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Repairing and Upcycling of Electrode Materials from Spent Lithium Ion Batteries

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With the rapid development of electric vehicles, electronic devices, and the energy storage industry, the production and disposal volumes of lithium-ion batteries are increasing daily. Lithium batteries contain substantial metal resources, and improper disposal not only wastes resources but also poses potential environmental risks. Consequently, lithium-ion battery recycling has increasingly become a focal issue of concern across society. Current battery recycling methods primarily rely on pyrometallurgical and hydrometallurgical processes. Both approaches involve destroying material structures to extract valuable elements, resulting in lengthy, costly procedures that require extreme conditions like high temperatures and strong acids. Economic and environmental benefits remain limited and require improvement. Developing clean, efficient battery material recycling methods that enhance the value of regenerated products represents a major challenge in battery recycling. Addressing these issues, the reporter proposes a direct regeneration strategy based on the structural characteristics of degraded materials, encompassing three key aspects: First, designing composition supplementation methods to drive phase reconstruction, repairing structures, and restoring material performance. Building on this, leveraging the intrinsic structural features of degraded materials to introduce modification techniques during repair, thereby enhancing the performance of regenerated materials. Finally, through target-guided composition control, the composition and structure of degraded materials are reorganized for use as next-generation energy catalytic materials, further elevating product value. Currently, the direct regeneration method designed by the reporter has undergone feasibility verification at the pilot scale, offering a promising new technological framework and theoretical guidance for battery recycling research and industry.

References

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