SOLID-STATE LITHIUM-SULFUR BATTERIES BASED ON NANO - CONFINED $LiBH_4$

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The development of cost-effective electricity storage technologies is crucial for market penetration of electrical vehicle and integration of renewable, energy sources into the grid system. For state-of-the-art lithium-ion batteries, limited improvement in capacity and cost are expected because of the use of liquid or gel electrolytes, limiting the choice of electrode materials and exposing to safety concerns.
A solution of choice would be to replace the liquid electrolytes by solid-state electrolyte. However to find a good material with the adequate properties is a challenging task.
During the last years, $LiBH_4$ has been proposed as a solid-state electrolyte. It shows a high ionic conductivity, but only at elevated temperatures. Since then a range of other complex metal hydrides has been reported to show similar characteristics.[1] We recently found that if $LiBH_4$ is confined in a mesoporous SiO_2 scaffold, the lithium conductivity is multiplied by 1000![2] The solid electrolytes based on $LiBH_4$ and SiO_2 scaffolds are purely cationic (Li^+) conductors with no electronic conductivity and their transference number for Li^+ are very close to 1. They are stable in contact with lithium metal. Their thermal and electrochemical stabilities are proved for an extended range of temperatures (at least up to 140°C) and voltages (at least up to 6 V) which makes them compatible with most high voltage cathodes.
We have characterized solid-state lithium-sulfur batteries based on these solid electrolytes. The batteries show very good performances, delivering high capacities versus sulfur mass, typically 1220 $mAhg^{-1}$ after 40 cycles at moderate temperature (55 °C), 0.03 C rates and working voltage of 2 V. To date, this is the first report of batteries based on complex hydrides solid electrolyte, achieving such high capacities at moderate temperature.[4]

References

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