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EDITORIAL

On the thermal safety of battery materials for electric vehicles

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Over 170 countries have agreed to The Paris Agreement, which involves reducing carbon emissions and setting carbon peak and neutrality targets to combat climate change. The transportation sector is a significant contributor to global greenhouse gas emissions, accounting for nearly a quarter of all emissions globally[1]. By transitioning to electric vehicles (EVs), these emissions can be significantly reduced, especially as the electricity grid continues to become cleaner through the use of renewable energy sources like wind and solar. Many countries around the world have set goals to transition to electric vehicles in the coming years, and the use of lithium-ion batteries (LIBs) is a critical component of this transition. When it comes to the implementation of LIBs in EVs, safety is a crucial concern[2].

Although it is understood that LIBs are generally safe, there have been isolated incidents of fires and explosions in EVs, often due to mechanical, electrical, or thermal abuse[3,4]. One of the primary causes of battery fires in EVs is a thermal runaway, which is a self-perpetuating reaction that can occur when the battery's temperature rises too high, causing a chemical reaction that generates even more heat. This can lead to a rapid increase in temperature and pressure, which can ultimately result in a fire or explosion. Furthermore, battery explosions in EVs can release a colorless, highly reactive, and toxic fluoride gas that can cause serious health effects when inhaled. Battery explosions can also release other hazardous materials, including heavy metals and corrosive chemicals, which can pose a risk to humans and the environment[5].

Efforts have been made at multiple levels to improve the safety of LIBs. However, it is worth noting that the pace of thermal safety development has not kept up with the pace of energy density improvement[6]. In light of the above situation, from the perspective of battery materials development, there are several aspects that need to be concerned. Safety is a must and not all people want 600 km-range EVs on a single charge[7]. It is more urgent to develop safe anode, cathode, electrolyte, and separator materials than to improve their energy density performance. Firstly, as for anode, LIBs typically use graphite. There are several materials being researched as potential alternatives for graphite with improved safety, such as titanium- and silicon-based anodes. In addition, it is also worth mentioning that controlling the formation of solid electrolyte interphase on the anode's surface has been shown to be an efficient way to prevent the thermal failure of batteries[8]. Secondly, tailoring elemental composition and distribution as well as microstructure to develop safe cathode materials is crucial. There was a significant breakthrough to improve safety by using concentration-gradient cathode materials[9]. Thirdly, it is crucial to develop a more efficient electrolyte system with a non-flammable electrolyte and minimal amount of fluorine in order to advance the sustainable development of LIBs[10,11]. The development of separator materials possessing high thermal stability and mechanical strength is of utmost importance in advancing the performance and safety of batteries. In addition, the integration of intelligent separators, such as dendrite-detecting and thermal shutdown separators, is a critical area of research in the pursuit of enhanced battery safety and performance[12]. With proper materials selection in conjunction with good engineering of the battery management system, modules, and packs technologies, more safe LIBs can be realized. In addition, battery safety standards and assessments should also be regularly updated and strongly encouraged by the governments for small, medium, as well as big battery manufacturers.

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Conflict of interest

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