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Commentary & Opinion

Why Are Battery Electrolytes Feared? A Battery Scientist's Perspective on Public Perception, Risk, and Responsibility

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Abstract. As batteries become essential to modern society, concerns surrounding their safety have grown significantly, particularly regarding the danger of electrolytes in used batteries. Among the general public, battery electrolytes are frequently viewed as inherently toxic, corrosive, and high environmental risk, regardless of battery chemistry or condition. From the perspective of a battery scientist, this perception often diverges significantly from scientific risk assessment. This opinion paper reflects on how public fear of battery electrolytes has developed, the reasons for its persistence, and how it contrasts with established knowledge in electrochemistry and materials science. It is important to recognize that while battery electrolytes are hazardous under certain conditions, the real-world risks associated with used batteries are often overstated. This gap between perception and reality has important implications for recycling behavior, regulatory policy, and public trust in energy technologies. Finally, the discussion highlights the responsibility of battery scientists to engage more actively in risk communication and proposes strategies to foster a more balanced, evidence-based public understanding of electrolyte hazards.

Keywords: Battery safety; Electrolyte hazard; Public perception; Risk communication; Lithium-ion batteries; Battery recycling

1. Introduction

Battery technologies now support daily life, from smartphones and laptops to electric vehicles and grid-scale energy storage systems. The rapid expansion of electric vehicles and grid-scale storage systems is strongly supported by international energy outlooks (IEA, 2026). Lithium-ion batteries dominate this expansion due to their high energy density and declining cost trajectory (Hasan et al., 2025; Orangi et al., 2024). With this widespread adoption has come increased attention to the safety and environmental impact of batteries, particularly at the end of their life cycle. Among the many components of a battery, the electrolyte has emerged in public concern. Phrases such as toxic battery chemicals, dangerous battery liquid, or acid leaking from batteries are commonly encountered in media reports and informal discussions (Figure 1).

As a battery scientist working closely with electrochemical materials and systems, A clear disconnect exists between public perceptions of battery electrolytes and the way these materials are interpreted within the scientific community. While electrolytes undeniably possess hazardous properties, the assumption that used batteries are universally dangerous does not reflect all relevant details. In scientific risk assessment, it is important to distinguish between hazard, exposure, and probability of failure. Hazard refers to the intrinsic chemical properties of a material, whereas risk depends on whether exposure occurs and how likely a failure event is under real operating or disposal conditions. This perception gap likely arises from several interacting factors, including limited public familiarity with scientific risk assessment, media coverage that often highlights rare battery failure events, and regulatory hazard classifications that may be interpreted by non-specialists as indicators of immediate danger rather than conditional risk.

This opinion paper does not dismiss public concerns as irrational. Public fear often reflects genuine uncertainty when people encounter complex technologies. However, when concerns are shaped by incomplete or inaccurate information, they may lead to unintended consequences. These include resistance to battery recycling programs, improper disposal practices, and regulatory measures that do not align with actual risk levels (Mathew et al., 2023). This article

examines why battery electrolytes are perceived as dangerous, how this perception differs from established principles of scientific risk assessment, and what role battery scientists should play in addressing this gap.



Figure 1. The contrast between public perception and scientific assessment of battery electrolyte hazards.

2. Electrolytes Through the Eyes of a Battery Scientist

In electrochemical terms, an electrolyte is simply a medium that allows ionic transport between electrodes while preventing electronic conduction (Boz et al., 2021). Depending on the battery chemistry, electrolytes may be aqueous, organic, polymeric, or solid-state in nature. From a scientific standpoint, electrolytes are not defined by danger but by function.

In lead–acid batteries, the electrolyte is sulfuric acid in water. In lithium-ion batteries, it is typically a mixture of organic carbonate solvents containing lithium salts such as $LiPF_6$ (Larsson et al., 2017). Nickel-based batteries rely on alkaline electrolytes such as potassium hydroxide (Breddemann et al., 2025; Evans et al., 2024). Each of these systems has distinct chemical properties, hazards, and failure modes.

To scientists, these differences are fundamental. To the public, however, they are often collapsed into a single category: battery chemicals.

One of the most persistent challenges in public communication is the distinction between hazard and risk. Hazard refers to the intrinsic properties of a substance, for example, whether it is corrosive, flammable, or toxic. Risk, however, depends on the likelihood and severity of exposure. Battery electrolytes are hazardous materials, a fact that is widely acknowledged. However, in used batteries, electrolytes are typically: (i) sealed within multilayer casings, (ii) present in limited quantities, and (iii) inaccessible without deliberate mechanical or thermal abuse. From a scientific perspective, this dramatically reduces exposure probability, and therefore risk. Yet public discussions often treat hazard as synonymous with inevitable harm.

3. How Public Fear of Battery Electrolytes Emerges

Language plays a central role in shaping perception. Terms such as acid, chemical, and toxic are emotionally loaded and often evoke immediate danger. When these words are used without context, they reinforce fear rather than understanding. For example, describing lithium-ion batteries as containing "flammable chemicals" is technically accurate but incomplete. It fails to convey that these chemicals are stable under normal conditions and become dangerous primarily under abuse scenarios such as overheating, crushing, or internal short circuiting (Feng et al., 2018).

Battery related accidents, particularly fires, involving electric vehicles or consumer electronics receive significant media attention. In many cases, the underlying mechanisms involve thermal runaway, electrical faults, or mechanical damage. However, these events are often simplified into narratives about "dangerous battery chemicals," reinforcing the idea that electrolyte toxicity is the primary threat. Such narratives rarely distinguish between (i) intact used batteries, (ii) damaged batteries, (iii) industrial scale battery systems, and (iv) small consumer cells. As a result, the public perception of electrolyte danger is shaped by worst-case scenarios rather than typical conditions.

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4. Used Batteries: What the Science Actually Says

From a scientific standpoint, the danger posed by a used battery depends far more on its physical condition than on the mere presence of electrolyte (Sun & Xu, 2024). An intact lithium-ion battery at end of life, stored and handled correctly, presents minimal chemical exposure risk. In contrast, a mechanically damaged battery can pose both chemical and thermal hazards. This distinction is rarely made outside technical circles. Many people assume that a used battery is more dangerous simply because it is old, rather than considering whether it has been compromised.

Another overlooked factor is scale. The quantity of electrolyte in small consumer batteries is often on the order of grams or milliliters. While still hazardous, this is vastly different from industrial chemical spills that often inform public imagination. Scientists instinctively consider dose, exposure route, and duration. Public discourse, however, tends to treat any amount of hazardous material as equally dangerous, regardless of scale.

5. Consequences of Misaligned Perception

Fear of electrolyte danger can discourage individuals from participating in battery recycling programs. Some people avoid handling used batteries altogether, leaving them in household waste. Ironically, this behavior can increase overall risk by concentrating batteries in uncontrolled environments. From a sustainability perspective, exaggerated fear can hinder the circular economy needed for battery technologies. Public pressure driven by fear can lead to regulations that focus on visible safety measures rather than evidence-based risk management. Strict handling standards are necessary for industrial scale battery processing. However, applying the same level of restriction to small consumer batteries may reduce recycling efficiency without greatly improving safety. In many cases, policies related to battery technologies are shaped more by public perception than by quantitative risk assessment.

6. The Role of Battery Scientist

Historically, many scientists have assumed that technical accuracy alone is sufficient, that facts will speak for themselves. In the context of battery safety, this assumption has proven inadequate. When scientists remain silent, public narratives are filled by speculation and incomplete information. Given the scientific understanding of both the hazards and the safeguards associated with battery electrolytes, active engagement from the battery research community is an ethical responsibility. Effective communication does not mean denying danger. It means explaining danger in context. For example, stating that "battery electrolytes can be hazardous if released" should be accompanied by explanations of when release is likely and how often it occurs. This approach respects public concern while providing clearer understanding of the real risks.

7. Toward a More Balanced Public Understanding

Rather than attempting to convince the public that battery electrolytes are safe, scientists should aim to improve risk literacy. This includes: (i) explaining the difference between hazard and risk, (ii) emphasizing the role of containment and design, and (iii) clarifying realistic failure scenarios. Battery safety communication should not be left solely to academic papers. Collaboration with educators, recycling agencies, and policymakers can help translate scientific understanding into accessible guidance for the public.

8. Conclusion

Public concern about battery electrolytes reflects broader anxiety about complex, invisible technologies that underpin modern life. While these concerns are understandable, they often diverge from scientific assessments of risk. As a battery scientist, I believe that the challenge is not to dismiss public fear, but to contextualize it. Electrolytes in used batteries are hazardous substances, but they are not inherently dangerous objects in everyday contexts. Recognizing this distinction is essential for fostering trust in battery technologies, improving recycling practices, and enabling informed policy decisions. Scientific risk assessment can also support the development of practical policy frameworks. By considering exposure pathways and the probability of failure, regulations can focus on stages where risks are most likely to occur, such as battery transport, storage, and recycling operations. Such targeted approaches help maintain safety while also supporting the expansion of large-scale battery recycling systems. Bridging the gap between perception and reality will require active engagement from the battery science community not only as researchers, but as communicators.

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