Functional material-oriented metallurgy enabled by spray pyrolysis toward advanced nanostructures for energy storage and conversion

With the support by the National Natural Science Foundation of China, the research group led by Prof. Li XinHai (李新海) and Associate Prof. Wang JieXi from the School of Metallurgy and Environment, Central South University conducted foundational research on functional material-oriented metallurgy and made a series of important progress in recent years. Based on the previous research foundation, this group recently demonstrated spray pyrolysis enabled functional material-oriented metallurgy toward advanced nanostructures for energy storage and conversion, which was published in *Chemical Society Reviews* (2019, 48: 3015—3072).

Advanced energy storage and conversion devices (such as secondary batteries, supercapacitors, fuel cells, and solar cells) are the great white hope to alleviate the current energy shortage and environmental pollution. However, most common methods for preparing energy storage materials (such as hydrothermal, templating, and vapor deposition) usually need rigorous synthesis conditions, tedious operational procedures, and lengthy reaction times, so that they are of limited use for practical mass production. Spray Pyrolysis (SP) is a simple, efficient method to synthesize powder materials and thin films from solution via a one-pot continuous process. During the SP process, each droplet can act as an individual microreactor, which undergoes a series of physical and chemical reactions, including solvent evaporation, precipitation, drying, and decomposition. SP technology has been widely demonstrated for the large-scale synthesis of various nanostructures by modifying the solution composition and controlling the process parameters. In this work, the research group led by Prof. Li and Wang from the Central South University comprehensively introduced the equipment and working principle of the SP technique, and thoroughly described the guidelines and strategies for designing nanostructures with controlled morphology and composition. In addition, they further demonstrated their suitability for a wide range of energy storage and conversion applications such as rechargeable batteries, supercapacitors, highly active catalysts, and for solar cells. Finally, they emphasized and discussed potential advantages and challenges of SP, and highlighted several perspectives on future research and development directions of SP. This paper has great guiding significance for both foundational research and industrial application of the preparation of functional materials.

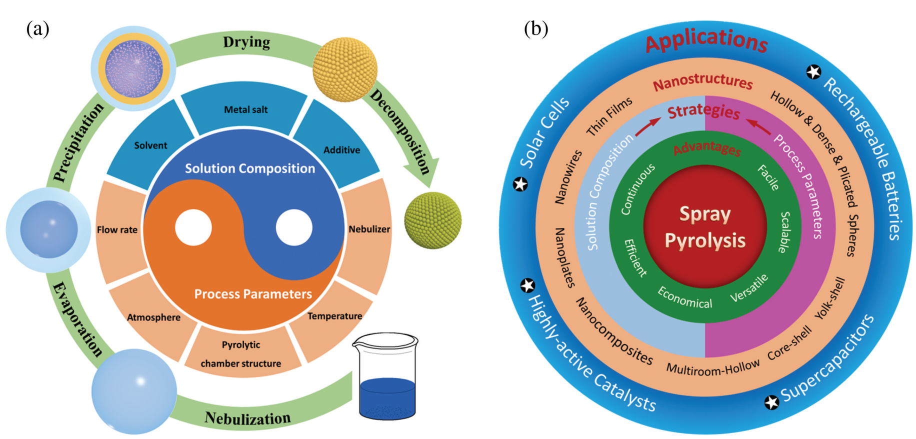

Figure (a) Schematic illustration of typical apparatus for the spray pyrolysis and (b) overview of the topic covered in this paper.