3-8 Material Allowing Stable Fuel Supply to Fusion Reactor

－Development of Advanced Tritium Breeder Materials for Fusion Reactor－

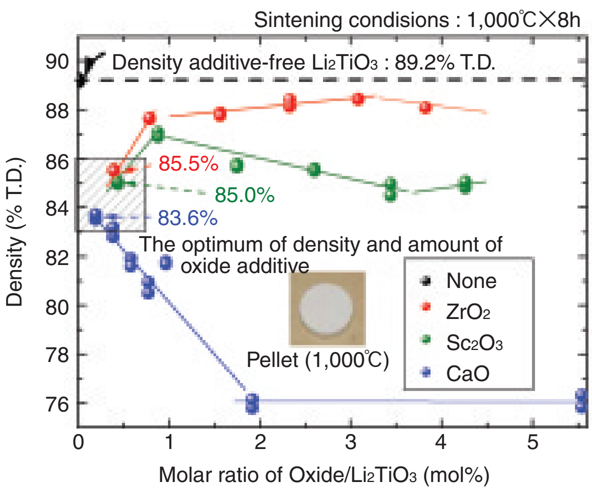

Fig.3-20 Density of Sintered Li_2TiO_3 with different amounts of oxide additives
The density of the sintered pellet was restrained by adding an oxide (ZrO_2, Sc_2O_3, and CaO) to Li_2TiO_3. The reduction of tritium release due to grain growth when Li_2TiO_3 is used for a long time at high temperatures could be prevented by adding the oxide as a grain growth control material.

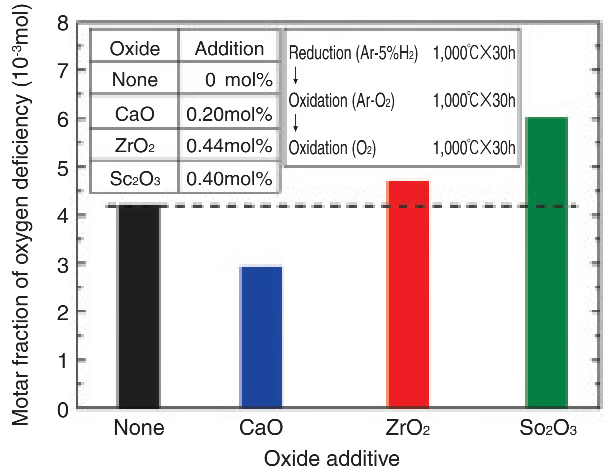

Fig.3-21 Molar fraction of oxygen deficiency of Li_2TiO_3 with oxide additives
Because tritium, the fuel of the fusion reactor, is collected by hydrogen (H_2) gas, Li_2TiO_3 is used in an H_2 atmosphere. Ti in Li_2TiO_3 was reduced in the hydrogen atmosphere, causing oxygen loss, but the oxygen loss could be lowered by adding CaO.

Tritium (T) doesn't exist in the natural world, but a fusion reactor uses deuterium (D) and T as fuel in the DT nuclear fusion reaction. Therefore, it is necessary to irradiate lithium (Li) filled to the fusion reactor blanket with neutrons, thus producing T artificially. Among materials including Li, Lithium titanate (Li_2TiO_3) has a good T release properties and so is attracting attention. On the other hand, when Li_2TiO_3 is used in an H_2 atmosphere for a long time at high temperature, crystal grains grow, and the Ti in Li_2TiO_3 is reduced. Thus, there is a problem that the amount of the T release decreases. It is necessary to develop a method of controlling Li_2TiO_3 crystal grain growth so that it is not reduced easily with the H_2 gas. This research dealt with improvement of Li_2TiO_3 by the addition of oxides.

CaO, ZrO_2, and Sc_2O_3 were investigated as the added oxide. The sample was sintered at 1,000°C, and made into pellets (Fig.3-20). The dependence of decrease in density after sintering upon addition of small amounts of oxide was obtained from the density of the sintered pellets and the amount of the oxide addition (Fig.3-20).

Next, the reduction of Li_2TiO_3 with added oxide in the H_2 atmosphere was examined by means of thermogravimetry. If Li_2TiO_3 is reduced with H_2, O loss is caused. The amount of the oxide addition was adjusted to achieve the optimum density as shown in Fig.3-20. The color of the sample changed from white into thin blue if the sample was reduced, and a weight decrease due to O loss was observed. Fig.3-21 shows the calculated O deficiency in the samples. Li_2TiO_3 with CaO added had less oxygen deficiency than the other kinds of Li_2TiO_3.

The overall results suggest that the oxide additives are able to control not only the growth of the grain size but also the amount of oxygen deficiency. Thus, the present study confirmed the efficacy of oxide addition to Li_2TiO_3 in developing high-temperature resistant breeding materials.

Reference

Hoshino, T. et al., Non-Stoichiometry of Li_2TiO_3 under Hydrogen Atmosphere Condition, Fusion Engineering and Design, vol.75-79, 2005, p.939-943.