Synthesis and characterization of lithium silicates powders

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Lithium-based ceramics, such as Li2O, LiAlO2, Li4SiO4, Li2SiO3, Li2TiO3 and Li2ZrO3, have long been recognized as promising tritium breeding-materials for D-T fusion reactor blankets. Among these candidate materials, lithium orthosilicate (Li4SiO4) and lithium metasilicate (Li2SiO3) are recommended by many ITER research teams as the first selection for the solid tritium breeder. Li4SiO4 has even been selected as the breeder material for the helium-cooled solid breeder test blanket module (HCSB TBM) in China and EU. In present study, the processes of solid-state reaction between amorphous silica and Li2CO3 powders was studied by thermogravimetry analysis–differential scanning calorimetry (TGA/DSC); the lithium silicate powders were synthesized at 700, 800 and 900 ºC with Li:Si molar ratios of 0.5, 1, 2 and 4, respectively, using solid-state reaction method. The as-prepared lithium silicates were characterized by X-ray diffractometry (XRD) and scanning electron microscopy (SEM). The results show that the phase composition and morphology of the as-prepared samples change with the different synthesis conditions. At low temperature of 700 ºC, all samples contain the amorphous silica, and the major crystalline phase is Li2SiO3 with different microstructure for Li/Si ratio of 0.5, 1 and 2. As for Li/Si = 4, 98% purity of Li4SiO4 can be obtained at 700 ºC. At high temperature of 900 ºC, the significant sinterization effect will occur in all samples and Li4SiO4 will even decompose. The results also show that pure Li4SiO4 can be synthesized by calcining at 800 ºC for 4 h, and its’ solid-state reaction synthesis may be divided into two steps:

1. 515–565 ºC: Li2CO3 + SiO2 → Li2SiO3 + CO2;
2. 565–754 ºC: Li2CO3 + SiO2 → Li2SiO3 + CO2 and then Li2SiO3 + Li2CO3 → Li4SiO4 + CO2.

While Li/Si = 2, 99% purity of and pure Li2SiO3 can be obtained at 800 and 900 ºC, respectively.

Keywords: Test blanket module; Tritium breeder; Lithium silicates; Solid-state reaction; X-ray diffractometer; Scanning electron microscope