Comprehensive Stability Improvement of Core-shell Structured Li_4TiO_4-Li_2TiO_3 Tritium Breeding Ceramic Pebbles by Pvp-Assisted Granulation

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Abstract

This work designed a novel approach with PVP acting as a bridging agent when fabricating Li_4TiO_4-Li_2TiO_3 core-shell pebbles by granulation technology. The phase compositions, morphology and microstructure of Li_4TiO_4-Li_2TiO_3 core-shell pebble were investigated. Moreover, the water vapor release behavior and weight reduction of Li_4TiO_4-Li_2TiO_3 core-shell pebble at elevated temperatures under hydrogen atmosphere were also investigated.

Keywords: tritium breeding materials, core-shell structure

1. Introduction

Li_4TiO_4 is thermodynamically stable at temperatures up to at least 950 °C and has a lithium density of 0.51 g/cm^3, which tend to be a promising breeder material. However, the high sensitivity of Li_4TiO_4 to CO_2 makes it not a stable breeder material. In order to take advantage of the high lithium density of Li_4TiO_4 and suppress its instability at the same time, the ideal solution is to cover a layer of Li_2TiO_3 ceramic on the Li_4TiO_4 pebbles.

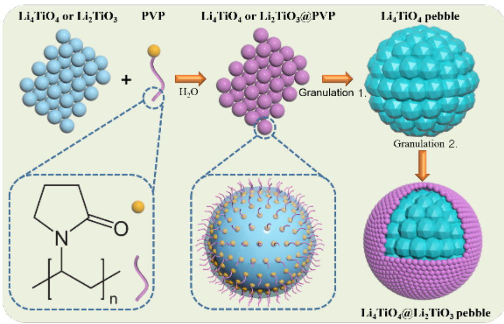

Fig. 1 Schematic diagram of PVP assisted synthesis of Li_4TiO_4-Li_2TiO_3 core-shell pebble.

2. Experimental Section

Fig. 1 illustrates the schematic diagram of PVP assisted synthesis of Li_4TiO_4-Li_2TiO_3 core-shell green pebbles. First, Solid-state reaction method was used to synthesize Li_4TiO_4 and Li_2TiO_3 powders. After that, Li_4TiO_4 and Li_2TiO_3 powders were separately added to the PVP solution in order to cover a layer of PVP on the surface of powder, which was marked as Li_4TiO_4@PVP and L_2TiO_3@PVP powder respectively. Finally, the as-prepared powder through granulation and sintered at 900 ℃ to obtain Li_4TiO_4-Li_2TiO_3 core shell pebbles.

3. Result and discussion

Fig. 2 shows the typical SEM images of Li_4TiO_4-Li_2TiO_3 core-shell ceramic pebble sintered at 900 °C for 4 h. It can be seen that the core-shell pebble has satisfactory sphericity, and no obvious cracks and pores are found. The cross-section morphology reveals that the core-shell pebble is composed of Li_4TiO_4 core with a diameter of ~700 μm and Li_2TiO_3 shell with a thickness of ~350 μm.

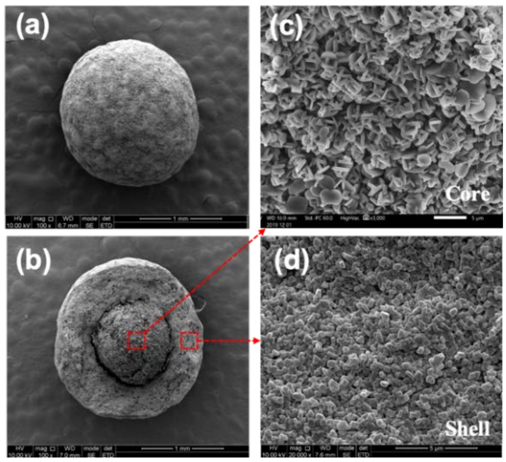

Fig. 2 SEM images of Li_4TiO_4-Li_2TiO_3 core-shell pebble a sintered at 900 °C for 4 h.

In order to verify the barrier properties of the core-shell ceramic pebble to CO_2, the sample is heated in 100 vol.% CO_2 atmospheres from room temperature to 900 °C, and the results are shown in Fig. 3. Li_4TiO_4 pebble begin to absorb CO_2 at room temperature, and the CO_2 absorption increases drastically at 350 °C, reaching the maximum value around 750 °C. In addition, it can be found that the curve begins to decline after the temperature is higher than 800 °C, indicating that the CO_2 desorption process has begun. On the other hand, Li_4TiO_4-Li_2TiO_3 core-shell ceramic pebble apparently did not absorb CO_2, which can be explained by its high thermal stability and dense structure.

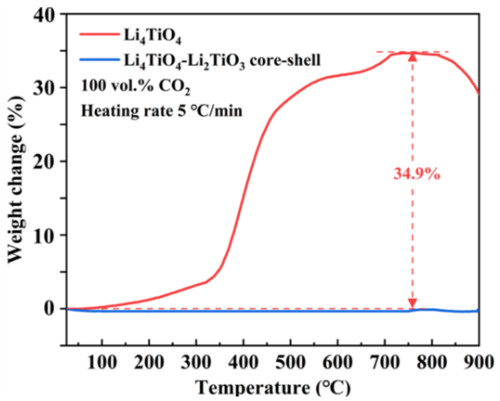

Fig. 3 Temperature dependences of weight change of the pebbles.

References

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