Water vapor release behavior and mass loss of Li_4TiO_4-Li_2TiO_3 core-shell breeding ceramic pebbles with enhanced stability

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Abstract
Li_4TiO_4-Li_2TiO_3 core-shell pebble with enhanced stability was prepared by a granulation method with PVP assistance. The water vapor release behavior of this core-shell pebble compared with pure phase Li_4TiO_4 pebble was studied. The results show that Li_4TiO_4 has a strong ability to generate water in H_2/Ar. The mass loss of this core-shell pebble at 900 °C for 30 days was estimated to be 4.8% of initial sample weight.

Key words: breeding ceramic, Li_4TiO_4-Li_2TiO_3, water vapor, mass loss

1. Introduction

The instability of Li_4TiO_4 to carbon dioxide (CO_2) and moisture (H_2O) was considered to be the main obstacle to its practical application as a tritium breeding material. Using Li_2TiO_3 ceramic coating as a physical barrier wrapped on the surface of Li_4TiO_4 pebbles was still considered to be the optimal solution. In addition, studying the water vapor release behavior and Li mass loss of this material was of great significance for the evaluation of tritium breeding materials

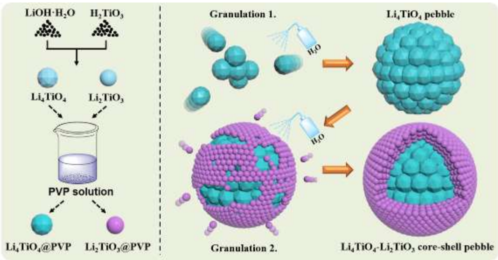

Fig. 1 Schematic diagram of PVP assisted synthesis of Li_4TiO_4-Li_2TiO_3 core-shell pebble.

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°C to obtain Li_4TiO_4-Li_2TiO_3 core shell pebbles. The water vapor release behavior and Li mass loss of 0.3g core-shell samples were tested on the experimental platform of Katayama laboratory of Kyushu University [1].

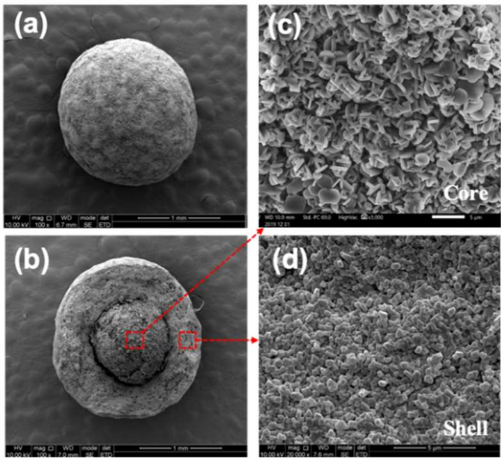

Fig. 2 SEM images of Li_4TiO_4-Li_2TiO_3 core-shell pebble a sintered at 900 °C for 4 h.

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.

The results of the water vapor release behavior experiment show that the concentration of water vapor generated by Li_4TiO_4 pure phase pebbles (1847 ppm) is much higher than that of Li_4TiO_4- Li_2TiO_3 core-shell pebbles (688 ppm), indicating that Li_4TiO_4 has a high surface oxygen activation site concentration. Moreover, the experiment results of heating for 30 days in H_2/Ar atmosphere at 900 °C show that the mass loss rate of Li is faster in the first 10 days, and then the loss rate gradually slows down and the mass loss reaches 4.8 % at 30 days.

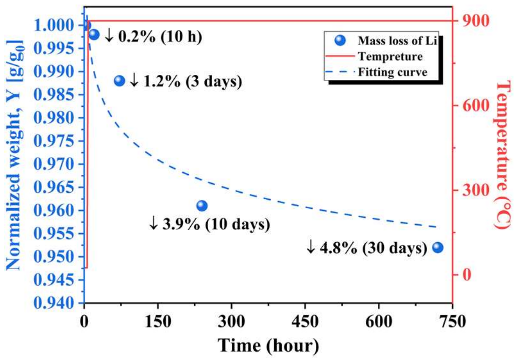

Fig. 3 Normalized weight change with heating time

References [1] Katayama K, et al. Fusion Engineering & Design, 2012, 87(5-6):927-931.