# Why hoverboards explode

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Northeastern research professor K.M. Abraham goes inside the self-balancing scooters to reveal the science behind their combustion. Credit: YouTube/BuleBritish

On Thursday, the U.S. Consumer Product Safety Commission addressed a letter to "manufacturers, importers, and retailers of self-balancing scooters," or hoverboards. The agency warned that hoverboards that

didn't meet the new safety standards set by the independent safety-science group UL could be detained, seized, or recalled by the CPSC Office of Compliance and Field Operations.

What led to the letter? Reports to the CPSC from people in 24 states of 52 hoverboard fires resulting in more than $2 million in property damage over an 11-week period.

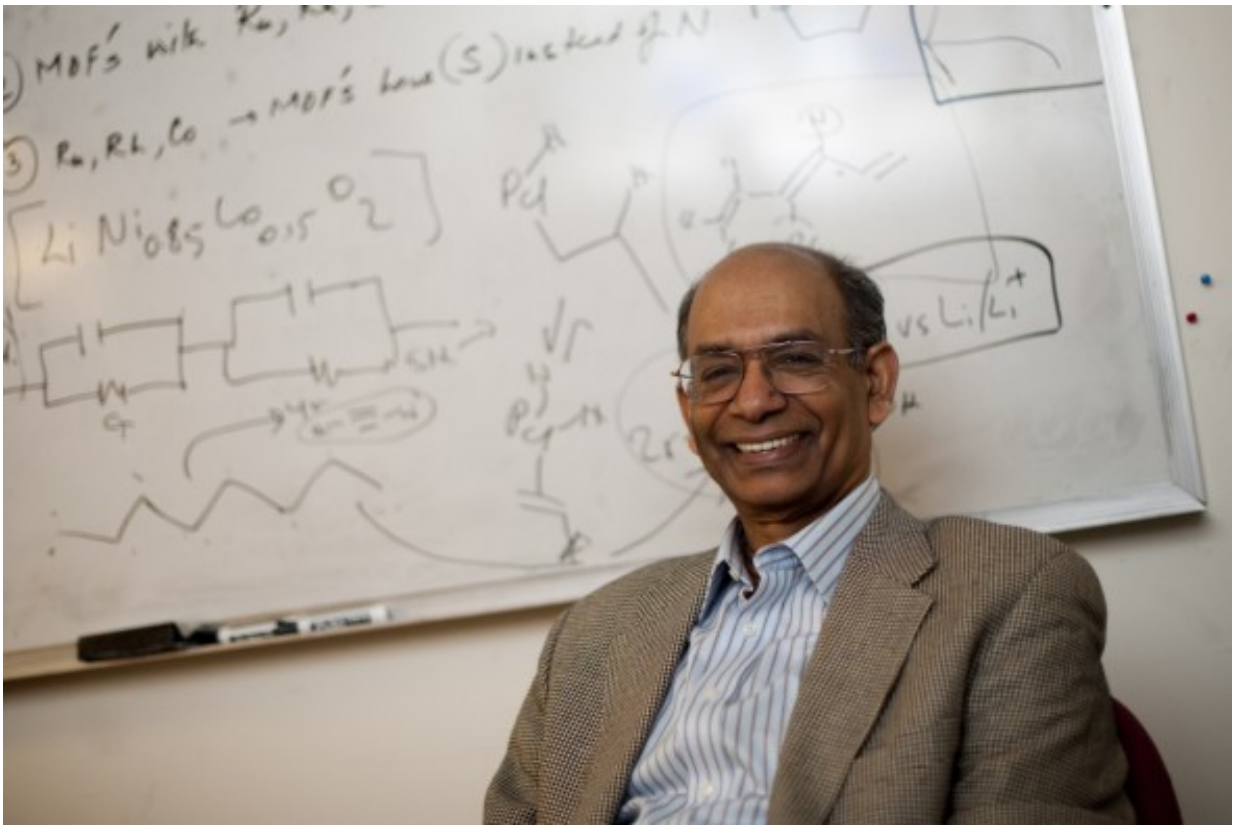
In January, Northeastern banned using or charging the popular "levitation" devices inside residence halls or other university-owned buildings, citing safety concerns.

K.M. Abraham, research professor at Northeastern's Center for Renewable Energy Technologies, penned a technical commentary for the Electrochemical Society on why hoverboards are exploding and what role the lithium-ion batteries powering them play in their combustion.

We asked him to take us under the hood, so to speak, to break down the science to help users stay safe.

## Haste makes waste

Lithium-ion, or Li-Ion, batteries serve as the power source for everything from smartphones and laptops to electric cars such as the Tesla Model S and the Chevrolet Volt. They are rechargeable and have four to six times the energy of your standard nickel-cadmium batteries. Yet you don't hear stories about iPhones or Macs, Teslas or Volts, self-immolating in record numbers.



K.M. Abraham, research professor at Northeastern's Center for Renewable Energy Technologies

That's because the Li-Ion batteries in those technologies are made by "experienced and highly reliable manufacturers," says Abraham, who is also the principal of E-KEM Sciences, a battery-consulting company in Needham, Massachusetts. They know how to construct them in a way that balances the amount of power produced with the amount of power consumed by the device during its operation.

"When that balance is compromised, the battery can heat up '" he says, "leading to a thermal runaway reaction and the uncontrolled release of large stores of energy." Translation: an explosion. The race to feed the hoverboard fad brought in scores of less-than-expert battery suppliers

using perhaps defective materials or improper engineering of parts.

## The parts determine the whole

What happens when battery engineering runs amok?

A Li-Ion battery has three primary parts: Two "electrodes"—an "anode" made of graphite and a "cathode" made of lithium cobalt oxide or a similar metal oxide —and a very thin, but porous, polyethylene "separator" that keeps the two apart.

The electric current flows between the anode and the cathode via a liquid, called the "electrolyte." If the anode and cathode are not engineered correctly for the power draw or the separator is imperfect—say, it's been punctured by mechanical impact or even impurities—a short circuit can result. When that happens, the electrolyte heats up, the cathode and anode become unstable, and the two react violently with the electrolyte. The temperature may reach the boiling point, says Abraham, "causing the battery to eject its hot internal contents, which catch fire or explode when they come in contact with oxygen in the atmosphere."

Hoverboards pose additional risks, given the operation and construction of the machines themselves: They draw energy from batteries much faster than, for example, cellphones and laptops do, which strains the electrodes and ratchets up the internal heat. They also bang into things or, as Abraham gently puts it, "are subject to more mechanical as well as electrical abuse."

So, is there a way to avoid danger, other than hanging up your hoverboard? Abraham suggests the following: "Make sure that the batteries are reliably made with good materials as well as proper engineering and tested for use in a hoverboard specifically." To test your

device, he recommends investigating the consumer-technology battery-testing division of UL itself.

Provided by Northeastern University