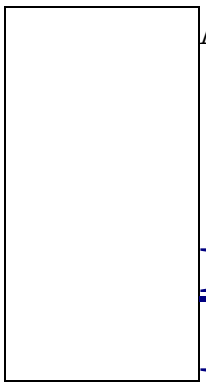
Blame Lithium Batteries for Samsung Note 7 Fires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Chris Wiltz, Managing Editor, Design News

The major recall of Samsung Galaxy Note 7 phones could also be a wakeup call for manufacturers and consumers about lithium-ion (Li-ion) batteries.

"My brand new Note 7 exploded this morning while I was still asleep, it was plugged in and charging." So begins a Reddit post from a user in Australia, detailing how a Samsung Galaxy Note 7 caught fire in a hotel room -- causing $1,800 in damage.

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An image of a damaged Samsung Galaxy Note 7 shows that the overheating began at the center of the Li-ion battery.

(Source: Reddit user -- Crushader)

The Reddit post, made in September, was the first noted case in Australia but it would be far from the last in the world. According to the US Consumer Product Safety Commission, beginning in mid-September Samsung received 96 reports of Note 7 phones overheating, of those 13 resulted in burn injuries and 47 in some type of property damage.

On Sept. 15, Samsung initiated a recall of the Note 7, offering to replace units for customers. But in early October the Note 7 made its biggest headlines when a replacement model phone started emitting smoke on a Southwest Airlines flight from Louisville to Baltimore. Airlines subsequently banned the Note 7 from flights and Samsung would go on to recall all of its Note 7 models, including the replacements -- a total of 1.9 million phones, according to the US Consumer Product Safety Commission.

Initially Samsung stayed quiet on what was causing the phones to overheat, but after dozens of pictures of burnt out Note 7s were posted online, Internet sleuths were able to figure out the problem. Noting where the burn marks appear, a technology reviewer on YouTube who goes by the name JerryRigEverything deduced that the failure was happening with the phone's lithium-ion battery itself and not with the charging port or any part of the motherboard, which were also potential points of failure.

South Korea-based Samsung has since acknowledged that the problem is with the battery but hasn't gone deep into specifics. However, Bloomberg obtained documents from Korea's Agency for Technology and Standards saying the overheating was being caused by a lack of insulation between the battery's positive and negative electrodes, which created a short. Chris Robinson, research analyst at Lux Research, told *Design News* that battery shorts like this are common, but there could be more to these Samsung incidents. "A battery short is a common mode of failure, which results when electrical contact is made between the positive and negative electrodes. This oftentimes is caused by a manufacturing defect, such as a contaminant getting into the manufacturing process, but in this case there may be more to the Samsung story," Robinson said via email. "The replacement batteries started catching fire, which could indicate a larger problem with the design of the handset."

Of course, the Note 7 is only the latest in what has been a series of recent lithium-ion-related issues in consumer products. Back in 2012 the Fisker Karma was recalled because of battery overheating issues. In 2013 a Tesla Model S caught fire, revealing a design flaw in which the vehicle's battery pack wasn't properly shielded against road debris that could potentially puncture it. And just last Christmas the hottest item on the shelves -- the hoverboard -- had its hype train derailed when reports started surfacing of shoddy knockoff products with defective lithium-ion batteries catching fire.

It really brings to question why we rely on such a potentially volatile solution for our battery needs. But Robinson said that issues with lithium-ion batteries do not happen at random. "These incidents are problems given how much we use electronic devices and the severity of the fires, but Li-ion batteries can be made safe. However, with Li-ion battery fires there is almost always a reason why they catch fire -- it's not just a random event," he said. "Considering the hoverboard fires, they were caused by mostly Chinese Li-ion manufacturers with poor quality control and no established track record of making volumes of batteries, who hoverboard manufacturers turned to as Li-ion demand increased ahead of rushing these products to market ahead of the holiday season. Fisker battery fires were caused by coolant leaks which led to batteries overheating, and several Tesla fires were related to external damaging of the battery from debris or a crash."

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"The key component which prevents shorting, a major failure mode of batteries, is the separator," Robinson said. "Many use a polymer separator, but ceramics have been of some interest to the industry for improved safety and durability. However, these add weight and cost to the battery, which is why most companies forego their use." He suggested that, moving forward, these types of separators may become more attractive to companies looking

to increase product safety. Next-generation chemistries, things like solid-state batteries, could also be an option. "This also could allow for improved energy density," Robinson said. "But these batteries are not manufactured at the large scale required to supply cell phones, and also add significant costs.

Right now, despite any risks, Li-ion batteries are still the best choice for consumer products and electric vehicles since they offer the best balance of energy and power density and lifecycle. "Previous chemistries, primarily NiMH batteries, could only offer about half of the performance relative to size and weight that Li-ion batteries can provide." Robinson said.

However, as consumers demand products that are not only higher performing but also increasingly light and thin, we may be putting a greater burden on OEMs as far as ensuring product safety. Cramming a battery into a smaller and smaller space while still demanding more power and performance also opens the door for the sort of incidents seen with the Note 7. The Note 7, for example, is Samsung's lightest and thinnest Note model yet (by a small margin), but also has more sensors, a better camera, and more hard drive storage space.

"As manufacturers push for lighter and thinner phones that does make both the battery and system design more difficult," Robinson said. "Batteries must be kept fairly cool to prevent thermal runaway, which leads to fires, and increasingly small space make this difficult. Furthermore, on the cell level, manufacturers try to use the thinnest and cheapest separators as possible, since they add weight, volume, and price to the cell."

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