Synthesis of High-Energy-Density Fuel over Mesoporous Aluminosilicate Catalysts

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High-energy–density fuels (HEDFs) have attracted considerable attention due to their advantages such as high volumetric energy content and good stability. Compared with refined aviation fuels, combusting equal volume of high-energy–density fuel can generate more propulsion [1,2]. Because norbornadiene dimer (NBDD) has a high molecular hydrogen/carbon ratio and is a multi-cyclic hydrocarbon, it has a compact structure with a high density level. Moreover, NBDD causes additional strain energy and has therefore received a considerable amount of attention as an ideal HEDF candidate. NBDD is prepared by dimerization using norbornadiene (NBD) as a raw material, and nearly 14 different types of isomers can be produced.

Currently, a homogeneous catalyst is being used in the NBDD manufacturing process. But in this process, the cost of a catalyst is high and the separation process is quite complicated [3-5]. If the homogeneous catalyst is replaced with the heterogeneous catalyst, in this process, recovery and reuse of a catalyst are possible and the cost of catalyst can be innovatively reduced [6].

In this study, we used mesoporous Al-KIT-6 as a heterogeneous catalyst in synthesis of NBDD from NBD. The effects of aluminum grafting over KIT-6 on the catalyst characteristics were studied with respect to the synthesis of NBDD. Physical and chemical properties of catalyst were analyzed by N_2 adsorption, temperature-programmed desorption of ammonia, and infrared spectroscopy of adsorbed pyridine.

The Al-KIT-6 prepared through Al grafting over KIT-6 was shown to have a well-arranged mesoporous structure, a large surface area, and a large pore size. Grafting of Al on KIT-6 generated Lewis acid sites with weak strength. The NBDD yield over the Al-KIT-6 catalysts was higher than that over KIT-6 during NBD dimerization (Fig. 1). It might be attributed to the higher number of acid sites in the Al-KIT-6 catalyst.

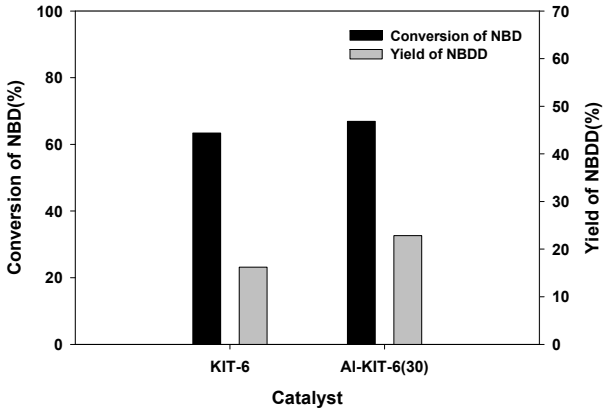

Fig.1 NBD conversion and NBDD yield over KIT-6 and Al-KIT-6 catalysts catalysts (reactant(NBD) weight = 90 g, catalyst weight = 3.85 g, temperature = 250 ℃, reaction time = 12 h).

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