaneously disconnect the high-voltage source from the battery, effectively preventing over-voltage risks. It also features the world's first foldable battery for smartphones. By dividing a single battery into four independent cells and utilizing flexible circuit boards and high-density stacking technology, these cells are folded and integrated into the mobile phone. Each cell has a thickness of only 2.9mm, yet its capacity is 10% higher than that of traditional designs. This remarkable design allows a 4420mAh battery to be fully charged in just 4 minutes and 30 seconds.

▪ **240W Charging Technology**

The 240W charging technology employs three charge pumps in parallel for current sharing. It disassembles the 20V high-voltage input into three independent outputs, ensuring balanced heat dissipation across the entire device. The 240W adapter, designed with dual-gallium nitride technology and paired with a 12A customized charging cable, can effectively control the temperature rise in the charging circuit. It also incorporates a time-power protection mechanism and private-protocol encryption function to guarantee user charging safety. Laboratory tests indicate that it can fully charge a mobile phone with an equivalent battery capacity of 4500mAh in approximately 9 minutes.

▪ **150W/120W Direct-Charging Technology**

The 150W and 120W direct-charging technologies leverage gallium-nitride direct-charging technology (two gallium-nitride components for 150W and one for 120W). This enables high-power charging while simultaneously reducing device heat generation, with a charging efficiency as high as 99.5%. Compared to charge-pump-based solutions, these technologies optimize the circuit-board layout space of the entire device, allowing for a more compact and efficient device design.

▪ **100W Charging Technology**

The 100W charging technology utilizes two charge pumps in parallel for low-voltage fast charging. It also places multiple tabs on a single cell to reduce the cell impedance, achieving "dual-channel fast charging". This design effectively reduces charging heat and improves charging speed. Moreover, it supports all-protocol types, making it compatible with mainstream adapters available in the market. Laboratory tests show that it can charge a mobile phone with a 7200mAh silicon-carbon battery to 50% in approximately 20 minutes.

▪ **Full-protocol Bypass Charging Technology**

To address the issues of device overheating during simultaneous charging and gaming and the impact of long-term adapter charging on battery life, the full-protocol bypass charging technology is introduced. This technology uniquely uses the adapter's high-current fast-charging path to power the mobile phone system while disconnecting the fast-charging path to the battery. The mobile phone then adjusts the charger's output current according to its system power consumption, ensuring that the charging current precisely matches the system's power demand. This not only maintains the phone's battery level but also reduces the heat generated during gaming and decreases the number of battery charge cycles.

3.2 Other Battery Technologies

▪ Battery balance technology:

In multi-cell series-connected battery configurations, discrepancies in cell consistency can lead to voltage imbalance among cells when achieving higher charging powers. This imbalance can result in a reduction in the battery's available capacity, a decline in its lifespan, and even pose safety risks. Battery balance technology addresses this issue by continuously monitoring the operating status of each cell and using the device's battery equalization circuit. This ensures that the voltages of all cells are balanced, thereby enhancing the charging power while also guaranteeing the long-term reliability and safety of the battery.



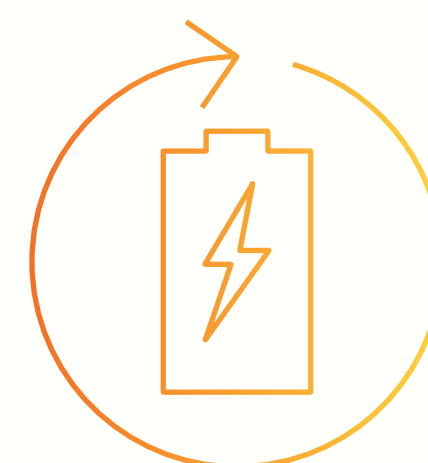
▪ Safety-system battery technology:

Safety-system battery technology is a comprehensive approach that integrates material innovation, structural design, intelligent management, and safety certification to construct a full-link protection system from the battery cell to the entire system. At the material level, it uses solid-state electrolytes, flame-retardant electrolytes, low-expansion silicon-carbon anodes, and high-stability cathode materials to enhance the inherent safety of the battery. Structurally, it adopts multi-cell independent packaging, aerogel thermal insulation, notch-type explosion-proof design, and three-dimensional heat-dissipation structures to strengthen physical protection. Intelligent management relies on a high-precision BMS system that integrates multiple sensors for real-time monitoring and dynamic regulation. It also incorporates AI algorithms to predict risks and respond promptly. Additionally, it complies with international standards such as UN38.3 and UL 2054 to ensure the battery's safety under extreme conditions like overcharging, high temperatures, and short-circuits, providing reliable protection for electronic devices and new energy applications.



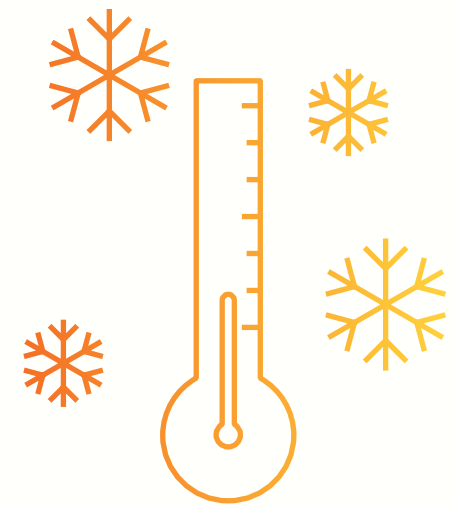
▪ Life-algorithm calculation technology:

Life-algorithm calculation technology involves building a mathematical model of the battery and continuously monitoring its usage status. By doing so, it can effectively prevent the occurrence of "lithium plating" throughout the battery's life cycle, maximizing the number of active lithium ions in the battery. This technology ensures fast charging while preventing overcharging and optimizing the use of battery capacity, thereby extending the battery's lifespan by more than 200 charge-discharge cycles.



▪ Extreme-cold mode (-20°C low-temperature) charging technology:

At low temperatures, the activity of the lithium-ion battery electrolyte decreases significantly. As a result, mobile devices usually limit battery charging or only allow low-current charging, which slows down the charging process for users. To overcome this issue, the extreme-cold mode charging technology is introduced. This technology utilizes the device's middle frame and graphite sheets as heat-transfer components. The device draws power from the adapter to pre-heat the battery, rapidly raising the battery temperature to a range suitable for normal or high-power fast charging. This effectively solves the charging difficulties in low-temperature scenarios and improves the charging speed in cold environments.



▪ High-energy-density battery technology:

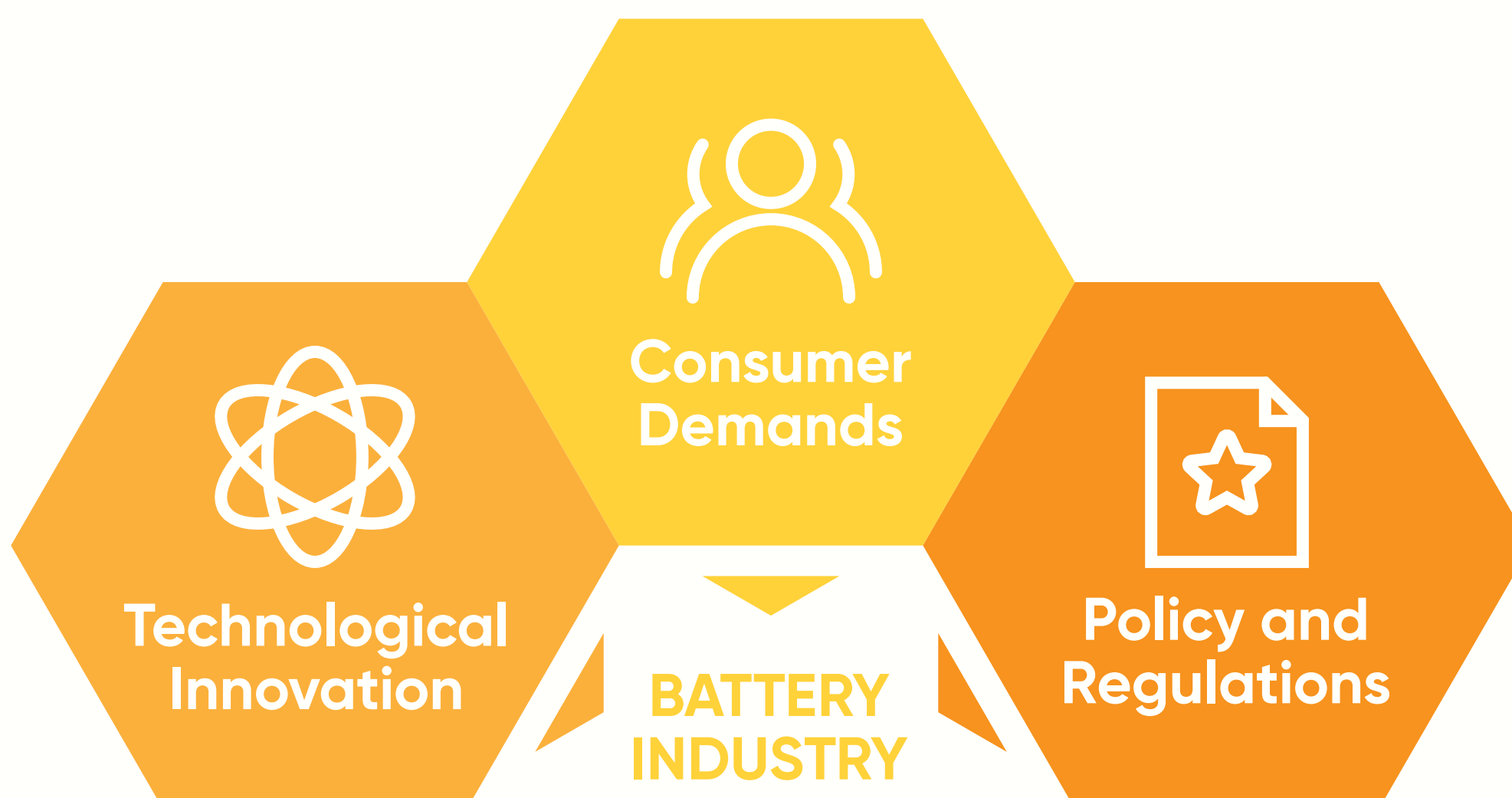
High-energy-density battery technology aims to significantly enhance the power-storage capacity per unit volume or mass through material system innovation, structural design optimization, and manufacturing process upgrading. In terms of materials, it uses high-nickel ternary materials (such as NCM811 and NCA) for the cathode to increase the specific capacity and pairs them with silicon-based anodes (silicon-carbon/silicon-oxygen composites) to break through the theoretical capacity limit of graphite. It also incorporates high-voltage electrolytes (supporting charging above 4.5V) and solid-state electrolytes (with an energy density of over 500Wh/kg) to form a core material system. Structurally, it adopts technologies like CTP (Cell to Pack) to reduce redundant components (for example, BYD's blade-shaped battery increases volume utilization by 50%), 4680 large-cylinder batteries (used by Tesla, with a 5-fold increase in capacity), and CTC (Cell to Chassis) integrated design to maximize space-utilization efficiency. In the manufacturing process, technologies such as dry-electrode processing (reducing internal resistance by 20%) and nano-coating of silicon-based anodes (suppressing expansion) are introduced to balance energy density and cycle life.



Chapter 4

Future Trends of Battery Technologies

In the future, mobile phone batteries are expected to evolve towards higher energy density, enhanced safety, and environmental sustainability. The confluence of market demands and technological innovation will drive the progress of the industry.



Driven by Technological Innovation:

Key performance dimensions of mobile phone batteries, including environmental adaptability (both high and low temperatures), cycle life, safety, rate performance (charging and discharging), and high energy density (in terms of volume and weight), are set to be influenced by technological advancements. In the short term, the progress and industrial application of advanced battery technologies will lead to varying degrees of improvement in some of these dimensions. In the long run, with the gradual breakthrough of battery technologies, a comprehensive enhancement across all five dimensions is anticipated.

Driven by consumer demand:

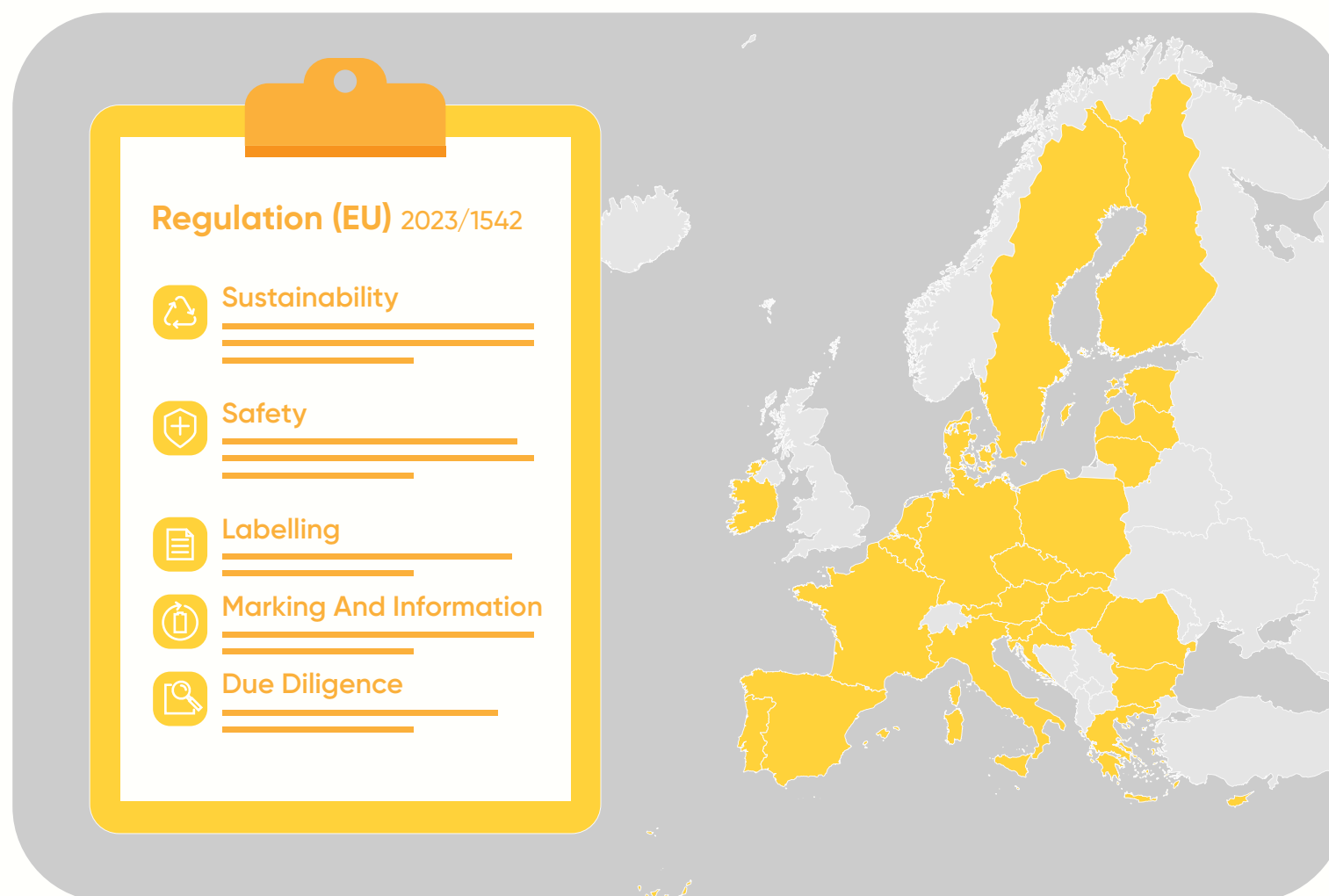
With the enhancement of smartphone functions such as 5G and end-to-end AI, as well as the increasingly exquisite game graphics and software interfaces, high-performance baseband and SoC will put higher demands on batteries. Under the limitations of mobile phone usage scenarios, future mobile phone batteries will inevitably need to provide longer battery life for phones under the requirements of small size and light weight.

- **High-energy-consumption challenges from 5G technology:** 5G technology, with its high-speed data transfer, low latency, and large-capacity communication capabilities, offers users an unprecedented mobile-internet experience, enabling seamless high-definition video streaming and instant-response cloud gaming. However, it also significantly increases the power consumption of mobile phones. The power consumption of 5G chips is notably higher than that of 4G chips. The continuous high-frequency signal processing during data transmission accelerates the depletion of the phone's battery. Tests show that when conducting continuous video calls or large-file downloads in a 5G network, the battery power consumption rate is 20%-30% faster than in a 4G network. Therefore, there is an urgent need for batteries with higher energy density to store more power and for fast-charging technologies to rapidly replenish power, meeting the battery-life requirements of users during frequent 5G usage.
- **Increasing energy-consumption and battery performance requirements from high-performance SoC:** High-performance SoCs, such as the Snapdragon 8 Gen series and Dimensity 9000 series, continuously improve the computing speed and graphics-processing capabilities of mobile phones, enabling smooth handling of complex multitasking and high-end 3D games. However, this high-performance operation comes at the cost of high energy consumption. For example, when running graphically-intensive games like "Genshin Impact" with high-quality settings, the phone's processor operates under high load for extended periods, leading to rapid battery depletion. To adapt to high-performance SoCs, batteries need to not only increase energy density but also optimize discharge characteristics to ensure stable and continuous power output. Meanwhile, fast-charging technologies need to further increase power to quickly recharge the battery and maintain the phone's battery life during high-performance operation.
- **New requirements of AI applications for batteries and fast-charging:** AI applications in mobile phones are becoming increasingly widespread, covering areas such as intelligent voice assistants, intelligent photo optimization, and real-time translation. The operation of AI algorithms requires continuous computing power support, which significantly increases the computational load of the phone's processor and thus raises energy consumption. For instance, when using AI for real-time high-definition video beautification, the phone's energy consumption rises noticeably. AI also drives the continuous improvement of the phone's data-processing capabilities, such as AI-based analysis of a large number of images and videos, further burdening the battery. To meet the requirements of AI applications, batteries need to have higher energy-conversion efficiency to reduce energy losses, and fast-charging technologies need to quickly restore battery power to ensure the continuous operation of AI functions.

- **Long-lasting demand: All-day battery life:** Consumers' reliance on mobile phones is growing steadily, with usage scenarios expanding from daily communication and social entertainment to mobile work. They expect mobile phones to last throughout the day without the need for recharging, whether they are traveling, working long hours, or participating in extended activities. A long-lasting battery can relieve users of "battery anxiety". Market research shows that over 70% of consumers consider battery life as a crucial factor when purchasing a mobile phone. They hope that the battery capacity of mobile phones can be further increased from the current common range of 4000–6000mAh while maintaining the phone's slim and portable design.
- **Fast-charging: Rapid power replenishment:** In today's fast-paced life, consumers desire to fully charge their mobile phones in a short time. Fast-charging technology allows users to quickly recharge their phones during fragmented time intervals, such as during breakfast or lunch breaks. For example, if a user finds that their phone has low battery power before going out in the morning, a high-power fast-charging-enabled phone can be charged with a significant amount of power in 15–30 minutes, meeting the initial usage requirements for the day. In the market, an increasing number of consumers prefer mobile phones that support 65W, 120W, or even higher-power fast-charging. The expectation for faster charging speeds continues to rise, aiming for a shorter time to reach a full-charge state and further enhancing the convenience of mobile phone use.

Driven by Policy and Regulations:

- **The far-reaching impact of the EU Battery Law:** The EU's "New Battery Law", Regulation (EU) 2023/1542, entered into force on August 17, 2023, and was implemented starting from February 18, 2024. This regulation governs the battery industry from multiple perspectives, driving battery enterprises to optimize production processes, improve recycling mechanisms, enhance circular utilization, and advance the industry toward low-emission, low-consumption, and high-performance development.



- **Global trends in battery policy:** Aligned with the global trends of carbon neutrality and sustainability, other countries or regional organizations will inevitably impose requirements on the battery industry across key stages, from raw material production to end-of-life battery management. Against the backdrop of uneven raw material distribution, coupled with the surging demand for lithium-ion batteries and increasingly comprehensive regulatory policies, the battery industry is compelled to optimize extraction processes, perfect recycling technologies, and standardize circular utilization practices.



Chapter 5

Summary and Forecast

As a vital tool for communication, mobile phones have witnessed a significant optimization in both performance and battery life. This progress is attributed to the collective advancements in multiple fields, including battery materials, chip manufacturing, and software development. With the continuous exploration of the mobile phone industry and the application of advanced technologies, mobile phone battery life is expected to reach new heights in tandem with performance improvements. It is reasonable to anticipate that in the near future, the battery capacity of mobile phones will exceed 10000mAh, providing a more enduring battery life experience. This will revolutionize users' perceptions of mobile phone charging frequencies, allowing them to use their devices more freely without constantly search for charging facilities, truly achieving "all-day worry-free" battery life.

TÜV Rheinland, a leading independent inspection, testing, and certification institution, will continue to collaborate closely with realme in mobile phone battery life technologies. We will jointly conduct in-depth research to tackle various technical challenges in the process of increasing battery capacity. TÜV Rheinland, with its strict standards and professional testing procedures, ensures that while pursuing high-capacity batteries, key indicators such as safety, stability, and service life can also reach industry-leading levels. This enables users to enjoy extended battery life without any concern, jointly opening a new chapter in mobile phone battery life technology and leading the industry towards a higher battery performance era.