
A DARKER SHADE OF GREEN: HAZARDS ASSOCIATED WITH LITHIUM-
ION BATTERIES

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I. Introduction

Just as the invention of fire was integral to the survival of Neanderthals, Lithium-Ion (“li-ion”) batteries are indispensable to Millennials. In today’s modern, technology-driven world, the li-ion battery can be used to power electronic devices ranging from cell phones, to laptops, and even to cars.¹ At its most basic level, a battery is “a device that stores electrical energy,” which can be transferred through an “easily controlled electro-chemical reaction” to power many of the electronic devices employed today.² A li-ion bat-

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¹ See *Lithium-ion Batteries*, PHYSICS CENTRAL (2015), archived at <https://perma.cc/8TDQ-4HZN> (noting the various electronic devices that can be powered by a lithium-ion battery).

² See *id.* (explaining the basic process by which batteries charge and transfer energy). More specifically, a battery is composed of “a series of cells that produce electricity,” with each cell consisting of “three essential components: the anode, the cathode, and the electrolyte.” *Id.* The anode “donates” electrons, as the cathode is on the receiving end of those electrons, and the difference between “electrode potentials” is what ultimately determines the voltage. *Id.* The anode and the cathode are connected by a wire, but separated by the electrolyte, which usually takes the form of some kind of liquid or gel, which acts as a conductor of electricity. *Id.* The process that this single cell then undergoes is referred to as “reduction-oxidation,” which is the chemical reaction that actually produces the energy used to power an electronic device; this process eventually erodes the anode and cathode, which ultimately results in a battery dying. *Id.*

tery, more specifically, is a rechargeable battery, where the stored energy is depleted with use, but has the capability of being restored by plugging the battery, charger, or device into a power outlet, enabling a device to be “recharged many times over without much loss of capacity.”³ Li-ion batteries also possess a higher voltage than a standard alkaline battery, thus making li-ion batteries more advantageous.⁴

As miraculous as the lithium-ion battery may sound, that is not to say that this technological advancement does not have its drawbacks. The least of these concerns may be that extended use of li-ion batteries over time will eventually decrease the charging capacity of the battery, or decrease the amount of energy that is able to be stored in a li-ion battery, resulting in an overall decrease in the battery life of an electronic device.⁵ A more sinister issue, and frankly the focus of this Note, is the danger associated with a malfunctioning li-ion battery.⁶

Overcharging and extended use of a li-ion battery can wear on the internal components of a battery, and thus make the battery susceptible to overheating.⁷ When the internal components overheat, the

³ See *Lithium-ion Batteries*, *supra* note 1 (discussing the methods by which li-ion batteries can be recharged). Li-ion batteries are recharged, when plugged into a power source, by running the anode and cathode reactions in reverse; so rather than the anode sending electrons to the cathode, it is the cathode that sends electrons to the anode. *Id.* A power source does not have to be a wall socket in particular; plugging an electronic device into a car’s cigarette lighter, or other power outlet, achieves the same desired result. *Id.*

⁴ See *Lithium-ion Batteries*, *supra* note 1 (comparing li-ion batteries to alkaline batteries). In a li-ion battery, lithium-ion is the positively charged ion that runs from anode to cathode; the inclusion of li-ion in this process is what produces a higher voltage. *Id.* A higher voltage ultimately gives li-ion batteries a better “energy density” than alkaline batteries or other, lesser rechargeable batteries. *Id.* This is due in large part to the relatively small size of the element lithium, which is the third smallest element on the periodic table. *Id.* Thus, lithium ions can keep an electrical charge in a very small amount of space. *Id.*

⁵ See *Lithium-ion Batteries*, *supra* note 1 (providing examples of electronic devices, such as cell phones and laptops, where the batteries’ capacity to hold a charge decreases over time).

⁶ See *Lithium-ion Batteries*, *supra* note 1 (addressing that the two major concerns with li-ion batteries are overheating and overcharging).

⁷ See *Lithium-ion Batteries*, *supra* note 1 (discussing that a potential problem with li-ion batteries is overheating at the anode and oxygen production due to overcharging at the cathode, which creates good conditions for a fire and is most likely to occur during the charging of the battery).

most common result is the battery itself catching fire.⁸ When a li-ion battery catches fire, contrary to popular belief, water may be ineffective in suppressing the fire, and electronics users may not have the knowledge or awareness to place the battery outside to ventilate.⁹ A naïve pedestrian, not knowing the complexity of the issue, is placed in excess danger when attempting to extinguish such a fire.¹⁰ Aside from the physical hazards alone, the issue of liability remains. Is it the responsibility of the consumer to fully understand the implications of his or her use, even when the product is used as intended? Or should the onus of liability fall upon the manufacturer or company that places an unsafe product into the stream of commerce?

II. History

A. *Inception and Evolution of Lithium-Ion Technology*

In 2014, John Bannister Goodenough, a German physicist, was recognized by the National Academy of Engineering for his prominent role in the creation of the lithium-ion battery.¹¹ Goodenough's work did not start there; rather, this award stemmed from a lifetime of work beginning at England's Oxford University back in 1979 with Dr. Peter G. Dickens.¹² Thanks to their discovery, a dec-

⁸ See *Lithium-ion Batteries*, *supra* note 1 (recognizing that when a li-ion battery overheats, it creates an ideal condition for a fire, but there are also other potential outcomes that can occur from overheating).

⁹ See Michael Bell, *Lithium-Ion Battery Fire*, NASA (May 18, 2010), *archived at* <https://perma.cc/U7VQ-VWB8> (indicating that toxic gasses are emitted by a li-ion battery when it overheats, thus making it unsafe to remain in an unventilated area).

¹⁰ See Andrew McClary, *Aren't Lithium Ion Batteries A Fire Hazard?*, HIGH VOLTAGE HOT RODS (2015), *archived at* <https://perma.cc/R36M-3C24> (explaining that lithium-ion batteries need to be treated with caution because there is always a danger involved when the product contains stored energy).

¹¹ See *UT Austin's John B. Goodenough Wins Engineering's Highest Honor for Pioneering Lithium-Ion Battery*, UT NEWS (Jan. 6, 2014), *archived at* <https://perma.cc/P82C-WLYS> (expressing the University's appreciation for Goodenough's accomplishment). John B. Goodenough is now a professor at the University of Texas. *Id.*

¹² See JOHN B. GOODENOUGH & PETER G. DICKENS, UNIV. OF OXFORD INORGANIC CHEMISTRY LAB., *NEW MATERIALS FOR ELECTROCHEMICAL CELLS* (1981), *archived at* <https://perma.cc/4YH8-VLA2> (citing a final report for Goodenough and Dickens' discovery at the University of Oxford). This report concentrates on li-ion as an electrical conductor. *Id.*

ade later, in 1991, Sony became “the first in the world to commercialize a lithium-ion rechargeable battery, forever changing the history of mobile devices.”¹³ Since 1991, the market for devices powered by lithium technology has seen an “explosive growth,” namely because of a demand for portable electronic devices.¹⁴ Perhaps this boom in demand can also be attributed to the many advantages lithium-ion batteries have in comparison to other forms of energy storage, including “higher energy density,” “relatively low self-discharge,” and “minimal upkeep.”¹⁵ For the average consumer who is not well versed in the nuances of the technology behind lithium-ion batteries, preference for these batteries is most likely attributed to “higher terminal voltages” (i.e. longer battery lives), plus the lightweight metal and compact size of the battery, which makes for sleeker, sexier electronics.¹⁶

B. Dangers Associated with Lithium-Ion Batteries

There are some aspects of lithium-ion battery usage that are cause for concern.¹⁷ First and foremost, there is a process called a “thermal runaway reaction” that can occur from overcharging a lithium-ion battery, which ultimately results in battery failure, and in some instances, flammable gasses are vented and may ignite.¹⁸ Aside from over-

¹³ See *About Sony*, SONY ENERGY DEVICES CORPORATION, archived at <https://perma.cc/T24F-C4FJ> (reviewing the history behind Sony products and Sony energy devices). This article includes a small history section of “gel polymers” used in lithium-ion batteries, where the lithium-ion itself serves as the electrolyte that is essential to the battery. *Id.*

¹⁴ See Ralph J. Brodd, *Comments on the History of Lithium-Ion Batteries*, ELECTROCHEM, archived at <https://perma.cc/6B3B-EYFV> (explaining briefly the inner workings of the lithium-ion battery and reasons behind a boom in consumption of products containing lithium-ion batteries).

¹⁵ See *Lithium Ion Battery History*, PMBL LIMITED (2015), archived at <https://perma.cc/NR8F-A7HC> (presenting a limited history of lithium-ion batteries and noting a few advantages).

¹⁶ See *Hooked on lithium*, ECONOMIST (June 20, 2002), archived at <https://perma.cc/YS94-3ZB7> (highlighting the prominence of lithium-ion batteries and recognizing the advantages of the technology).

¹⁷ See R. Thomas Long et al., *Lithium-Ion Battery Hazards*, FIRE PROTECTION ENGINEERING (Oct. 7, 2012), archived at <https://perma.cc/FVY7-XNKB> (focusing on the hazards associated with lithium-ion batteries).

¹⁸ See *id.* (describing consequences resulting from thermal runaway reaction that occur from overcharging a battery). The process of a thermal runaway reaction is as follows: a cell’s internal temperature increases, which increases a cell’s internal

charging, there are other causes of battery failures, which can contribute to an eventual fire.¹⁹ Precariously, an effective “fire suppression strategy” has not yet been developed to combat fires caused by li-ion batteries.²⁰ Perhaps even more alarming is that in the event of a fire there are additional hazards to be aware of aside from the fire itself.²¹

The next logical place to turn to is the effect that li-ion batteries have on the environment, and although this technology has not yet been in circulation long enough to fully grasp the long-term effects, in comparison to other batteries, the environmental impact appears to be minimal, but not insubstantial.²² The Environmental Protection

pressure, a cell then undergoes a venting of gasses (which are flammable and may ignite), contents of the cell may eject, in which case, this “thermal runaway” may spread to nearby cells. *Id.*

¹⁹ *See id.* (recognizing other factors that cause thermal stability limits of li-ion batteries to fail). In addition to overcharging, other factors that can contribute to battery failure are as follows: “thermal abuse” (external heating), “mechanical abuse” (dropping or denting), “electrical abuse” (short circuiting or over-discharge), “poor cell electromechanical design” (imbalance between positive and negative electrodes), and “internal cell faults associated with cell manufacturing defects” (poor electrode alignment). *Id.* Any one of these factors can contribute to a cell becoming unstable. *Id.*

²⁰ *See Long, supra* note 17 (inferring that there is no standard for putting out fires caused by a malfunctioning li-ion battery). At the moment there are no “fire protection standards specific to li-ion cells.” *Id.* There is no proof that a “water based suppression system” is a good system for extinguishing fires caused by a li-ion battery. *Id.* In fact, experimental testing of water based suppression systems have “shown to provide a minimum level of protection.” *Id.*

²¹ *See Long, supra* note 17 (realizing the additional hazards posed by a li-ion battery that catches fire). In addition to the fire itself, there are subsequent hazards created by an electrical fire. *Id.* Most notably, the “venting and projectile potential” of li-ion batteries make a combusting battery even more hazardous. *Id.* A combusting battery draws comparisons to ammunition or butane lighters combusting, with reference to projectiles ejecting. *Id.* There are also comparisons to aerosol products with a flammable propellant because there are flammable gasses venting, posing a threat of further ignition, which is also the case with a li-ion battery. *Id.*

²² *See John C. Monica, Jr., Nanotechnology Environmental Regulatory Issues, in NANOTECHNOLOGY LAW* § 4:103 (2015) (evaluating the environmental impact of li-ion batteries). To better analyze the environmental impact, it is important to analyze the six stages of the “product life cycle,” which are as follows: “materials extraction, materials processing, component manufacturing, product manufacturing, product use, and end of life.” *Id.* It was also determined that global warming potential was still greater with the use of coal and fossil fuels than it was with the use of lithium-ion batteries. *Id.*

Agency (“EPA”) put together a “life-cycle assessment” to further explore the environmental impact of the use of li-ion batteries, and made recommendations based off of their findings.²³ Considering the nuanced nature of li-ion batteries and their relatively recent prominence on the international stage, there is not yet expansive, developed law on this subject, but there is, however, at least some brief federal recognition in the United States Code Annotated.²⁴

C. Product Liability Law in General

Beginning around the mid-nineteenth century, product liability law became relevant in American jurisprudence as a sort of blending of tort law and contract law.²⁵ Perhaps the very first case that sets the stage for today’s product liability law is a nineteenth century English case, *Winterbottom v. Wright*,²⁶ where the concept of “privity” is first developed.²⁷ Albeit true, at that time, privity became a

²³ See Shanika Amarakoon et al., *Application of Life-Cycle Assessment to Nanoscale Technology: Lithium-Ion Batteries for Electric Vehicles*, ENVTL. PROTECTION AGENCY (Apr. 24, 2013), archived at <https://perma.cc/2XM2-C2GA> (assessing impacts of use of li-ion batteries on public health and environment). The EPA made suggestions to lessen the negative effects on the environment caused from the life cycles of li-ion batteries. *Id.* Their recommendations are as follows: “increase the lifetime of the battery, reduce cobalt and nickel use, reduce the percentage of metals by mass, incorporate recovered material in the production of the battery, use a solvent-less process in battery manufacturing, reassess manufacturing process and upstream materials selection to reduce primary energy use for the cathode, and produce the anode more efficiently for commercialization.” *Id.*

²⁴ See 15 U.S.C. § 2064 (2012) (examining the law surrounding hazardous products including li-ion batteries).

²⁵ See 1 FRUMER & FRIEDMAN, PRODUCTS LIABILITY § 1.01 (Matthew Bender, rev. ed., 2015) (describing how product liability law came to existence as a sort of meshing of tort law and contract law). It is well established that negligence is a popular tort in the United States, and negligence with a contractual backdrop essentially led to the creation of product liability law. *Id.* Put more eloquently, “a contractual virus was being transmitted across the Atlantic Ocean from the former mother country that was to have a profound effect on negligence for more than seven decades.” *Id.* However, followers of Oliver Wendell Holmes, Jr., a famed legal scholar, may argue “negligence principles (e.g., ‘fault’) were always present in the common law and merely became expanded upon by the state courts in the nineteenth century.” *Id.*

²⁶ (1842) 152 Eng. Rep. 402 (EP).

²⁷ See *Winterbottom*, 152 Eng. Rep. at 405 (establishing the concept of privity). The Postmaster-General contracted with Wright to repair a coach and keep it in

requisite for the finding of contractual or tortious liability, however, this is not a steadfast rule, evidenced by the holding in *Thomas v. Winchester*.²⁸ Here, Chief Judge Ruggles delivered the opinion of the court, holding that absent privity, a defendant may still be liable when “the defendant’s duty [arises] out of the nature of his business and the danger to others incident to its mismanagement.”²⁹ Then, *Huset v. J. I. Case Threshing Machine Co.* established three exceptions to the privity rule, which would eventually become the precedent for which this case is remembered.³⁰ At the time, Chief Judge Sanborn was reluctant to “overthrow or shake the established rule,”

good condition. *Id.* at 402-03. Atkinson also contracted with the Postmaster-General to provide the horses, and hired Winterbottom to drive. *Id.* at 403. Winterbottom was driving the coach and, due to a latent defect, was thrown from the coach and injured. *Id.* Winterbottom proceeded to sue Wright for damages resulting from his injuries but the court refused to award Winterbottom damages, as he had not contracted with Wright; hence, there was no “privity of contract.” *Id.* at 405. Perhaps the concept is stated best by Lord Abinger in his opinion, “[u]nless we confine the operation of such contracts as this to the parties who entered into them, the most absurd and outrageous consequences, to which I can see no limit, would ensue.” *Id.*

²⁸ See *Thomas v. Winchester*, 6 N.Y. 397, 402 (1852) (holding that privity need not be necessary to “entitle the aggrieved party to sue”); see also FRUMER & FRIEDMAN, *supra* note 25 (distinguishing the ruling of *Winterbottom* from that of *Thomas*). *Thomas* has long been considered the “best reason” for the privity rule, but also proved that the rule is not infallible. *Id.* Historically speaking, this case also may be viewed as the “first dent in the still-new armor of privity.” *Id.*

²⁹ See *Thomas*, 6 N.Y. at 410 (understanding that a “distinction is recognized between an act of negligence imminently dangerous to the lives of others, and one that is not so”). Ultimately, when the subject of a negligence lawsuit pertains to dangerous activities that are readily apparent, the negligent party is liable regardless of the existence of privity of contract. *Id.* Put simply, “the defendant is justly responsible for the probable consequences of the act.” *Id.* Perhaps the best analogy in the court’s opinion is that “[t]he owner of a loaded gun who puts it into the hands of a child by whose indiscretion it is discharged, is liable for the damage occasioned by the discharge.” *Id.* The policy reasoning behind such a rule is ultimately that the law values human life so greatly that “it admits no justification wherever life has been lost and the carelessness or negligence of one person has contributed to the death of another.” *Id.* at 409.

³⁰ See *Huset v. J. I. Case Threshing Mach. Co.*, 120 F. 865, 870 (8th Cir. 1903) (introducing exceptions to the privity rule into product liability law); see also FRUMER & FRIEDMAN, *supra* note 25 (setting forth the exceptions for which the privity rule would ultimately cede legal prominence). In the opinion of the court, the judge makes note that negligence actions “are for breaches of duty.” *Id.* Also, absent an independent, intervening cause for a plaintiff’s injury, a manufacturer’s negligence will not be “insulated” from liability to the aggrieved party. *Id.*

but nevertheless delivered an opinion of the court that helped guide product liability law to the position it is today.³¹ The “virtual disappearance” of privity from product liability law is further developed by the court in *MacPherson v. Buick Motor Co.*³² The court in *MacPherson* held that regardless of contractual agreements, when a manufacturer markets his product to the public, “[i]f he is negligent, where danger is to be foreseen, a liability will follow.”³³

With the issue of privity in product liability law all but expelled, and keeping with the theme of automobile cases, *Henningsen*

³¹ See *Huset*, 120 F. at 870 (noting that at the time of the opinion, the court did not intend to open the door for the demise of the privity rule). The first step to the ultimate abandonment of the privity rule in product liability law was, in fact, Chief Judge Sanborn’s three exceptions, even though he believed these exceptions were “insufficient in themselves” to do so. *Id.* The first exception is that an “act of negligence of a manufacturer or vendor which is imminently dangerous to the life or health of mankind, and which is committed in the preparation or sale of an article intended to preserve, destroy, or affect human life, is actionable by third parties who suffer from the negligence.” *Id.* The second exception is that an “owner’s act of negligence which causes injury to one who is invited by him to use his defective appliance upon the owner’s premises may form the basis of an action against the owner.” *Id.* at 870-71. Lastly, the third exception is that “one who sells or delivers an article which he knows to be imminently dangerous to life or limb to another without notice of its qualities is liable to any person who suffers an injury therefrom which might have been reasonably anticipated, whether there were any contractual relations.” *Id.* at 871.

³² See *MacPherson v. Buick Motor Co.*, 217 N.Y. 382, 400-01 (1916) (supporting previous court decisions by delineating privity from product liability law in the present case); see also FRUMER & FRIEDMAN, *supra* note 25 (conferring the notion that the decision in *MacPherson v. Buick Motor Co.* “propelled” the policy away from recognizing privity as a requisite to negligence actions). The rule established by the court in *MacPherson* is ultimately that a “manufacturer, by marketing a product, assume[s] a responsibility to the consumer, *resting not upon the contract* but upon the relation arising from his purchase together with the foreseeability of harm if proper care [is] not used” (emphasis added). *Id.* *MacPherson* is regarded for “simply chang[ing] products liability forever.” *Id.* In fact, “*MacPherson* has now been adopted by every American jurisdiction, except Virginia.” *Id.*

³³ See *MacPherson*, 217 N.Y. at 389 (attaching liability to manufacturers of products which may be dangerous when negligently made or not thoroughly tested). A manufacturer must always be vigilant, but when there is “the presence of a known danger, attendant upon a known use, [that] makes vigilance a duty.” *Id.* at 390. Also, with reference to the danger, “[t]here must be knowledge of a danger, not merely possible, but probable.” *Id.* at 389. Lastly, to define the danger, “[i]f the nature of a thing is such that it is reasonably certain to place [life] and limb in peril when negligently made, it is then a thing of danger.” *Id.*

v Bloomfield Motors, Inc.,³⁴ emerged as the landmark case for warranties.³⁵ This court held that an automobile manufacturer is liable for injuries to the plaintiffs, and accordingly, the manufacturer is unable to disclaim the implied warranty of merchantability because allowing such a result would be “so inimical to the public good.”³⁶ Similarly, the concept of strict liability was developed therefrom in the case of *Escola v. Coca-Cola Bottling Company of Fresno*,³⁷ the holding of which resulted in doctrinal change.³⁸ Through this case, strict liability has been touted as a sort of “liability without negligence” standard, where if a manufacturer’s actions lead to a plaintiff’s injuries, that entity is liable regardless of negligence.³⁹ This notion of absolute liability is later expanded upon in the ruling of

³⁴ 161 A.2d 69 (N.J. 1960).

³⁵ See *Henningsen*, 161 A.2d at 74 (regarding warranties as the “focal point of the case”); see also FRUMER & FRIEDMAN, *supra* note 25 (transitioning to the topic of warranties as explained by the *Henningsen* case). With respect to product liability law, *Henningsen* is to warranties what *MacPherson* is to negligence. *Id.*

³⁶ See *Henningsen*, 161 A.2d at 95 (recognizing that the interest of public safety sometimes outweighs the manufacturer’s interest in enforcing a disclaimer). Ultimately the court makes it a point to say that the “obligation of the manufacturer should not be based alone on privity of contract,” but rather “upon the demands of social justice.” *Id.* at 83. Also, when a manufacturer places an item into the stream of commerce for use by the public, “an implied warranty that it is reasonably suitable for use as such accompanies it into the hands of the ultimate purchaser.” *Id.* at 84. Further, the court does not discriminate when it comes to liability and the perceived dangerousness of the item manufactured, as the court sees “no rational basis for differentiating between a fly in a bottle of beverage and a defective automobile.” *Id.* at 83.

³⁷ 24 Cal.2d 453 (1944).

³⁸ See *Escola*, 24 Cal.2d at 463 (introducing the concept of strict liability, also known as “liability without negligence”); see also FRUMER & FRIEDMAN, *supra* note 25 (identifying the first mention of strict liability in American jurisprudence). At its most basic level, this case is about a glass bottle of Coca-Cola that was delivered to a restaurant, and exploded in the hand of a restaurant employee while she was in the process of stocking the refrigerator. *Id.* Relying on the doctrine of *res ipsa loquitur*, or in other words, “the facts speak for themselves,” the jury awarded damages to the plaintiff without regard for the existence of negligence on the part of the bottle’s manufacturer. *Id.*

³⁹ See *Escola*, 24 Cal.2d at 463 (defining strict liability, which is often also referred to as absolute liability). Chief Justice Gibson delivered the opinion of the court, with Justice Roger Traynor concurring. *Id.* at 456, 461. Justice Traynor notes that “the manufacturer’s negligence should no longer be singled out as the basis of a plaintiff’s right to recover.” *Id.* at 461. Furthermore, “a manufacturer incurs an absolute liability when an article that he has placed on the market, knowing that it is to be used without inspection, proves to have a defect that causes injury.” *Id.*

Greenman v. Yuba Power Products, Inc., where it went from a mere suggestion to an accepted doctrine.⁴⁰ Here, the court dismissed the manufacturer's argument that liability may only be assigned upon the plaintiff proving that an express warranty did not exist, and the court opined that assigning liability need not depend on the existence of a warranty at all, but rather on the simple fact that the product was defective.⁴¹

III. Facts

A. Relevant Codes and Standards

The lithium used in powering our electronic devices comes primarily from China, South America, and Australia.⁴² As of 2015,

⁴⁰ See *Greenman v. Yuba Power Prods., Inc.*, 59 Cal.2d 57, 63 (1963) (recognizing a doctrinal shift from contract law to tort law governing product liability); see also FRUMER & FRIEDMAN, *supra* note 25 (establishing strict liability as an accepted doctrine of law instead of a speculative idea). In an opinion again delivered by Justice Traynor, the idea of strict liability was unanimously adopted by the California Supreme Court. *Id.* Ultimately, "*Greenman* was the flagpole upon which was hoisted the ensign of strict liability." *Id.*

⁴¹ See *Greenman*, 59 Cal.2d at 62 (negating the need for negligence or a warranty for a plaintiff's tort action to succeed under the doctrine of strict liability). Part of this rule assumes that the manufacturer is placing an item on the market, while "knowing that it is to be used without inspection for defects." *Id.* The law will not allow a manufacturer to benefit from rules that were implemented to "meet the needs of commercial transactions," and use such rules to "govern the manufacturer's liability to those injured by their defective products." *Id.* at 63. Basically, the court does not want the remedy for persons injured by defectively manufactured goods to "depend upon the intricacies of the law of sales." *Id.* at 64. In turn, the policy reasoning behind strict liability is to "insure that the costs of injuries resulting from defective products are borne by the manufacturers that put such products on the market." *Id.* at 63. The bottom line for this case and for product liability cases going forward is that the manufacturer will assume liability where the plaintiff can prove that "he was injured while using the [manufactured good] in a way it was intended to be used as a result of a defect in design and manufacture of which the plaintiff was not aware." *Id.* at 64.

⁴² See *Statistics and facts about the lithium-ion battery industry*, STATISTA, archived at <https://perma.cc/A88B-EW8T> (discussing locations where the majority of lithium is mined from); see also *Countries with the largest lithium reserves worldwide as of 2015 (in metric tons)*, STATISTA (2016), archived at <https://perma.cc/CK7P-SR98> (noting the countries with the largest lithium reserves). Chile is the leader in lithium production, with 7,500,000 metric tons in reserve, followed by China with 3,200,000 metric tons, Argentina with 2,000,000

the estimated lithium battery market is about \$23.5 billion U.S. dollars⁴³ and li-ion batteries are estimated to occupy about 24% of the consumer electronic market by 2020.⁴⁴ As previously established, this increase in li-ion battery usage does not come without environmental and personal safety hazards, many of which are governed by “codes and standards developed by several organizations.”⁴⁵

Because lithium-ion batteries are considered “hazardous materials,” Title 49 of the Code of Regulations governs transportation of such materials.⁴⁶ As defined by the Secretary of Transportation, hazardous materials are those that are “capable of posing an unreasonable risk to health, safety, and property when transported in commerce.”⁴⁷ More specifically, li-ion batteries are listed as a “Class 9” hazardous material, and have specific regulations attached to them.⁴⁸ In light of the potential for danger, the Department of Transportation

metric tons, and Australia with 1,500,000 metric tons. *Id.* Portugal, Brazil, the United States, and Zimbabwe account for another 169,000 metric tons combined. *Id.*

⁴³ See *Statistics and facts about the lithium-ion battery industry*, *supra* note 42 (showing the enormity of the lithium battery industry in terms of an estimated monetary figure).

⁴⁴ See *Projected split of the global lithium-ion battery market in 2020, by Segment*, STATISTA (2016), <https://perma.cc/E33X-KDMX> (estimating the percentage of market share dominated by li-ion batteries in different segments). Li-ion batteries are estimated to occupy about 37.6% of the renewable energy storage segment share, 30% of the automotive industry, 29.3% of consumer electronics, and 8.5% of industrial manufacturing. *Id.*

⁴⁵ See CELINA MIKOLAJCZAK ET AL., LITHIUM-ION BATTERIES HAZARD AND USE ASSESSMENT 34 (2011) (discussing codes and standards which govern li-ion batteries).

⁴⁶ See *id.* (focusing on federal regulations for commerce of li-ion batteries).

⁴⁷ See 49 C.F.R. § 105.5 (2015) (defining “hazardous materials” in the context of commerce); 49 U.S.C. § 5103(a) (2012) (furthering definition and characteristics of “hazardous materials”). Included in the Secretary of Transportation’s definition of “hazardous materials” is any material or class of materials which are “explosive, radioactive . . . infectious . . . flammable or combustible . . . toxic, oxidizing, or corrosive.” *Id.*

⁴⁸ See 49 C.F.R. § 173.185 (2015) (setting forth the specific requirements, as they pertain to li-ion batteries). After satisfying the classification requirement for li-ion batteries, there are specific procedures for packaging, transporting, and recycling, as well as procedures for disposal of damaged, defective, or recalled li-ion batteries. *Id.* There are, however, exceptions for shipping smaller cells and batteries; li-ion batteries containing two grams or less of lithium content are exempt from these provisions. *Id.* See also MIKOLAJCZAK ET AL., *supra* note 45, at 34 (recognizing a particular class of hazardous materials and specifying safety requirements).

and other American regulatory bodies have adopted the United Nations testing requirements and packaging requirements for shipping.⁴⁹

Another set of standards designed to reduce hazards, specifically fire hazards, associated with lithium-ion batteries are those put in place by Underwriters Laboratories, and are mainly derived from United Nations standards.⁵⁰ The International Electrotechnical Commission provide various procedures for performance testing, which are almost identical to the Underwriters Laboratories tests, but also provide for additional safety tests.⁵¹ The Institute of Electrical and Electronics Engineers has also devised their own set of standards, much of which is adopted from the United Nations, Underwriters Laboratories, and the International Electrotechnical Commission.⁵² The one distinguishing aspect of the Institute of Electrical and Electronics Engineers' testing requirements is that they focus on the interrelatedness of "the cells, the battery pack, the host device, the power supply accessories, the user, and the environment."⁵³ Although these testing

⁴⁹ See MIKOLAJCZAK ET AL., *supra* note 45, at 34-35 (highlighting areas in which the United Nations has mandated model regulations). For example, for shipping purposes, the United Nations has mandated that cells or batteries be separated to prevent short circuits, that there be a strong outer packaging, limiting the number of cells or batteries that can be placed in a single package, specific labeling of outer packaging, and training for employees who package and ship hazardous materials. *Id.*

⁵⁰ See MIKOLAJCZAK ET AL., *supra* note 45, at 36 (requiring testing of lithium-ion batteries to reduce fire hazards under UL 1642). These extensive testing requirements include a short-circuit test, abnormal charging test, forced-discharge test, crush test, impact test, shock test, vibration test, heating test, temperature cycling test, and an altitude simulation test. *Id.*

⁵¹ See MIKOLAJCZAK ET AL., *supra* note 45, at 39 (recommending performance testing under CEI/IEC 61960, and safety testing under CEI/IEC 62133). Although the International Electrotechnical Commission tests are almost identical to the Underwriters Laboratories' tests, they do include a few additional tests. *Id.* There is also a free fall test, where a battery is dropped from different heights onto a concrete floor, and an overcharge test for high-voltage overcharging. *Id.* All the International Electrotechnical Commission tests are voluntary for the United States, but mandatory for the shipment of any telecommunication devices to Brazil. *Id.*

⁵² See MIKOLAJCZAK ET AL., *supra* note 45, at 41 (accumulating standards from a culmination of other bodies' standards). Many of the Institute of Electrical and Electronics Engineers' testing requirements go beyond those required by the other authorities. *Id.*

⁵³ See MIKOLAJCZAK ET AL., *supra* note 45, at 41 (emphasizing the safety of the battery as it pertains to the entirety of the components). The purpose of the Insti-

requirements are merely recommended within the United States, major distributors of consumer electronic devices often make these standards mandatory because they framed after the United Nations standards.⁵⁴

Additionally, there is a movement afoot to create uniform testing of lithium-ion batteries used in electric vehicles, but “development in the automotive industry is in a formative stage.”⁵⁵ With that being said, the United States Department of Education has released a series of test manuals, but has yet to adopt one in particular.⁵⁶ International organizations have also drafted safety and performance standards for electric vehicles, but many of these standards have not been updated to include applicability of li-ion technologies.⁵⁷ Given the lack of uniformity and hesitance to commit to one set of standards, individual automakers have begun to write their own internal standards, but there are significant experimental challenges and expenses attached to the testing of these large li-ion car batteries.⁵⁸

tute of Electrical and Electronics Engineers’ standards is to recognize that the “responsibility for total system reliability is shared between the designers/manufacturers/suppliers of the subsystems and the end user.” *Id.*

⁵⁴ See MIKOLAJCZAK ET AL., *supra* note 45, at 37 (noticing that although these standards are not mandatory, many of them are adhered to nonetheless).

⁵⁵ See MIKOLAJCZAK ET AL., *supra* note 45, at 42 (understanding that the establishment of uniform li-ion battery testing standards for electric cars is not yet fully developed). To date, there are no established standards in place that govern “cell sizes or form factors, module or pack sizes or form factors, pack voltage requirements, or protection electronics approaches.” *Id.*

⁵⁶ See MIKOLAJCZAK ET AL., *supra* note 45, at 42 (highlighting the state of flux in adopting safety standards for li-ion batteries in electric vehicles). Test manuals span from 1996 to 2009 and can be attributed to multiple sources. *Id.*

⁵⁷ See MIKOLAJCZAK ET AL., *supra* note 45, at 42-44 (addressing a lack of uniformity in implementing standards for li-ion batteries in electric cars in the international community). Many foreign organizations are creating safety and testing standards for li-ion batteries, including the European Committee for Standardization, L’Institut National de l’Environnement Industriel et des Riques, Japan Electric Vehicle Association, the International Organization for Standardization, and the Society of Automotive Engineers. *Id.* at 42.

⁵⁸ See MIKOLAJCZAK ET AL., *supra* note 45, at 44 (suggesting that automakers are assuming responsibility of developing safety and transportation testing procedures in absence of formalized, mandated procedures). Considering the difficulties of testing such large batteries, automakers are likely to experiment on a small scale by testing a single battery pack, and extrapolating those results over projected large format cells and battery packs rather than test multiple battery packs. *Id.*

B. Media Appearances and Litigation

It is no secret that lithium-ion batteries are quickly becoming the preferred energy storage device due in large part to their small size, lightweight design, and ability to “store more energy in less space than any other type of rechargeable battery.”⁵⁹ These li-ion batteries can now be implanted in just about every electronic device ranging from phones to cars.⁶⁰ However, with advancements in technology comes controversy, and there doesn’t seem to be any major electronics brands immune from public scrutiny.⁶¹ In April of 2006, a Japanese couple filed suit against Apple and Sony after their computer caught fire, burnt the husband and damaged their home, but the suit was later dropped and the case settled out of court for a meager \$12,900.⁶² In the wake of Sony’s lawsuit and subsequent global recall, Dell became the subject of a Canadian class action lawsuit,

⁵⁹ See *Hooked on lithium*, *supra* note 16 (noting prominent advantages to lithium ion batteries in comparison to other rechargeable types of batteries). In 1982, a battery pack for a cell phone weighed about 9.8kg, but a typical mobile phone today weighs less than 100g, which is over an astronomical 99% reduction in weight. *Id.* Now, an average cell phone can run for a week straight on a battery that is about “the size of ten business cards stacked on top one another.” *Id.* Li-ion batteries are also considered superior because they are not susceptible to “battery memory effect,” which is basically a loss of charging capacity due to recharging a battery before it is “fully depleted.” *Id.*

⁶⁰ See *Hooked on lithium*, *supra* note 16 (demonstrating wide-ranging versatility of the li-ion battery, and its ability to be used in just about any electronic device). Since the 1970s, the li-ion battery has been utilized in powering “watches, calculators and medical implants,” among other things. *Id.* Li-ion technology could be used to power all cars, but “[a] set of lithium-ion batteries capable of powering an electric car now costs around \$10,000.” *Id.* However, thanks to the development of the “hybrid car,” which incorporates the use of petrol gasoline, a much smaller battery pack is required, and thus drives the cost of the battery down to only about \$1,000. *Id.*

⁶¹ See Jacqui Cheng, *Apple, Sony agree to pay out over battery fire lawsuit*, ARS TECHNICA (Apr. 14, 2008), archived at <https://perma.cc/U4KT-LH2T> (recognizing that nearly all of the major electronics brands have had issues with li-ion batteries). In 2006, Dell, Toshiba, and Apple all issued recalls of Sony-made li-ion batteries; this came to be known as “the Great Laptop Battery Recall.” *Id.* In late 2006, Sony issued a global recall of all their li-ion batteries due to months of reports that their batteries were exploding and causing fires. *Id.* Sony classified this recall as an opportunity to address “recent overheating incidents,” and then Sony proceeded to recall almost ten million units. *Id.*

⁶² See Cheng, *supra* note 61 (presenting just one case of many where an end user filed suit against a manufacturer of li-ion batteries). The husband suffered burns

which culminated in Dell recalling more than four million batteries because of a “potential fire hazard.”⁶³ Furthermore, this class action lawsuit and other relevant litigation should not be considered frivolous by any means, as evidenced by the fact that the United States Consumer Protection Safety Commission (“CPSC”) found it necessary to issue a press release ordering a federal recall on the aforementioned products.⁶⁴ Similarly, the CPSC determined that overheating batteries, specifically, were the culprit behind these flaming and exploding electronic devices.⁶⁵

These massive, multi-million unit recalls of Sony and Dell products weren’t the only major companies catching heat for their de-

while attempting to remove the flaming laptop from their home, which also suffered a considerable amount of damage. *Id.* The couple filed suit in search of \$20,000 but wound up settling for \$12,900, which covered medical expenses and home repairs. *Id.* Because this case was settled out of court, without discovery and fact-finding determinations being made at trial, Sony is able to maintain that the cause of the fire “has not been determined.” *Id.*

⁶³ See Antony Savvas, *Dell faces lawsuit over fire-hazard laptop batteries*, COMPUTER WKLY. (Jan. 16, 2007), archived at <https://perma.cc/F8VP-HLVW> (offering yet another incident with a malfunctioning li-ion battery leading to litigation). It is believed that Dell was using the same batteries that were manufactured by Sony, which caused them legal troubles, and as a result of all the commotion, Apple, Toshiba, Lenovo and others issued a recall of more than two million more batteries. *Id.* This lawsuit against Dell alleges “design defects” make the devices “susceptible to overheating,” and assert that this is a “systematic problem.” *Id.*

⁶⁴ See *Dell Announces Recall of Notebook Computer Batteries Due To Fire Hazard*, U.S. CONSUMER PROD. COMM’N (Aug. 15, 2006), archived at <https://perma.cc/5A25-2KBJ> (recognizing the potential danger of malfunctioning li-ion batteries). This press release essentially made it illegal to sell, resell, or attempt to sell or resell batteries that were listed in the document. *Id.* This order also required a recall of approximately 2.7 million batteries manufactured by Sony in China or Japan, and used in Sony or Dell products. *Id.*

⁶⁵ See *Laptop Batteries may cause Fires*, BIGCLASSACTION.COM (July 5, 2006), archived at <https://perma.cc/M2ZN-FBLV> (concluding that faulty laptop batteries were the precise cause of the 2005 recall). The CPSC statement cites forty-three reports of laptop fires occurring between 2001 and the 2006 recall, including several incidents in which the heat from the laptop actually melted and burned the carpet beneath it. *Id.* One manufacturer even admitted that “defective notebook batteries” were the cause of these laptop fires, however, one research analyst cited additional features, such as a DVD player in the laptop, as a contributing factor to these fires, as they “make[] the batteries work harder.” *Id.* Another cause of laptop fires might just have more to do with design than it does anything else, because as newer devices are updated and remodeled, they generally become slimmer, and thus there is less room for ventilation of the lithium ion battery. *Id.*

fective batteries; Hewlett-Packard (HP) also drew plenty of media attention for their li-ion battery malfunctions, culminating in lawsuits and recalls.⁶⁶ Similarly, computers and cell phones are not the only products that are under fire for malfunctioning li-ion batteries, as everything from speakers and fax machines to electronic cigarettes and “hoverboards” are also in the news.⁶⁷ With li-ion battery recalls

⁶⁶ See *Lawsuit Blames HP Pavilion Notebook Fire for Destroying Home*, ABOUTLAWSUITS.COM (Jan. 15, 2010), archived at <https://perma.cc/6BFR-2AB4> (identifying HP as another company recalling products due to overheating batteries). Since 2005, HP has issued “a number” of recalls for their li-ion batteries “due to the risk of overheating,” including a recall in 2009 for their Pavilion Notebooks “due to the risk of the batteries rupturing.” *Id.* John Norrie, a resident of Massachusetts, filed a product liability lawsuit against HP alleging one of their li-ion powered laptops overheated, caught fire, and burned his house down in late 2006. *Id.* Norrie is seeking \$225,000 in damages for “the destruction of his home” and serious personal injuries he suffered from falling down a flight of stairs while attempting to escape the fire. *Id.* The crux of Norrie’s argument might very well lie in the state police’s investigative report, which “confirmed that the blaze appeared to have been started by the overheated laptop.” *Id.* See also Steven Trader, *Allstate Sues HP Over Laptop Battery Fire*, LAW360 (July 7, 2015), archived at <https://perma.cc/C5Z4-A3V2> (referencing another instance of HP surfacing in the media for their legal troubles). In April 2014, at the residence of Cary Corbin in Valdosta, Georgia, Allstate Insurance Company alleges that an HP computer’s battery overheated, melted part of the computer, then caught fire and ignited nearby combustible materials. *Id.* Allstate is now suing HP to recover \$177,888 they paid out to the policyholder, claiming HP was negligent and is thus strictly liable for the damages. *Id.* Allstate supports their argument by asserting that the battery at issue was original to Corbin’s laptop, he used the product in a manner consistent with the intended purpose, and that the laptop contained insufficient warning labels. *Id.* Furthermore, Allstate argues that they are “entitled to reimbursement because the laptop contained one or more defects when it was sold, and because HP failed to correct it before it hit the market.” *Id.* These allegations should be taken seriously, as HP has not been immune from battery related shortcomings, given their recent history in 2012 when they paid \$425,000 to settle allegations levied by the Consumer Product Safety Commission. *Id.* But see Lana Birbrair, *HP Fined For Failing To Warn Of Defective Battery Dangers*, LAW360 (Jan. 23, 2012), archived at <https://perma.cc/Y5HE-Q2YH> (criticizing the Consumer Product Safety Commission for levying “infinitesimal” monetary penalty). Robert S. Adler, Commissioner of the Consumer Product Safety Commission, criticized the \$425,000 penalty imposed against HP as being far too small for the hundred-billion-dollar company, and thus unlikely to be much of a deterrent. *Id.* While HP denied the Commission’s allegations, they nonetheless acquiesced and reluctantly paid the penalty despite their position. *Id.*

⁶⁷ See Greg Ryan, *HP Recalls Fax Machines Over Fire Risk*, LAW360 (Feb. 2, 2012), archived at <https://perma.cc/VG33-Z995> (presenting estimates of HP’s recall of over one million fax machines in North America due to multiple reports of

gaining international attention and sparking safety discussions, the IPC, otherwise known as the Association Connecting Electronics Industries, sponsored an Original Equipment Manufacturers (OEMs) Critical Components Committee to bring major manufactures together to explore a method of streamlining production of li-ion batteries in a way that would further industry-wide standardization.⁶⁸ In fact, many major OEMs have cooperated in adopting IPC's standards, which in turn "help achieve quality, reliability, and consistency in their end products."⁶⁹ Despite the widespread push for increased

overheating and causing personal injury and/or property damage); *see also* Jody Godoy, *Apple Recalls Beats Speakers Over Battery Fire Risk*, LAW360 (June 3, 2015), *archived at* <https://perma.cc/AC8H-TNLV> (identifying portable speakers as another type of electronic device which utilizes li-ion batteries and therefore not immune from fire hazards). In June 2015, Apple issued a recall of almost a quarter of a million Beats Pill speakers after multiple reports of overheating. *Id.* *See also* Hailey Branson-Potts, *Woman burned by exploding e-cigarette battery awarded \$1.9 million*, L.A. TIMES (Oct. 1, 2015), *archived at* <https://perma.cc/SB46-TA57> (recognizing yet another type of portable electronic device causing graphic injuries when li-ion batteries explode). When li-ion batteries malfunction in electronic cigarettes, usually due to incompatible voltages, they have been known to explode and cause horrific burns. *Id.* *See also* Steven Trader, *Modell's, Swagway Hit With Suit Over 'Hoverboard' Explosion*, LAW360 (Dec. 11, 2015), *archived at* <https://perma.cc/5RVR-VTS6> (emphasizing new age products like hoverboards are still susceptible to media scrutiny for defective batteries). Although Swagway, the manufacturer of the hoverboard in question, claims that their product is comprised of "the finest products," it still allegedly short-circuited and combusted during its first charge. *Id.*

⁶⁸ *See* Jacqui Cheng, *Notebook companies meet to determine battery standards*, ARS TECHNICA (Sept. 20, 2006), *archived at* <https://perma.cc/WU8T-TYTA> (highlighting the very pressing need for communication and collaboration between li-ion battery manufacturers to ensure consumer safety). The focus of the meeting was to accelerate the process of standardization across the companies producing li-ion batteries to create one, single manufacturing standard, which would ultimately increase safety and decrease costs for the consumer. *Id.* This discussion was chaired by Dell, represented by HP, Polycom, Inc., and Lenovo, but spurned by Apple, who was invited but did not participate. *Id.* Worth noting, Sony, the company at the center of the 2006 battery recall, was inexplicably not invited to the conference. *Id.*

⁶⁹ *See* *Why Should Original Equipment Manufacturers (OEMs) Use IPC Standards?*, IPC, *archived at* <https://perma.cc/DKM8-5Z2H> (showing that many large OEMs have actually adopted IPC's standards). There seems to be a three-prong advantage to adhering to IPC standards; gain control over end product quality and reliability, improve communication with suppliers and employees, and help contain costs. *Id.* Quality and reliability may be the two most important aspects that affect a company's profitability, and adhering to IPC standards throughout the manufacturing process can "help ensure better performance, longer life, and compliance

industry standardization, a uniform standard has not been established, but perhaps a ban on lithium batteries in passenger planes' cargo holds will further awareness of the gravity of this issue.⁷⁰

IV. Analysis

The lithium-ion battery offers greater energy storage capacity than many of its contemporaries and energy storage counterparts, but is also not without its flaws. The following subsections are designed to offer some practical solutions and general recommendations to the woes that plague the li-ion battery's image and utility.

A. *Developing a Fire Suppression Strategy*

To date, there exists no fire suppression protocols that are specific to lithium-ion batteries.⁷¹ End users can take as much precaution as is reasonably necessary, but li-ion battery fires can occur

with lead-free regulations." *Id.* In terms of improving communication with suppliers and employees, implementing IPC standards will guide cooperating companies to "speak the same language," and create more fluidity in the global electronic industry. *Id.* Lastly, IPC standards can help contain costs by ensuring that the electronic components used in production are up to par with industry standards, and thus pass future quality tests, minimize delays, and eliminate reworking periods. *Id.*

⁷⁰ See Jody Godoy, *U.S. Seeks Ban On Batteries In Passenger Plane Cargo*, LAW360 (Oct. 8, 2015), archived at <https://perma.cc/3WD4-4Q7K> (suggesting that prohibiting the shipment of li-ion batteries in cargo holds would inconvenience Americans enough to bring their attention to the issue). According to a spokesperson for the Federal Aviation Administration (FAA) at a United Nations aviation standards meeting in late 2015, the United States will advocate for a temporary "ban on shipping li-ion batteries in the cargo holds of passenger planes because of the fire hazard they pose." *Id.* This proposed ban rides on the coattails of an FAA research project where it was determined that the fire suppression strategies utilized by commercial air carriers are insufficient to effectively extinguish the type of fire created when li-ion batteries overheat and ignite. *Id.* According to FAA records, since 1991, there have been 158 incidents involving smoke and/or fire coming from passengers' luggage, most of which have occurred in the past five years and involved a li-ion battery. *Id.* As one might expect, the fires are likely attributed to "thermal runaway" within a battery. *Id.*

⁷¹ See MIKOLAJCZAK ET AL., *supra* note 45, at 45 (summarizing the point that there is no uniform fire suppression strategy attributed to li-ion batteries).

for a multitude of reasons, most of which are above the level of understanding for the average consumer.⁷² At this point in the lithium-ion debate, it is rather astonishing that a competent fire suppression strategy has not been devised specifically for li-ion batteries, as common “fire suppression techniques are not appropriate for controlling a [l]i-ion battery fire.”⁷³ An average person, unfamiliar with the complexities of fire suppression strategies, would likely turn to water to extinguish a fire, yet none of the accepted standards for putting out fires caused by li-ion batteries call for the use of water.⁷⁴ This may prove to be problematic considering that “[w]ater-based automatic sprinklers are the most widely used fire suppression system[s]” in much of the existing infrastructure.⁷⁵ In fact, this issue has become so pressing that even commercial, passenger airlines have mulled over the possibility of banning products containing li-ion batteries from traveling in cargo holds because of the lack of a tried and true fire suppression strategy.⁷⁶ This sentiment rings even more trouble-

⁷² See Long, *supra* note 17 (addressing the various, complex causes of li-ion battery fires). Li-ion battery fires may be caused by a number of factors:

Both energetic and non-energetic failures of [l]i-ion cells and batteries can occur for a number of reasons, including poor cell design (electrochemical or mechanical), cell manufacturing flaws, external abuse of cells (thermal, mechanical, or electrical), poor battery pack design or manufacture, poor protection electronics design or manufacture, and poor charger or system design or manufacture.

Id.

⁷³ See Long, *supra* note 17 (noting that the typical use of water to combat li-ion battery fires may not be an effective fire suppression strategy).

⁷⁴ See Long, *supra* note 17 (asserting that water is not likely to be useful in putting out a fire caused by a li-ion battery, despite this misconception).

⁷⁵ See Long, *supra* note 17 (focusing on the fact that fire suppression strategies utilizing water sprinklers are most common).

⁷⁶ See Godoy, *supra* note 70 (making reference to the seriousness of the lack of an accepted fire suppression strategy for li-ion battery fires).

some when considering the widespread use of li-ion batteries in almost every major electronic, consumer product,⁷⁷ and by nearly all mainstream electronics brands.⁷⁸

A competent fire suppression strategy need not be created for the safety of the manufacturer alone, but also for the unsuspecting consumer using their electronic device as any other reasonable consumer would.⁷⁹ That same reasonable consumer would likely then turn to the nearest water source to extinguish a fire, not realizing that water-based fire suppression systems “have been shown to provide minimum level protection.”⁸⁰ This story has played out time and time again, and the end result, at least for the people noted herein, is extensive property damage and personal injury.⁸¹ Ultimately for many of these people, if they are fortunate, their damages may be paid out by insurance companies,⁸² otherwise they may be stuck fighting long-term legal battles with mega-wealthy companies.⁸³ Also, adding insult to injury, compensatory and punitive damages

⁷⁷ See *Hooked on lithium*, *supra* note 16 (suggesting that no consumer is immune to the reach of li-ion batteries, considering their use in cell phones); *Trader*, *supra* note 67 (demonstrating the broad application of li-ion batteries, as they are even used in newfangled “hoverboards”).

⁷⁸ See *Cheng*, *supra* note 61 (referencing the use of li-ion batteries by many, if not all, of the trusted manufacturers, including Apple, Sony, Dell, and Toshiba).

⁷⁹ See *Long*, *supra* note 17 (inferring that a reasonable consumer under the circumstances would not foresee the dangers of overcharging a cell phone, dropping or denting a cell phone, or the like). Such seemingly innocuous activities can prove disastrous if such overcharging or dropping/denting of a phone causes a “thermal runaway,” because that can cause a phone or other electronic device overheat and ignite. *Id.*

⁸⁰ See *Long*, *supra* note 17 (theorizing that a layperson would not know that water is not likely to be useful or effective in putting out a fire stemming from a li-ion battery).

⁸¹ See *Cheng*, *supra* note 61 (referencing the burns suffered by a Japanese man from a malfunctioning Sony battery in an Apple computer); *Lawsuit Blames HP Pavilion Notebook Fire for Destroying Home*, *supra* note 66 (referencing injuries suffered by a Massachusetts resident when his HP laptop caught fire); *Trader*, *supra* note 66 (referencing a Georgian man who sustained property damages when his HP laptop melted and ignited other combustibles nearby); *Branson-Potts*, *supra* note 67 (referencing a Los Angeles woman whose electronic cigarette blew up and burned her face).

⁸² See *Trader*, *supra* note 66 (explaining that in some instances, an aggrieved consumer may have damages covered by insurance).

⁸³ See *Laptop Batteries may cause Fires*, *supra* note 65 (predicting that lawsuits would arise from the forty-three reports of laptop fires between 2001 and 2006).

awarded to consumer plaintiffs,⁸⁴ monetary compensation settled on between parties,⁸⁵ and fines levied against the manufacturers are not even close to taking a financial toll on these conglomerates.⁸⁶

With financial penalties proving to be fruitless as a deterrent, companies have no incentive to develop a fire suppression strategy.⁸⁷ For a company like HP, which employs hundreds of thousands of people and “generates annual revenues in excess of a hundred billion dollars,” it is fallacious to think a \$425,000 penalty imposed by the CPSC could incentivize any change at all.⁸⁸ Further, a lack of administrative pressure and overall disorganization contributes to the apathetic approach to li-ion safety, all culminating in the absence of a competent fire suppression strategy.⁸⁹ In the end, it is the end user that will be most susceptible to the unexpected perils of a battery fire, and thus a fire suppression strategy needs to be developed for the safety of the consumer.⁹⁰

B. *Creating a Uniform Safety Standard*

As it stands now, the safety standards applicable to the li-ion battery manufacturing and transportation industry are far from uniform.⁹¹ There does not appear to be one, single, mandatory, uniform set of safety standards that manufacturers and transportation providers *must* adhere to, but there does seem to be a preference towards

⁸⁴ See Branson-Potts, *supra* note 67 (discussing an award of damages to a California resident when her electronic cigarette exploded).

⁸⁵ See Cheng, *supra* note 61 (offering a \$12,900 settlement, which was accepted as compensation for the destruction of a consumer’s home, as well as personal injuries).

⁸⁶ See Birbrair, *supra* note 66 (criticizing a \$425,000 fine paid by HP due to its failure to warn about battery defects as too low). This transaction received condemnation from many commentators as being too insignificant to have any deterrent effect on HP or their contemporaries. *Id.*

⁸⁷ See Birbrair, *supra* note 66 (noting that \$425,000 fine paid by HP “represents a tiny fraction” of HP’s financial worth).

⁸⁸ See Birbrair, *supra* note 66 (characterizing the CPSC penalty as “infinitesimal”).

⁸⁹ See Birbrair, *supra* note 66 (inferring that a lack of administrative oversight is contributing to, or resulting in, the failure to develop a widely accepted fire suppression strategy).

⁹⁰ See Birbrair, *supra* note 66 (emphasizing the importance of enhanced product safety laws to protect consumers).

⁹¹ See MIKOLAJCZAK ET AL., *supra* note 45, at 37-45 (referencing the number of different safety standards and how they vary).

borrowing from or adopting entirely the United Nations Model Regulations and United Nations Tests.⁹² Among the regulatory bodies that make use of the United Nations Model Regulations is the Department of Transportation,⁹³ in the Code of Federal Regulations Title 49, which governs hazardous materials.⁹⁴ Additionally, international administrative bodies also make use of United Nations recommendations, such as the International Air Transport Association, the International Civil Aviation Association, and the International Maritime Association.⁹⁵ The preceding four regulatory bodies, both domestic and international, have chosen to adopt United Nations recommendations, and even imposed additional safeguards for packaging and shipment.⁹⁶

Although there is not one uniform safety standard for the manufacturing and transportation of li-ion batteries, there exists a number of consumer electronic standards developed by a few leading organizations in the industry.⁹⁷ Aside from the United Nations Transportation Tests, similar tests have been developed by Underwriters Laboratories, the International Electrotechnical Commission, and the Institute of Electrical and Electronics Engineers.⁹⁸ Among the chaos lies a significant amount of overlap in the testing and regulations that comprise the individual safety standards.⁹⁹ With the exception of the Institute of Electrical and Electronics Engineers, who have developed a couple of their own “unique” safety tests, including

⁹² See MIKOLAJCZAK ET AL., *supra* note 45, at 35 (noting that the United Nations Model Regulations are merely recommendations, not requirements).

⁹³ See MIKOLAJCZAK ET AL., *supra* note 45, at 35 (noting that the Department of Transportation is one regulatory body which has adopted the U.N. recommendations).

⁹⁴ See 49 C.F.R. § 105.5 (2006) (restating the classification of li-ion batteries as “hazardous materials”).

⁹⁵ See MIKOLAJCZAK ET AL., *supra* note 45, at 35 (recognizing international administrations that implement U.N. recommendations).

⁹⁶ See MIKOLAJCZAK ET AL., *supra* note 45, at 35 (offering additional requirements which are not mandatory, yet were still adopted by some organizations).

⁹⁷ See MIKOLAJCZAK ET AL., *supra* note 45, at 36-42 (discussing how different organizations in the industry can develop their own standards).

⁹⁸ See MIKOLAJCZAK ET AL., *supra* note 45, at 36-42 (listing the relevant organizations which offer their own safety standards).

⁹⁹ See MIKOLAJCZAK ET AL., *supra* note 45, at 36-42 (suggesting there is overlap between the different sets of standards).

a “Pack Drop Test,” the other three organizations have almost identical tests.¹⁰⁰ Between the United Nations Transportation Tests, the Underwriters Laboratories’ 1642 Standards, and the International Electrotechnical Commission’s 62133 Standards, all three contain Vibration Tests, Shock Tests, Short Circuit Tests, Forced Discharge Tests, Abnormal Charging Tests (otherwise known as Overcharging Tests), Altitude Simulation Tests (otherwise known as Low Pressure Tests), and Temperature Cycling Tests (otherwise known as Thermal Cycling Tests).¹⁰¹ Aside from those seven identical, or nearly identical, durability tests, two out of these three organizations employ the use of Impact Tests, Crush Tests, and Heating Tests.¹⁰²

Such significant overlap would lead a reasonable person to the conclusion that a mandatory, uniform safety standard could be developed by meshing the shared tests into one set of standards.¹⁰³ In fact, developing a new set of standards is not entirely necessary, as the Underwriters Laboratories 1642 Standards actually encompasses everything in both the United Nations Transportation Tests and the International Electrotechnical Commission’s 62133 Standards.¹⁰⁴ The only additional test that could be added to this hypothetical set of standards is the Pack Drop Test, as explained in the Institute of Electrical and Electronics Engineers’ 1725 safety tests.¹⁰⁵ After further review, it appears as though the safety tests themselves have been thoroughly developed, so the last hurdle is finding an international regulatory body to make these standards mandatory and applicable to

¹⁰⁰ See MIKOLAJCZAK ET AL., *supra* note 45, at 36-42 (distinguishing the Institute of Electrical and Electronics Engineers tests with those of other consumer electronics organizations, as the latter have almost identical standards).

¹⁰¹ See MIKOLAJCZAK ET AL., *supra* note 45, at 36-42 (realizing that the three major administrations actually share seven tests in common).

¹⁰² See MIKOLAJCZAK ET AL., *supra* note 45, at 36-42 (comparing the remaining tests not shared by all three administrations discussed, and recognizing that these remaining tests are still shared by one other organization).

¹⁰³ See MIKOLAJCZAK ET AL., *supra* note 45, at 36-42 (inferring that identical requirements shared by three different organizations is frivolous and unnecessary).

¹⁰⁴ See MIKOLAJCZAK ET AL., *supra* note 45, at 36-42 (concluding that the Underwriters Laboratories’ 1642 Standards include all the necessary tests found in the other applicable organizations’ standards).

¹⁰⁵ See MIKOLAJCZAK ET AL., *supra* note 45, at 36-42 (recalling the only other test not found in the 1642 Standards is the Institute of Electrical and Electronics Engineers’ 1725 Pack Drop Test).

all domestic and international OEMs, and their respective countries.¹⁰⁶ In the event of noncompliance, companies would have to face the steep consequence of a total prohibition from placing their manufactured products into the stream of commerce of complying countries.¹⁰⁷

C. Assigning Liability

“Failures that occur in the field are seldom related to cell design; rather, they are predominantly the result of manufacturing defects.”¹⁰⁸ The fact that many of these battery malfunctions derive from the manufacturing process becomes incredibly important when assigning liability because the doctrine of strict liability asserts that “a *manufacturer* incurs an absolute liability when an article that he has placed on the market . . . proves to have a defect that causes injury.”¹⁰⁹ Relevant case law has steered in the direction of abandoning the requirement for privity in the presence of negligence, as a duty for manufacturers is created by virtue of a consumer purchasing their product.¹¹⁰ However, important to the liability discussion is the notion that liability need not always be accompanied by negligence for a product liability action to succeed, as “the manufacturer’s negligence should no longer be singled out as the basis of a plaintiff’s right to recover.”¹¹¹ Ultimately, it was decided that liability should be strictly administered, and need not depend on a contractual relationship at all.¹¹²

¹⁰⁶ See MIKOLAJCZAK ET AL., *supra* note 45, at 42-44 (explaining that the transport of batteries for electric and hybrid vehicles is not yet regulated, but the international community is working to create applicable standards and rules).

¹⁰⁷ See MIKOLAJCZAK ET AL., *supra* note 45, at 37 (reiterating that the compliance rules are mandatory for distributors). Cell phone distributors, along with distributors of other common consumer electronic devices, must comply with these rules internationally. *Id.*

¹⁰⁸ See Long, *supra* note 17 (emphasizing that the foremost reason for battery failures are, in fact, manufacturing defects).

¹⁰⁹ See *Escola*, 24 Cal.2d at 461 (emphasis added) (highlighting the fact that it is ultimately the manufacturer which assumes liability).

¹¹⁰ See *Thomas*, 6 N.Y. at 402 (establishing that there is no need for privity when a product is purchased and later causes injury).

¹¹¹ See *Escola*, 24 Cal.2d at 461 (recognizing “liability without negligence” with the emergence of strict liability in the product liability context).

¹¹² See *MacPherson*, 217 N.Y. at 397-98 (recognizing a doctrinal shift in abandoning requisites for privity and negligence in product liability lawsuits).

With case law already being well developed in the realm of product liability law, and because we are dealing with a hazardous material,¹¹³ liability should attach to manufacturers of li-ion batteries as “the presence of a known danger . . . makes vigilance a duty.”¹¹⁴ Going further, in the absence of negligence, strict liability will control in this area as liability attaches to a li-ion battery manufacturer simply by “knowing that it is to be used without inspection for defects.”¹¹⁵ The public policy rationale behind such a rule is more or less that the manufacturer of a good is better positioned to absorb monetary backlash resulting from a malfunctioning product than the average consumer is.¹¹⁶ The hitch in this rule is that strict liability only attaches when the consumer’s injury results from the product defect, while the consumer was using the product as the manufacturer intended.¹¹⁷

Applying this rule to the instant situation, a court is likely to find that simple overcharging, a cause of the most severe thermal runaway reaction,¹¹⁸ is likely considered within the scope of the manufacturer’s intended use,¹¹⁹ and would therefore suggest that liability should fall strictly on the manufacturer when the li-ion battery overheats, ignites, and causes personal injury or property damage.¹²⁰ Following the doctrine of strict liability, with all else remaining the

¹¹³ See 49 U.S.C. § 5103(a) (characterizing lithium-ion as a hazardous material).

¹¹⁴ See *MacPherson*, 217 N.Y. at 390 (creating a duty by virtue of dealing with a dangerous material).

¹¹⁵ See *Greenman*, 59 Cal.2d at 62 (articulating how manufacturers assume the risk of being held strictly liable when placing goods into the stream of commerce).

¹¹⁶ See *id.* at 63 (“insur[ing] that the costs of injuries resulting from defective products are borne by the manufacturers that put such products on the market”).

¹¹⁷ See *id.* at 64 (exploring the boundaries of strict liability).

¹¹⁸ See Long, *supra* note 17 (asserting that overcharging a li-ion battery, perhaps the most repetitious offense, can cause violent thermal runaway reactions).

¹¹⁹ See MIKOLAJCZAK ET AL., *supra* note 45, at 36-42 (inferring that an “Overcharging Test” implies that manufacturers are aware that the average consumer frequently overcharges electronic devices). “Overcharging Tests” are often performed by the three major organizations previously discussed. *Id.* This underscores the argument that overcharging should be considered part of the “intended use” of a product. *Id.*

¹²⁰ See *Greenman*, 59 Cal.2d at 62 (noting that “[a] manufacturer is strictly liable . . . when an article he places on the market, knowing that it is to be used without inspection for defects, proves to have a defect that causes injury to a human being”); *Escola*, 24 Cal.2d at 461 (recalling that “a manufacturer incurs an absolute liability when an article that he has placed on the market, knowing that it is to be used without inspection, proves to have a defect that causes injury to human beings”);

same, in similar situations involving defective li-ion batteries, courts should find in favor of the consumer and hold manufacturers strictly liable.¹²¹

V. Conclusion

In conclusion, in an attempt to remedy the issues raised herein, a few measures could and should be taken. For starters, a prudent course of action would be to develop a competent fire suppression strategy to combat fires caused by li-ion batteries that overheat and ignite. At the very least, manufacturers of electronic goods should have a duty to educate consumers on how best to deal with a li-ion battery malfunction. Next, it is pertinent that some international, administrative, regulatory body create uniform manufacturing and transportation standards for which all companies must adhere to, and dictate that a nonconforming company may not place their manufactured item into the stream of commerce of complying nations. As discussed previously, it is not necessary to reinvent the wheel with regards to safety standards, as most of the safety tests are widely accepted; the last step is simply to compile the tests into one set of standards. Finally, in the event of a battery malfunction, which causes personal injury or property damage, the product's manufacturer should be held strictly liable for paying whatever reparation is reasonable to make that end user whole, as long as his or her use was consistent with the intended purpose of the product. In sum, applying these suggestions to the growing lithium-ion debate is likely to create companies that are more socially and economically responsible and accountable, and perhaps even consumers that are more educated.

The critical concern at issue here always has been, or should be, the safety and wellness of the average, unassuming consumer. These issues with regards to the manufacturing, transportation, and eventual sale of consumer electronic products should focus on the well-being of the end user, and not the bottom line of a corporation's financial statement. All too often, these conglomerates are willing to cut corners and sacrifice product quality at the expense of consumer

FRUMER & FRIEDMAN, *supra* note 25 (referring to Judge Traynor's opinions in both *Greenman* and *Escola* regarding strict liability).

¹²¹ See, e.g., *Greenman*, 59 Cal.2d at 62 (discussing strict liability in general); *Escola*, 24 Cal.2d at 461 (addressing the rationale of imputing strict liability upon manufacturers).

safety. With that being said, lithium-ion batteries are just one example in a long line of irresponsible and outright shameful corporate governance. If menial monetary penalties are not enough to incentivize change, then perhaps imposing an absolute ban on the sale of products manufactured outside of required, administrative guidelines would make a large enough dent in a company's financials to *really* induce change.