Advanced photonic processes for low-cost and safe perovskite-based energy storage devices

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Metal halide perovskites have been recently proposed as promising anode materials for energy storage applications.[1,2] Despite their quite important electrochemical characteristics, all perovskite-based anodes are synthesized at high temperatures (90–150 °C) and with reaction durations of the order of tens of hours. In this work, we present perovskite materials synthesized with room temperature, simple and fast approaches for high-performance and stable electrodes for Li-air batteries. Hexagonally shaped nanocrystals capped with ligands[3] and ligand- free microcubes[4] synthesized with re-precipitation based protocols will be compared according to their storage capacity and stability.

Specifically, it is shown that the electrodes incorporating the ligand-free microcubes present outstanding stability at the same time with high specific capacity compared to the ligand-capped nanoparticulate system. These could be attributed to the high crystal quality of the materials and thus enhanced electrical conductivity, even under operation with an aqueous electrolyte. The large interfacial area between the perovskite material and the electrolyte along with the increase of the active sites on the exposed microcubes facets favor the Li ion intercalation. In addition, the absence of capping ligands contributes further to the enlargement of contact area and facilitates the ion penetration compared to ligand capped nanocrystals. The good crystallinity of the microcubes enhances the Li-ion intercalation and the electron transportation. The microcubes performance is the best among all the anodes utilizing metal halide perovskite nanostructures, reported to date.

We also discuss the photo-induced processes used for the coverage of the perovskite storage material in order to increase the stability of the anodes or that used for conjugation of perovskite nanocrystals with 2D materials in order to obtain anodes for Zn-air batteries. [5] The role of the shape and size of the metal halide perovskites, but also the conjugation with the 2D materials in the performance and the stability of the anodes will be discussed. The photo-induced deposition of the TiO_2 layer found that was crucial for the stability of the anodes in all the tested anodes

References

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