Recent Progress on High Energy Density Lithium Batteries Developed by CAS Battery Research Teams

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Increasing energy density of lithium battery will extend the driving range of electric vehicles dramatically and decrease the cost significantly. A "Strategic Priority Research Program" of the Chinese Academy of Sciences was initiated at the November 15, 2013. In this 5-year program, the 3rd generation lithium-ion battery of, solid-state metallic lithium battery, lithium-sulphur battery and lithium-air battery have been developed by 12 CAS teams. Challenging the limitation of the energy density is one of the targets of this program. At the end of 2015, the mass and volume energy density of a 24 Ah Li-ion pouch cell, with nano-silicon carbon composite material as negative electrode and lithium-rich material as positive electrode is achieved as 374 $Wh•kg^{-1}$ and 577 $Wh•L^{-1}$, respectively. The energy density of a 8 Ah Li/PE/NCM pouch cell using the polymer solid electrolyte is 240 $Wh•kg^{-1}$ at 60 ^{o}C, while the energy density of a solid-state lithium pouch cell based on the inorganic ceramic solid electrolyte is 240 $Wh•kg^{-1}$ at room temperature. The energy density of a 37 Ah lithium-sulphur pouch cell reaches 566 $Wh•kg^{-1}$ at room temperature and 616 $Wh•kg^{-1}$ at 50 ^{o}C. The energy density of a 5 Ah lithium-air battery is 526 $Wh•kg^{-1}$ at room temperature. Successful application of the developed materials and batteries in EVs is the final target of this program. Currently, volumetric energy density, rate performance and cyclic life cannot satisfy the application requirement. Therefore, further optimizations and creative solutions are needed to solve all technological barriers. Detailed progresses and challenges in developing 4 types of high energy density lithium batteries towards practical applications for EV and grid will be reported in this meeting.